ViewPoint Programmer's Manual

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1 Introduction

This *ViewPoint Programmer's Manual* is written for programmers who are developing applications to run on ViewPoint software. ViewPoint's open architecture philosophy allows applications to be developed easily.

You will find this manual useful only if you are already a Mesa programmer. You should have completed the Mesa Course and be familiar with the contents of the *XDE User's Guide* (610E00140) and the *Mesa Language Manual* (610E00170). You should also be familiar with the facilities described in the *Pilot Programmer's Manual* (610E00160) and the *Filing Programmer's Manual* contained in the *Services Programmer's Guide* (610E00180).

The *ViewPoint Programmer's Manual* provides you with the information you will need to implement the user interface of an application that runs on ViewPoint. This includes information such as how to:

- Represent applications as icons.
- Interact with the mouse and keyboard to process the user's instructions.
- Create folder-like containers.
- Create property sheets.
- Create menus.
- Paint pictures and text on the display.
- Create programmable keyboards.
- Represent and manipulate multinational text.

It does not provide you with Mesa, Pilot, or Services-specific information.

1.1 Document Structure

This introductory chapter describes the physical manual itself, how it is organized, who should read it, how it should be read, and why. Chapter 2, Overview, describes ViewPoint and discuss its history and overall design

Chapter 3, The Programmer's Guide, tells how to use the ViewPoint interfaces. It describes concepts essential to understanding ViewPoint and describes the facilities that are available. The most common interfaces are briefly discussed and grouped by application. All of the ViewPoint interfaces, with a short summary, are listed alphabetically at the end of the chapter.

The individual interface chapters are arranged alphabetically in Chapters 4 through 59. These chapters provide detailed descriptions of the interfaces that ViewPoint provides. Each interface chapter begins with an overview that explains the concepts behind the interface and the important data types that it manipulates. The second section of each chapter describes the actual items of the Mesa interface and groups them by function. The third section explains typical ways of using the interface and often contains programming examples, and the fourth section is the index of interface items. Within an interface chapter, the items of the broadest interest are presented first: more specialized items follow later.

Appendix A presents the system TIP Tables, references are in Appendix B, Appendix C contains a list of well-known Atoms, and Appendix D contains a listing of public symbols.

1.2 Getting Started

Chapters 1, 2, and 3 of the *ViewPoint Programmer's Manual* should be read in order. Within Chapter 3, you will sometimes be guided to various sections in task-relative rather than page-relative order. Chapters 4 through 59 (the interface chapters) can be read in any order, depending on your need.

2 Overview

2.1 What Is ViewPoint?

ViewPoint is a collection of facilities for writing application programs that run on a personal workstation with a high-resolution bitmap display. It supports an open-ended collection of applications, providing a framework and a set of rules that allow these independent applications to be integrated. It has an advanced user interface that also allows applications to be easily adapted for users in other countries.

Throughout this document, the term *user* describes people who interact with the applications built on ViewPoint via the mouse and keyboard. User actions are not predictable or controllable by programs. The term *client* describes programs that use the facilities described in this document The client may act as a result of some user action, but the behavior of the client is the result of a program and under control of its implementor.

2.1.1 User Abstractions

ViewPoint uses several abstractions that are part of the advanced user interface pioneered by the Star Workstation:

- *Icons and Desktop.* Icons that represent objects on a desktop are one basic abstraction. These objects can represent either functions or data. Data icons, such as a document, represent objects on which actions can be performed. Function icons, such as a printer, represent objects that perform actions. In the metaphor, they are on the desktop that also serves as the background for their display. With ViewPoint, clients may create new icons that provide additional functions within the desktop metaphor.

- *Windows.* Windows are rectangular areas on the screen that display the contents of an icon when it is opened. Each window has a header containing the name of the window's icon and a set of commands. The window also contains scroll bars that scroll the contents of the window vertically and horizontally

- *Property Sheets.* Property sheets are displayed forms that show the properties of an object. They contain several types of parameters, including state parameters, which may be on or off; choice parameters, which have a set of mutually exclusive values; and text parameters.

- *Selection.* The selection is an object or body of data identified by the user. It is the target of user actions; there can be only one selection at any one time. It can be a string of text that the user may then delete, copy, or change the properties of. It can be an icon on the desktop that is moved to a printer icon for printing or opened to display its contents. In general, it can be almost any piece of data that can be represented on the screen.

2.1.2 Client Abstractions

To implement the above user abstractions and to provide some building blocks for developing applications, ViewPoint uses several client abstractions:

- *Containee and StarDesktop.* Containee is an application registration facility that associates an application with a file type. Registering an application consists of providing procedures that paint iconic pictures and perform various operations. **StarDesktop**, using the desktop metaphor, displays the desktop window and iconic pictures for each file found in a particular directory.

- *Client Windows.* The client window abstraction is more primitive than the user window abstraction. The client window abstraction serves to isolate applications from the physical display and each other. A window can be thought of as a quarter of an infinite plane. Within that space, the client is called upon to display the contents of the window without regard to any other applications' windows. Windows may be linked to form a tree structure. A user's window is typically composed of a number of small client windows–one for the header, one for each scroll bar, and so forth.

- *Menus.* Menus are sequences of named commands, each consisting of a text name and a procedure. Menus may be displayed to the user in several forms, such as in a pop-up menu or as window shell header commands (see below).

- *Window Shells.* The user window abstraction is implemented by window shells. They provide the header, scroll bars, and body windows. The body windows are windows the client uses to display the content of an application. The commands in the header are menus.

- *Form Windows.* Form windows are the client abstraction that provides the basis for the user property sheet. Form windows allow form items in a window to be created and manipulated. There are several types of items: boolean items, choice items, text items, numeric text items, command items, form and window items. Window items allow the client to implement its own type of item. The property sheet user abstraction is implemented by putting a form window inside a window shell.

- *Container Windows.* Container windows implement a window that contains a list of items. Clients supply the source of items and the container window handles displaying the contents in a window and interacting with the user.

- *Selection.* The client selection abstraction is a framework in which a client can manifest itself as the holder of the user's current selection while other clients interrogate the selection and request that it be converted to a variety of data types. ViewPoint defines several selection conversion types, but the selection framework allows clients to define additional conversion types. The selection is the principal means by which information is transferred between different applications.

2.1.3 System Structure

ViewPoint's architecture contains a small set of public interfaces that provide the basic facilities for building workstation applications. Facilities are included in ViewPoint for several reasons. Some facilities implement system-wide features, such as the window package. If several applications tried to implement their own window packages, chaos would result. Facilities are also included in ViewPoint to provide consistent user interface, such as form windows and property sheets. A final reason for including facilities is to provide packages that are useful to many clients, such as the simple text facilities. As ViewPoint evolves, more facilities useful to a variety of clients will be added.

The ViewPoint interfaces fall into the following general categories:

Application registration:	**Containee**
Windows and display:	**Context, Display, StarWindowShell, Window**
Forms and property sheets:	**FormWindow, FormWindowMessageParse, PropertySheet**
User input and keyboards:	**BlackKeys, KeyboardKey, KeyboardWindow, LevelIVKeys, SoftKeys, TIP, TIPStar**
Strings and messages:	**XChar, XCharSets, XCharSetNNN, XComSoftMessage, XFormat, XLReal, XMessage, XString, XTime, XToken**
Selection:	**Selection**
Containers:	**ContainerCache, ContainerSource, ContainerWindow, FileContainerShell, FileContainerSource**
Text display and editing:	**SimpleTextDisplay, SimpleTextEdit, SimpleTextFont**
Miscellaneous user interface:	**Attention, Cursor, MenuData, MessageWindow, PopupMenu, StarDesktop, Undo**
Miscellaneous:	**Atom, AtomicProfile, Event, IdleControl**

2.2 History

ViewPoint is the result of past experience with Star and the Xerox Development Environment. In late 1982, the Star Performance and Architecture Project concluded that Star's monolithic system structure, in which every piece knew about every other piece, hindered its performance. The monolithic structure also made it difficult to develop new applications. In addition, there were hundreds of interfaces in the system but no distinction between public and private interfaces, making it difficult for programmers to learn how to write applications in the system.

In contrast to Star, the Xerox Development Environment had a modular system structure with a small number of well-documented public interfaces It also encouraged an open-ended collection of applications. While it performed well and was open, the Xerox Development Environment did not have as consistent a user interface as Star, nor did it support Star's multinational requirements.

As a result of this study, ViewPoint was created. It has the system structure, documented public interfaces, and openness of the Xerox Development Environment, yet supports Star's user interface and multinationality requirements.

While it was initially focused on providing a new foundation for Star, ViewPoint has become the basis for more software products from the Office Systems Division. It will evolve to replace the current foundation of the Xerox Development Environment and will likely support products from organizations outside the Office Systems Division.

2.3 Philosophy and Conventions

ViewPoint's philosophy and conventions apply both to applications that interact with the user and to packages that implement some facility. Some are just good system-building concepts. ViewPoint assumes that programs that run within it are friendly and that they are not trying to circumvent or sabotage the system. The system does not try to enforce many of these conventions but assumes that clients will adhere to them voluntarily. If these conventions are not followed, the system may degrade or break down altogether

2.3.1 Supported Public Interfaces

Systems should be designed to export public interfaces that are well documented and relatively stable. By defining a set of primitive facilities and stressing their stability, applications are encouraged to depend on the existing ViewPoint facilities rather than on other applications packages. This promotes an *open architecture* in which applications can be developed and loaded with relative ease, exchanging information among themselves while maintaining the independence of client modules. The open architecture allows designing for unknown applications as well as the class of applications expected in Star

In keeping with an open architecture, ViewPoint does not make far-reaching assumptions about the applications that run above it. While it provides facilities that make certain styles of applications easy, it does not preclude other styles of applications.

2.3.2 Plug-ins

ViewPoint is self-contained in that it does not import procedures that it expects a client to supply. Rather it waits, in effect, for clients to call it and state that they wanto to implement some facility. This is referred to as a plug-in approach: an application plugs itself in to a lower layer of software.

Plug-ins encourage modularity at the client level. Since ViewPoint can be run by itself (although it does not do much), it can also be run with just one application plugged in.

Thus each application can be implemented and debugged individually, simplifying system development.

Plug-ins also can break a dependency that would create a complex dependency graph. For example, the desktop has a dependency on the applications that appear in the desktop. If the desktop depended directly on the applications, it would have to change every time a new application was created. By having the applications plug themselves into the desktop, the direct dependency is broken.

2.3.3 Don't Preempt the User

Clients should avoid dictating what the user must do. The user should be free to interact with different applications as desired. For example, the current selection is something that the user should control. It should be changed only as a result of user actions. A background process should not change the selection out from under the user.

2.3.4 Don't Call Us, We'll Call You

Since the user is in control, a program must wait for the user to interact with it. The method of interacting with the user that is prevalent in terminal-oriented user interfaces is to get a command from the user and execute it, which results in the client regaining control while it awaits user input. With potentially multiple applications active simultaneously, the user should be free to interact with the one of his choosing. ViewPoint's input facilities notify a window when the user inputs to that window.

Events are another case in which the system calls the client. For example, a client may need to do something when the user logs in. If the client registers a procedure with the appropriate event, the procedure is invoked when the event occurs.

3

Programmer's Guide

This guide for ViewPoint application programmers is intended to point the programmer to the most important parts of the most important interfaces needed for writing an application in ViewPoint.

ViewPoint is a collection of interfaces to be used for writing application programs. It is primarily intended to support applications like those in the ViewPoint workstation; that is, there is support for icons, windows, property sheets, and so forth.

The first section (3.1 Guide) contains a jump table of the form, "If your application does X, then you use interfaces A and B, also you need to understand C and D, and you probably want to read section 3.1.x." The subsections (3.1.x) provide more detail about A, B, C, and D, pointing the programmer to the most important types and procedures in an interface. The second section (3.2 Getting Started) contains essential information for first-time ViewPoint programmers. Section 3.3 provides some flow of control descriptions for several common scenarios. It describes which interfaces call which client procedures when, and so forth. Section 3.4 discuss some programming conventions specific to ViewPoint interfaces. Section 3.5 contains a summary of all the ViewPoint interfaces.

First, we briefly define an application from the user's point of view: The user sees the icons on the desktop, and can operate on them in various ways. He can select an icon with the mouse and open it to display its contents. Or by selecting the icon and pressing PROPS, he can examine and change the icon's properties through a window called a property sheet. After an icon is opened, he can examine the properties of the contents and change them by again using the property sheet. By selecting one icon, pressing COPY or MOVE, and then selecting another icon, he can perform various application-specific operations. This is often referred to as "dropping one icon onto another." Each application attaches a different meaning to the drop on operation. For example, the folder takes the icon dropped onto it and adds it to the folder. The printing application (printer icon) prints the icon dropped onto it.

From the application's point of view, an icon is just a picture that represents a file. Files have a file type, and an application operates on all files of the same type. Thus when the user selects a folder icon, he is actually selecting a file with file type of folder. When the user performs some operation on an icon, the desktop calls the appropriate application based on the file type of the file represented by the selected icon.

3.1 Guide

The following table can help you readily find a desired section.

3.1.1 Guide to the Guide

If your application ...	**See section**
... Appears as an icon:	
- Read about icon applications in **3.2 Getting Started**	3.2.2
- Use **Containee** to register the icon's behavior	3.1.2
... Opens a window:	
- Use **StarWindowShell** to create a window	3.1.3
- Use **MenuData** to construct menus	3.1.4
... Manages the contents of a window:	
- Use **Display** and **Window** to display information	3.1.5
- Supply a **TIP.NotifyProc** to process user actions	3.1.5
- Use **Selection** to share data between applications	3.1.5
- Use **Context** to save data with the window	3.1.5
... Puts up a Property Sheet:	
- Use **PropertySheet** and **FormWindow** interfaces	3.1.6
... Manipulates strings:	
- Use the **XString** interfaces (including **XFormat**, **XToken**, **XChar**)	3.1.7
... Displays messages to the user:	
- Use the **XMessage** and **Attention** interfaces	3.1.8
... Displays a list of items like a folder:	
- Use the Container interfaces (**ContainerWindow**, **ContainerSource**)	3.1.9
... Redefines the function keys:	
- Use the **SoftKeys** interface	3.1.10
... Redefines the Black Keys:	
- Use **BlackKeys** and **KeyBoardKey** interfaces	3.1.11

3.1.2 Containee

Containee is an application registration facility. An *application* is a software package that implements the manipulation of one type of file. **Containee** is a facility for associating an application with a file type. (§3.2.2 explains how an application registers itself and is then invoked to perform various operations). The most important items in **Containee** are:

Implementation	A record containing several client procedures.
SetImplementation	Registers an application.
GenericProc	Client procedure called to perform OPEN, PROPS, COPY/MOVE-onto, and so forth.
PictureProc	Client procedure called to display an icon picture.
Data, DataHandle	Uniquely identifies a file.

3.1.3 Application Windows

StarWindowShell allows a client to create a Star-like window. A **StarWindowShell** window has a header that contains a title, commands, and popup menus. The window may have scrollbars, both horizontal and vertical. It also has interior window space that may contain anything the client desires. **StarWindowShell** also supports the notion of opening within.

A **StarWindowShell** is a window (see **Window** interface) that is a child of the desktop window. A **StarWindowShell** has an interior window which is a child of the **StarWindowShell** and is exactly the size of the available window space in the shell, that is, the window shell minus its borders and header and scrollbars. The interior window may have child windows created by the client. These children of the interior window are called *body windows*. The client may create an arbitrary number of body windows and may arrange them in an arbitrary fashion. **Note:** Since the body windows are children of the interior window, they are clipped by the interior window.

Body windows may be managed directly by the client, including all display and notification (user input). (See §3.2.4). Body windows can also be managed by various interfaces provided by ViewPoint, such as **FormWindow** and **ContainerWindow**. These interfaces have **Create** procedures that take a body window and turn it into a particular kind of window, providing all the display and notification handling for the window.

The most important items in **StarWindowShell** are:

Create	Creates a **StarWindowShell** window.
CreateBody	Creates a body window.
ShellFromChild	Returns the window shell, given a body window.
SetRegularCommands	Places commands in the header of a **StarWindowShell**.

AddPopupMenu	Adds a popup menu to the header of a **StarWindowShell**.

3.1.4 Menus

A *menu* is a list of named commands. When the user selects a menu command, a client procedure is called. The **MenuData** interface allows menu items and menus to be created. **MenuData** does not address the user interface for menus. Menu items may appear as commands in the header of a star window shell (**StarWindowShell.SetRegularCommands**). Entire menus may be accessed via a popup symbol in the header of a window shell (**StarWindowShell.AddPopupMenu**). Menu items may be added to the popup menu that is available to the user through the attention window (**Attention.AddMenuItem**).

The most important items in **MenuData** are:

CreateItem	Creates a menu item.
MenuProc	A client procedure that is called when the user selects a menu item.
CreateMenu	Creates a menu from an array of menu items.

3.1.5 Managing a Body Window

Clients can manage their own body windows. This involves handling both display and notification (user input), and often includes managing the current selection. Display is done by providing a window display procedure. Notifications are received through a client-provided **TIP.NotifyProc**. The current selection is managed using the **Selection** interface. Arbitrary data associated with a window can be saved with the window by using the **Context** interface.

3.1.5.1 Display

The client's display procedure is called by the **Window** interface to repaint the contents of the window. It is called when the window is initially made visible. It is also called when the window suddenly becomes more visible because an overlapping window was moved, or when the window is scrolled so that the part of it that was invisible before becomes visible. The display procedure should use the **Display** and/or **SimpleTextDisplay** interfaces to display bits in the window. The display procedure can be set when a window shell's body window is created (**StarWindowShell.CreateBody**), or by calling **Window.SetDisplayProc**.

The most important item in **Window** is the client's display procedure. There is no TYPE for this procedure, but it is discussed in the **Window** interface chapter. Other important items:

Box	Defines a rectangle in a window.
Place	Defines a point in a window.

The most important items in **Display** are:

Black	Displays a black box.
White	Displays a white box.
Invert	Inverts the bits in a box.
Bitmap	Displays an arbitrary array of bits.

The most important item in **SimpleTextDisplay** is:

StringIntoWindow	Displays a string in a window.

3.1.5.2 TIP and TIPStar

TIP provides basic user input facilities through a flexible mechanism that translates hardware-level actions from the keyboard and mouse into higher-level client action requests (result lists). The acronym TIP stands for *terminal interface package*. This interface also provides the client with routines that manage the input focus, the periodic notifier, and the **STOP** key.

The basic notification mechanism directs user input to one of many windows in the window tree. Each window has a **TIP.Table** and a **TIP.NotifyProc**. The table is a structure that translates a sequence of user actions into a sequence of results which are then passed to the notify procedure of the window.

The Notifier process dequeues user events, determines which window the event is for, and tries to match the events in the window's **Table**. If it finds a match in the table, it calls the window's **NotifyProc** with the results specified in the table. If no match is found, it tries the next table in the window's chain of tables. If no match is found in any table, the event is discarded.

TIP tables provide a flexible method for translating user actions into higher-level client-defined actions. They are essentially large select statements with user actions on the left side and a corresponding set of results on the right side. Results may include mouse coordinates, atoms, and strings for keyboard character input.

ViewPoint provides a list of normal tables that contain one production for each single user action. Client programmers can write their own table to handle special user actions and link it to system-defined tables, letting those tables handle the normal user actions. These system-defined tables are accessible through the **TIPStar** interface and are described in **Appendix A**.

Input Focus. The input focus is a distinguished window that is the destination of most user actions. User actions may be directed either to the window with the cursor or to the input focus. Actions such as mouse buttons are typically sent to the window with the cursor. Most other actions, such as keystrokes, are sent to the current input focus. Clients may make a window be the current input focus and be notified when some other window becomes the current input focus.

The current selection and the current input focus often go together. If the window in which a selection is made also expects to receive user keystrokes (function keys as well as black keys), **TIP.SetInputFocus** should be called at the same time as **Selection.Set** is called. This is also the time to call **SoftKeys.Push** or **KeyboardKey.RegisterClientKeyboards**, if necessary.

Modes. **TIPStar** also provides the notion of a global mode to support MOVE, COPY, and SAME. When the user presses down and releases the MOVE, COPY, or SAME keys, the client that currently has the input focus will receive the notification and should call **TIPStar.SetMode**. This changes the mouse TIP table so that atoms specific to the mode are produced rather than normal atoms when the user performs mouse actions. For example, in copy mode "CopyModeDown" instead of "PointDown" is produced when the left mouse button is pressed down. This informs the client that receives the atom that it should attempt to copy the current selection rather than simply select something.

The most important items in **TIP** are:

NotifyProc	Client procedure that is called to handle a user action.
Results, ResultObject	Right side of the table entry that matched the user action.
SetInputFocus	Sets a window to be the current input focus.

The most important items in **TIPStar** are:

NormalTable	Returns the chain of system-provided **TIP** tables.
SetMode	Sets the entire environment into MOVE, COPY, or SAMEAS mode, thus changing the results produced for mouse clicks.

3.1.5.3 Context

The **Context** interface allows arbitrary client data to be associated with a window. Client data is usually allocated and associated with the window when the window is created. The data may be retrieved any time, such as at the beginning of the client's display procedure and **TIP.NotifyProc**.

The most important items in **Context** are:

Create	Associates data with a window.
Find	Recovers the data previously associated with a window.

3.1.5.4 Selection

The **Selection** interface defines the abstraction that is the user's current selection. It provides a procedural interface to the abstraction that allows it to be set, saved, cleared, and so forth. It also provides procedures that enable someone other than the originator of the selection to request information relating to the selection and to negotiate for a copy of the selection in a particular format.

The **Selection** interface is used by two different classes of clients. Most clients wish merely to obtain the *value* of the current selection in some particular format; such clients are called *requestors*. These programs call **Convert** (or maybe **ConvertNumber**, which in turn calls **Convert**), or **Query**, or **Enumerate**. These clients need not be concerned with many of the details of the **Selection** interface.

The other class of clients are those that own or set the current selection; these clients are called *managers*. A manager calls **Selection.Set** and provides procedures that may be called to convert the selection or to perform various actions on it. The manager remains in control of the current selection until some other program calls **Selection.Set**. These clients need to understand most of the details of the **Selection** interface.

A client that is managing its own body window will be both a selection requestor and a selection manager in different parts of the code. For example, when the user selects something in another window and copies it to the client's window, the client must call **Selection.Convert** to *request* the value of the selection in a form appropriate to the application. On the other hand, when the user clicks a mouse button in the client's window, the client will usually become the selection manager by calling **Selection.Set**.

The most important items in **Selection** are:

Convert	Request the value of the selection in some target form.
Value	A record containing a pointer to the converted selection value, among other things.
CanYouConvert	Returns **TRUE** if the selection manager can convert the selection to a particular target type.
Set	Called by a selection manager to become the current manager.
ConvertProc	Manager-supplied procedure that will be called to convert the selection to some target type.
ActOnProc	Manager-supplied procedure that will be called to perform some action on the selection, such as mark, unmark, clear.

3.1.6 Property Sheets and FormWindow

A property sheet shows the user the properties of an object and allows the user to change these properties. Several different types of properties are supported. The most common ones are boolean, choice (enumerated), and text.

From a client's point of view, a property sheet is simply a **StarWindowShell** with a **FormWindow** as a body window. A property sheet is created by calling **PropertySheet.Create**, providing a procedure that will make the form items in the **FormWindow** (a **FormWindow.MakeItemsProc**), a list of commands to put in the header of the property sheet, such as Done, Cancel, and Apply (**PropertySheet.MenuItems**), and a procedure to call when the user selects one of these commands (a **PropertySheet.MenuItemProc**). When the user selects one of the commands in the header of the property sheet, the client's **PropertySheet.MenuItemProc** is called. If the user selected Done, for example, the client can then verify and apply any changes the user made to the object's properties.

The most important items in **PropertySheet** are:

Create	Creates a property sheet.
MenuItems	Used for specifying which commands to put in the header of the property sheet.
MenuItemProc	Client procedure called when the user selects one of the commands in the header.

The most important items in **FormWindow** are:

MakeItemsProc	Client procedure called to create the items in the form.
MakeXXXItem	Makes a form item. **XXX** can be **Boolean**, **Choice**, **Text**, **Integer**, **Decimal**, **Window**, **TagOnly**, **Command**.
GetXXXItemValue	Returns the current value of an item. **XXX** can be **Boolean**, **Choice**, **Text**, **Integer**, **Decimal**, **Window**, **TagOnly**, **Command**.

3.1.7 XString, et al.

The *Xerox Character Code Standard* defines a large number of characters, encompassing not only familiar ASCII characters but also Japanese and Chinese Kanji characters and others to provide a comprehensive character set able to handle international information processing requirements. Because of the large number of characters, the data structures in **XString** are more complicated than a **LONG STRING**'s simple array of ASCII characters, but the operations provided are more comprehensive

Characters are 16-bit quantities that are composed of two 8-bit quantities, their character set and character code within a character set. The Character Standard defines how characters may be encoded, either as runs of 8-bit character codes of the character set or as 16-bit characters where the character set and character code are in consecutive bytes. (See the **XChar** chapter for information and operations on characters.)

ViewPoint provides a string package consisting of several interfaces that support the *Xerox Character Code Standard.* **XString** provides the basic data structures for representing encoded sequences of characters and some operations on these data structures. **XFormat** converts other **TYPEs** into **XStrings**. **XToken** parses **XStrings** into other **TYPEs**. **XChar** defines the basic character type and some operations on it. **XCharSets** enumerates the character sets defined in the Standard. A collection of interfaces enumerate the character codes of several common character sets (**XCharSetNNN**). **XTime** provides procedures to acquire and edit times into XStrings and XStrings into times.

3.1.8 XMessage and Attention

XMessage supports the translation into other languages of text displayed to the user. This is accomplished by not including any string constants in the code of an application. Rather, all the string constants for an application are declared in a separate module and registered with **XMessage**. Then whenever the application needs a string constant, it obtains it by calling **XMessage.Get**. Several commonly used messages such as "Yes", "No", and days of the week are defined in **XComSoftMessage**.

The most important items in **XMessage** are:

Get	Retrieves a message.
RegisterMessages	Registers all the messages for an application.

The **Attention** interface provides a global mechanism for displaying messages to the user. **Attention** provides procedures to post messages to the user in the attention window, clear the attention window, post a message and wait for confirmation, and so forth.

The most important items in **Attention** are:

Post	Posts a message in the attention window.
Clear	Clears the attention window.
formatHandle	**XFormat.Handle**that may be used to format strings into the attention window.

3.1.9 Containers

The Container interfaces (**ContainerSource**, **ContainerWindow**, **FileContainerSource**, **FileContainerShell**, and **ContainerCache**) provide the services needed to implement an application that appears as an ordered list of items to be manipulated by the user. Star Folders are a typical example of such an application.

Figure 3-1 shows the relationships among the various interfaces and potential clients. Each interface is described below, followed by a discussion of which interfaces an application might need to use.

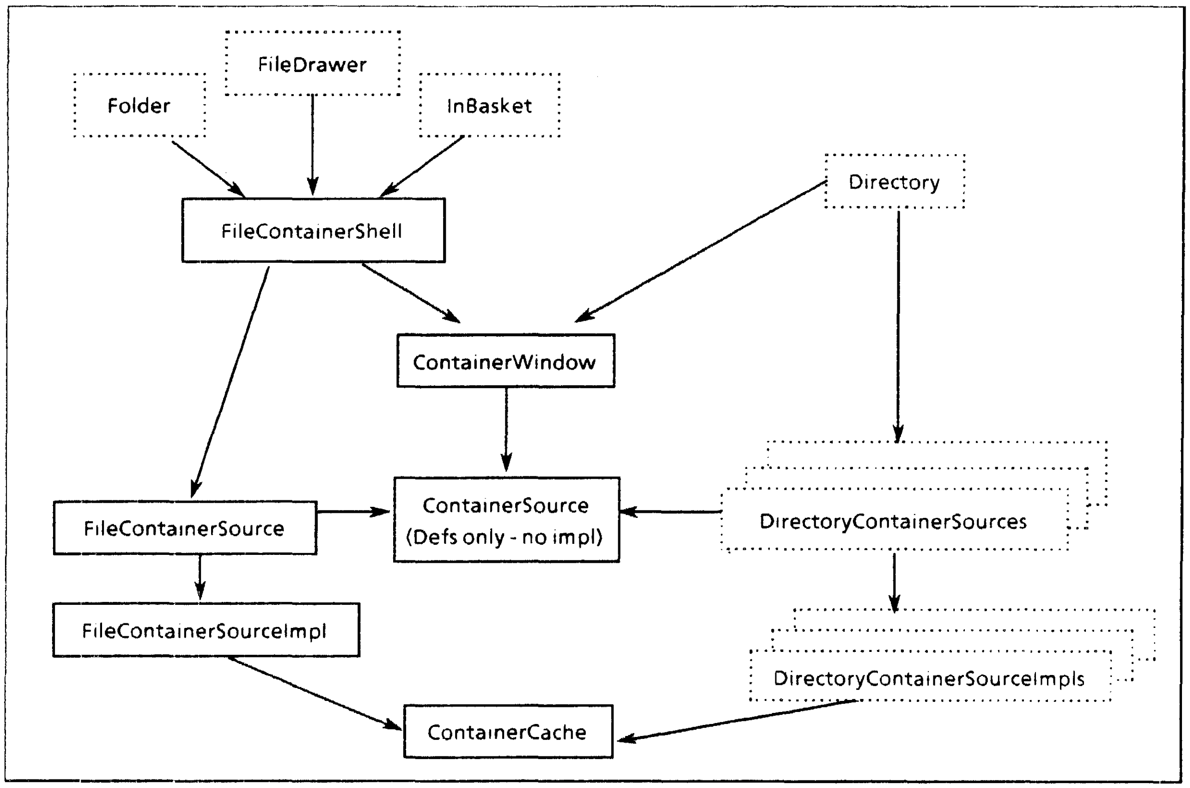

Figure 3.1 Container Interface Dependencies

The **ContainerWindow** interface takes a window and a **ContainerSource** and makes the window behave like a container. It maintains the display and manages scrolling, selection, and notifications. **Note:** This interface does not depend on **NSFile**.

A container source is a record of procedures that implement the behavior of the items in a container and the behavior of the container itself. **ContainerWindow** obtains the strings of each item by calling one of these procedures. **ContainerWindow** also performs user operations on items, such as open, props, delete, insert, take the current selection, and selection conversion by calling other procedures in the record. A container source can be thought of as a supply (source) of items for a container window. The **ContainerSource** interface defines each of the procedure TYPEs that a container source must implement. **ContainerSource** contains TYPEs only.

ContainerCache provides the implementor of a container source with an easy-to-use cache for storing and retreiving the strings of each item and some client-specific data about each item.

FileContainerSource provides an **NSFile**-backed container source. It takes an **NSFile.Reference** for a file that has children and each child file becomes an item of the container. Facilities are provided to specify the columns based on **NSFile** attributes.

The **FileContainerShell** interface takes an **NSFile** and column information (such as headings, widths, formatting), and creates a **FileContainerSource**, a **StarWindowShell**, and a container window body window. Most **NSFile**-backed container applications can use this interface, thereby greatly simplifying the writing of those applications.

Each of the items in a container must behave like to a file on the desktop; that is, each item must be able to be opened, show a property sheet, take a selection, and so forth. However, the items need not be backed by files. If the container is backed by an **NSFile** that has children, then the **FileContainerShell** interface is the only interface the client needs to use. Otherwise, the client must implement a container source and must make most of the calls that the **FileContainerShell** implementation makes; that is, **StarWindowShell.Create**, **StarWindowShell.CreateBody**, **ContainerWindow.Create**.

3.1.10 SoftKeys

The **SoftKeys** interface provides for client-defined function keys designated to be the isolated row of function keys at the top of the physical keyboard. It also provides a **SoftKeys** window whose "keytops" may be selected with the mouse to simulate pressing of the physical key on the keyboard. Such a window is displayed on the user's desktop whenever an interpretation other than the default **SoftKeys** interpretation is in effect. (The default is assumed to be the functions inscribed on the physical keys.)

The most important items in **SoftKeys** are:

Labels, LabelRecord	Strings to display on the keytops in the SoftKeys window.
Push	Install a client-specific interpretation for the soft keys.
Remove	Remove a previously installed interpretation.

3.1.11 Client-Defined Keyboards

KeyboardKey is a keyboard (the central set of black keys on the physical keyboard) registration facility. It provides clients with a means of registering system-wide keyboards (available all the time, like English, French, European), a special keyboard (like Equations), and/or client-specific keyboards (those that are available only when the client has the input focus). The labels from these registered keyboards are displayed in the softkeys window when the KEYBOARD key is held down by the user.

The **BlackKeys** interface provides the data structures that define a client keyboard.

The most important items in **KeyboardKey** are:

AddToSystemKeyboards	Adds a keyboard to the system keyboards.
RegisterClientKeyboards	Establishes the keyboards available to the user.

The most important items in **BlackKeys** are:

Keyboard, KeyboardObject	A keyboard interpretation.

3.2 Getting Started

This section is a guide for programmers who have never used the ViewPoint interfaces. It shows how two common types of applications are written using ViewPoint.

There are two ways that a user invokes a program in the ViewPoint environment. First is to select an icon and press a function key such as OPEN, PROPS, COPY, or MOVE. This type of program is called an *icon application*. Second, the user may also invoke a program by simply selecting an item in the attention window's popup menu. For example, in OS 5, a Show Size command reports on the size of the selected icon's file. The following sections describe how to write each of these types of programs.

3.2.1 Simplest Application

The simplest way to get a program running in the ViewPoint environment is to have the program add an item to the attention window's popup menu. When the user selects that item, the program is called. See the SampleBWSTool for an example of this type of application. Excerpts from SampleBWSTool:

```
Init: PROCEDURE = {
  sampleTool: XString.ReaderBody ← XString.FromSTRING["Sample Tool"L];
  Attention.AddMenuItem [
    MenuData.CreateItem [
      zone: sysZ,
      name: @sampleTool,
      proc: MenuProc ] ];
  };

-- Mainline code
Init[];
```

When the application is started, its startup (mainline) code creates a MenuData.ItemHandle by calling MenuData.CreateItem, then adds this item to the attention window's menu by calling Attention.AddMenuItem. Now the MenuProc passed to MenuData.CreateItem will be called when the user selects the Sample Tool item in the attention window's popup menu. The MenuProc can then do whatever is appropriate for the application.

3.2.2 Icon Application

Getting an icon application running in ViewPoint is a little more complex. The basic idea is that an application operates on files of a particular type. When an application is started, it registers its interest in files of that type. Then whenever the user operates on a file of that type, the application gets called. Here is a skeletal example of some application code, the full explanation follows:

```
-- Constants and global data

sampleIconFileType: NSFile.Type = ...;
oldImpl, newImpl: Containee.Implementation ← [];
```

```
-- Containee.Implementation procedures

GenericProc: Containee.GenericProc = {
   SELECT atom FROM
      canYouTakeSelection = > ...
      takeSelection = > ...
      takeSelectionCopy = > ...
      open = > ...
      props = > ...
      ENDCASE = > ...

PictureProc: Containee.PictureProc = {
   ...
   Display.Bitmap [...];
   ...
   };

-- Initialization procedures

InitAtoms: PROCEDURE = {
   open ←Atom.MakeAtom["Open"L];
   props ←Atom.MakeAtom["Props"L];
   canYouTakeSelection ←Atom.MakeAtom["CanYouTakeSelection"L];
   takeSelection ←Atom.MakeAtom["TakeSelection"L];
   takeSelectionCopy ←Atom.MakeAtom["TakeSelectionCopy"L];
   };

FindOrCreatePrototypeIconFile: PROCEDURE = {...};

SetImplementation: PROCEDURE = {
   newImpl.genericProc ← GenericProc;
   newImpl.pictureProc ← PictureProc;
   oldImpl ←Containee.SetImplementation [ sampleIconFileType, newImpl ];
   };

-- Mainline code

InitAtoms[];
FindOrCreatePrototypeIconFile[];
SetImplementation[];
```

The most important thing to note in the above example is the **SetImplementation** procedure and the call to **Containee.SetImplementation** in particular. This call associates the application's implementation (**newImpl**) with a particular file type (**sampleIconFileType**). This implementation is actually a **Containee.Implementation** that is a record which contains procedures. Whenever the user operates on files of type **sampleIconFileType**, the procedures in the **Implementation** record are called. An understanding of how this works requires an understanding of how the ViewPoint desktop implementation operates.

First, some background about **NSFiles**. All **NSFiles** have:

- a name
- a file type (LONG CARDINAL)

- a set of attributes, such as create date
- either:
  - content, such as a document
  - children that are also **NSFiles**, such as a folder

An **NSFile** that has children is often called a *directory*. Fine point: an**NSFile** can actually have both content and children, but we ignore that for now to simplify this discussion. Note that since the children of an **NSFile** can themselves have children, **NSFile** supports a hierarchical file system.

A ViewPoint desktop is an **NSFile** that has children. Each child file of the desktop's **NSFile** is represented on the screen by an icon picture. The desktop display of rows of icons is an illusion. The word "icon" is in quotes because, from the programmer's point of view, there really is no such thing as an icon. The only things that really exist are files (**NSFiles**), icon *pictures*, and application code.

Immediately after logging on, the desktop implementation enumerates the child files of the desktop file and calls an application's **Containee.PictureProc** for each child file, based on the child file's type. Each application's **Containee.PictureProc** should then display the icon picture for that file.

After logon is complete and the desktop is displayed, the desktop implementation receives user actions such as mouse clicks and pressing the OPEN or PROPS keys. For example, assume the user selects an icon picture and presses OPEN. When the user presses OPEN, the desktop implementation determines the file type for the file represented by the icon picture the user selected, then calls the **Containee.GenericProc** for the application that operates on files of that type, requesting that the application open the icon. It also passes the application a unique identifier for the particular file selected. At this point the application can do whatever is appropriate for that application. Typically, the application opens the file, reads some data out of the file, creates a **StarWindowShell**, and displays the contents of the file in the window in some application-specific form.

The desktop implementation does not call an application directly. Rather, ViewPoint maintains a table of file-type/**Containee.Implementation** pairs. When an application calls **Containee.SetImplementation**, an entry is added to the table. When the desktop implementation calls an application, it obtains the **Containee.Implementation** for the application by looking it up in the table (it actually calls **Containee.GetImplementation**).

3.2.3 Operational Notes

To write an icon application, a programmer *must obtain a unique file type*. Contact your ViewPoint consultant to obtain one.

In the example above, the application in its initialization code checks to be sure a prototype file exists and, if not, creates one. This usually involves creating a file with the proper file type for this application. This allows the user to get started with the application, usually by copying the blank prototype out of a special folder of prototypes.

Note: There is a clear distinction between a prototype file for an application and a bcd file that contains the code for the application. All bcd files are of the same type, while each prototype file is different for each application.

3.3 Flow Descriptions

The following flow descriptions are intended to show how everything ties together. For each example scenario, the exact sequence of calls is described, including ViewPoint interfaces and clients.

3.3.1 Select an Icon

The user points at an icon on the desktop.

- When the mouse button goes down over an icon picture, the notification goes to the desktop implementation's TIP.NotifyProc. The NotifyProc will be passed a Window.Place and a "PointDown" atom. The desktop implementation determines what file is represented by that icon picture. Fine Point: The desktop implementation maintains a mapping from icon picture locations to NSFile.References.
- The desktop implementation calls Containee.GetImplementation, passing in the file type of the file and getting back the Containee.Implementation for that file type.
- The desktop implementation calls the Containee.PictureProc that is in the Implementation; i.e., impl.pictureProc, passing in.
  - data: the NSFile.Reference for the file
  - old: normal
  - new: highlighted
- The application's PictureProc displays a highlighted version of its icon picture, perhaps simply calling Display.Invert.
- When the mouse button goes up (a "PointUp" atom), the desktop implementation becomes the current selection manager by calling Selection.Set. It sets the desktop window to be the current input focus by calling TIP.SetInputFocus. Setting the input focus to be the desktop window ensures that keys such as OPEN, PROPS, COPY, etc,. will all go to the desktop's NotifyProc.
- END

3.3.2 PROPS of an Icon

Assume an icon on the desktop is selected. The user presses PROPS. After changing some items in the property sheet, the user selects Done.

- The desktop implementation's TIP.NotifyProc gets the notification (a "PropsDown" atom) and determines which icon picture is currently selected and what file is represented by that icon picture.

- The desktop implementation calls Containee.GetImplementation, passing in the file type of the file and getting back the Containee.Implementation for that file type.

- The desktop implementation calls the Containee.GenericProc that is in the Implementation; i.e., impl.genericProc, passing in:
  - data: the NSFile.Reference for the file
  - atom: "Props"
  - changeProc: a Containee.ChangeProc that belongs to the desktop implementation
  - changeProcData: a pointer to some desktop implementation data that identifies the icon/file being operated on

- The application's GenericProc creates a property sheet by calling PropertySheet.Create. It probably also opens and retrieves some data out of the file (using various NSFile operations) and uses that data to set the initial values of the items in the property sheet.

- Typically, the client will want to save the NSFile.Handle for the file while the property sheet is open. In addition, if the opening and closing of the property sheet might cause the file's attributes to change, the application's GenericProc must save the passed changeProc and changeProcData. A typical example is when the file's name is one of the items in the property sheet and the user can change the name. This data is saved by allocating a record with this data in it and passing a pointer to the record as the clientData parameter to PropertySheet.Create. Later, when the user selects Done or Apply, this data may be recovered (see the rest of this flow description). **Note:** This data cannot be saved in a local frame (such as that of the GenericProc) since the GenericProc must *return* to the notifier after creating the property sheet, and when the user selects Done or Apply that is a new call stack. The client data should not be saved in a global frame either, because there may be more than one property sheet open at a time for a particular application.

- The application's GenericProc returns the StarWindowShell.Handle for the property sheet.

- The desktop implementation displays the property sheet by calling StarWindowShell.Push, then the desktop's NotifyProc returns to the notifier.

- The user changes some items and then selects Done.

- The PropertySheet implementation calls the client's PropertySheet.MenuItemProc that was passed in to PropertySheet.Create, passing in:
  - shell: the StarWindowShell for the property sheet
  - formWindow: the FormWindow for the property sheet
  - menuItem: done
  - clientData: the pointer to the client's data that was passed to PropertySheet.Create.

- The client's MenuItemProc recovers the client's data (the file handle, the changeProc and changeProcData, and any other relevant client data) from the clientData parameter. It determines if the user made any changes and, if so, updates the file accordingly *and* calls the **changeProc**, passing in the **changeProcData**, the file reference, and a list of the changed file attributes.

- The desktop's **ChangeProc** causes the icon picture to be redisplayed, since changing an attribute such as the name requires the picture to be updated with the new name.
- The client's **MenuItemProc** returns to the **PropertySheet** implementation, indicating that the property sheet should be destroyed.
- The **PropertySheet** implementation destroys the property sheet by calling **StarWindowShell.Pop** and returns to the notifier.
- END.

3.3.3 OPEN an Icon

Opening an icon is similar to opening a property sheet for an icon.

3.3.4 COPY Something to an Icon

Assume something has been selected. The user presses COPY and, then points at an icon.

- When COPY is pressed, the **NotifyProc** for the window that currently has the input focus (and the selection) is called. It calls **TIPStar.SetMode [copy]** to set the environment into copy mode and then returns to the notifier. It might also call **Cursor.Set** to change the cursor shape to indicate move mode.
- **SetMode** will replace the **NormalMouse.TIP** table with the **CopyModeMouse.TIP** table.
- The user presses the mouse button down over an icon on the desktop.
- The desktop's **NotifyProc** gets called with a "CopyModeDown" atom (instead of a "PointDown" atom because of the TIP table switch). It determines what file is represented by the icon picture the user is pointing at. It calls **Containee.GetImplementation**, passing in the file's type and getting back a **Containee.Implementation**. It calls the **Implementation**'s **GenericProc** passing in:
  - **data:** the **NSFile.Reference** for the file
  - **atom: "CanYouTake"**
- The application's **GenericProc** calls **Selection.CanYouConvert** or **Selection.HowHard** to determine if the current selection can be converted to target type(s) that the application can take. For example, if the icon being copied to is a printer icon, it will call **HowHard** with targets of **interpressMaster** and **file**.
- The current selection manager's **Selection.ConvertProc** is called by the **Selection** implementation and returns an indication of how hard it would be to convert the selection to the given target types.
- The application's **GenericProc** returns a pointer to **TRUE** if it determines that it can take the current selection and **FALSE** if it cannot.

- The desktop implementation changes the cursor shape to a question mark if the application's **GenericProc** returns FALSE. Otherwise, it leaves the cursor as it was.
- Now the user lifts up the mouse button.
- The desktop's **NotifyProc** gets called with a "CopyModeUp" atom. It determines what file is represented by the icon picture the user is pointing at. It calls **Containee.GetImplementation** passing in the file's type and getting back a **Containee.Implementation**. It calls the **Implementation**'s **GenericProc**, passing in:
  - **data:** the **NSFile.Reference** for the file
  - **atom: "TakeSelectionCopy"**
  - **changeProc:** a **Containee.ChangeProc** that belongs to the desktop implementation
  - **changeProcData:** a pointer to some desktop implementation data that identifies the icon/file being copied to
- The application's **GenericProc** calls **Selection.Convert** or (**Selection.Enumerate**) to convert the selection to the desired type. The application then operates on the converted selection value as appropriate for that application. For example, the printer icon application would convert the selection to an **interpressMaster** and send the master to the printer. (See the **Selection** chapter for a full flow description of the selection mechanism.)
- The application's **GenericProc** returns to the desktop's **NotifyProc**, which returns to the notifier.
- END.

3.4 Programming Conventions

The ViewPoint environment assumes that the programs that run in it are friendly and that they are not trying to circumvent or sabotage the system. The system does not enforce many of the conventions described here but assumes that application programmers will adhere to them voluntarily. If these conventions are not followed, the ViewPoint environment may degrade or break down altogether.

The most important principle is that users should have complete control over their environment. In particular, clients shall not pre-empt users. A user should never be forced by a client into a situation where the only thing that can be done is to interact with only one application. Furthermore, the client should avoid falling into a particular mode when interacting with the user; that is, an application should avoid imposing unnecessary restrictions on the permitted sequencing of user actions.

This goal of user control has implications for the designs of applications. A client should never seize control of the processor while getting user input. This tends to happen when the client wants to use the "get a command from the user and execute it" mode of operation. Instead, an application should arrange for ViewPoint to notify it when the user wishes to communicate some event to the application. This is known as the "Don't call us, we'll call you" principle.

The user owns the window layout on the screen. Although it is possible for the client to rearrange the windows, this is discouraged. Users have particular and differing tastes in the way they wish to lay out windows on the display; it is not the client's role to override the user's decisions. In particular, clients should avoid making windows jump up and down to try to capture the user's attention. If the user has put a window off to the side, then he does not want to be bothered by it.

3.4.1 Notifier

ViewPoint sends most user input actions to the window that has set itself to be the focus for user input; the rest of the actions are directed to the window containing the cursor. (See the **TIP** interface for details on how the decision is made where to send these actions.) A process in ViewPoint notes all user input actions and determines which window should receive each one. A client is concerned only with the actions that are directed to its window and need not concern itself with determining which actions are intended for it.

The basic notification mechanism directs user input to one of many windows in the window tree. Each window has a **TIP.Table** and a **TIP.NotifyProc**. The table is a structure that translates a sequence of user actions into a sequence of results that are then passed to the notify procedure of the window.

There are two processes that share the notification responsibilities, the Stimulus process and the Notifier process. The Stimulus process is a high-priority process that wakes up approximately 50 times a second. When it runs, it makes the cursor follow the mouse and watches for keyboard keys going up or down, mouse motion, and mouse buttons going up or down, enqueuing these events for the Notifier process.

The Notifier process dequeues these events, determines which window the event is for, and tries to match the events in the window's table. If it finds a match in the table, it calls the window's notify procedure with the results specified in the table. If no match is found, it tries the next table in the window's chain of tables. If no match is found in any table, the event is discarded.

The Notifier process is important. To avoid multi-process interference, some operations in the system are restricted to happening only in the Notifier process. Setting the selection is one such operation. The Notifier process is also the one most closely tied to the user. The Notifier waits until a NotifyProc finishes for one user action before processing the next user action. If an operation will take an extended time to complete (more than three to five seconds), it should be forked from the notifier process to run in a separate process so that the Notifier process is free to respond to the user's actions. Of course, the application writer must take great care when stepping into this world of parallel processing.

3.4.2 Multiple Processes, Multiple Instances

ViewPoint makes it possible to have many programs running simultaneously. The designer of a client-callable package should bear in mind that his package may be invoked by several different asynchronous clients. One implication of this constraint is that a package should be monitored.

The simplest design is to have a single entry procedure that all clients must call. While one client is using the package, all other clients will block on the monitor lock. Of course, no state should be maintained internally between successive calls to the package, since there is no guarantee that the same client is calling each time.

This simple approach has the disadvantage that clients are simply stopped for what may be a long time, with no option of taking alternate action. This restriction can be eased by having the entry procedure check a "busy" bit in the package. If the package is busy, the procedure can return this result to the client. The client can then decide whether to give up, try something else, or try again. This flexibility is less likely to tie up an application for a long period, and the user can use the application for other purposes.

If the package is providing a collection of procedures and cannot conform to the constraint that it provide its services in a single procedure, the package and its clients must pass state back and forth in the form of an object. The package can use a single monitor on its code to protect the object, or it can provide a monitor as part of each object. If it does the latter, then several clients can be executing safely at the same time.

Some packages require that a client provide procedures that will be called by the package. The designer of such a package should have these client-provided procedures take an extra parameter, a long pointer to client instance data. When the client provides the package with the procedures, it also provides the instance data to pass to the procedures when they are called. This instance data can then be used by the client to distinguish between several different instances of itself that are sharing the same code.

3.4.3 Resource Management

Programs in the Xerox Development Environment must explicitly manage resources. For example, memory is explicitly allocated and deallocated by programs; there is no garbage collector to reclaim unused memory. All programs share the same pool of resources, and there is no scheduler watching for programs using more than their share of execution time, memory, or any other resource.

Programs must manage resources carefully. If a program does not return a resource when it is done with it, that resource will never become available to any other program and the performance of the environment will degrade. The most common resource, and one of the more difficult to manage, is memory.

When interfaces exchange resources, clients must be very careful about who is responsible for the resource. We say that the program that is responsible for the deallocation of a resource is the *owner* of that resource. One example of a resource is a file handle. If a program passes a file handle to another program, both programs must agree about who owns that file handle. Did the caller transfer ownership by passing the file handle, or is it retaining ownership and only letting the called procedure use the file handle? If there is disagreement between the two programs, either the file will be released twice, or it will never be released at all. All interfaces involving resources must state explicitly whether ownership is transferred. To ease the problem of memory management when the ownership of memory can change, called the *system heap* is a common heap used in ViewPoint. If a piece of memory can have its ownership transferred, it is either allocated from the system heap or a deallocation procedure must be provided for it.

The most common resource appearing in interfaces is an **XString** (Reader or ReaderBody). There must be agreement about which program is responsible for deallocating the string's bytes. Typically, a string passed as an input parameter does not carry ownership with it;

implementors of such procedures should not deallocate or change the string. If it is necessary for the implementor to modify the string or use it after the procedure returns, the implementor should first copy it. Clients should be particularly careful when a procedure returns a string to note whether ownership has come with it.

3.4.4 Stopping Applications

The ViewPoint environment consists of cooperating processes. There are no facilities for cleanly terminating an arbitrary collection of processes. It is assumed that application writers will be good citizens and design their tools to stop voluntarily when asked to stop.

An application should stop if the user aborts the application. There are two ways to determine if the user has aborted an application. An application's window can have a **TIP.AttentionProc** that will be called as soon as the user presses the STOP key. Or, procedures in the **TIP** interface can check whether a user has aborted an application with the STOP key in the application's window. An application should check for a user abort at frequent intervals and be prepared to stop executing and clean up after itself. Because the application controls when it checks, it can check at points in its execution when its state is easy to clean up. Packages that can be called from several programs should take a procedure parameter that can be called to see whether the user has aborted.

3.4.5 Multinationality

ViewPoint is designed to support easy transport of applications to other countries. The string package (**XString**, **XChar**, **XFormat**, etc.) supports the *Xerox Character Code Standard*, which allows for strings in many languages to be intermixed. The **XMessage** interface supports the translation of user messages into other languages by allowing the application programmer to put all these messages into a module separate from the rest of the application code. The **KeyboardKey** interface supports the addition of keyboards for many languages.

Application programmers are strongly encouraged to allow their application to be multinational. This means for example, using **XString** for all string operations and using **XMessage** to manage any text that will be displayed to the user. It also means not making any language assumptions about characters received from the user. An application that expects typing input from the user should be prepared to receive characters from *any* character set.

3.5 Summary of Interfaces

Atom provides the mechanism for making **TIP**, **Event**, and **Containee** atoms.

AtomicProfile provides a mechanism for storing and retrieving global values.

Attention provides a means of displaying messages to the user.

BlackKeys provides the capability to change the interpretation of the central (black) section of the keyboard.

Containee is an application registration facility. It allows an application to register its implementation for files of a particular type.

ContainerCache provides a simple cacheing mechanism for the implementor of a container source.

ContainerSource defines the procedures that must be implemented to provide a source of items for a container window.

ContainerWindow creates a window that displays an ordered list of items that behave like icons on a desktop.

Context provides a mechanism for clients to associate data with windows.

Cursor provides facilities for a client to manipulate the appearance of the cursor that represents the mouse position on the screen.

Display provides facilities to display bits in windows.

Event provides clients with the ability to be notified of events that take place asynchronously on a system-wide basis.

FileContainerShell creates a **StarWindowShell** with a **ContainerWindow** as a body window that is backed by a **FileContainerSource**.

FileContainerSource creates a container source that is backed by a file that has children.

FormWindow creates a window with various types of form items in it, such as text, boolean, choice (enumerated), command, and window. **FormWindow** is used to create property sheets.

FormWindowMessageParse provides procedures that parse strings to produce various **FormWindow** TYPEs.

IdleControl provides access to the basic controlling module of ViewPoint.

KeyboardKey is a client keyboard (the central black keys) registration facility.

KeyboardWindow provides a particular implementation for a keyboard window.

LevelIVKeys defines the names of the physical keys.

MenuData allows menus and menu items to be created.

MessageWindow provides a facility for posting messages to the user in a window.

PopupMenu allows a menu to be displayed (popped up) anywhere on the screen.

PropertySheet creates a property sheet. A property sheet is used to show the properties of some object to the user and allows the user to change the properties.

Selection provides the facilities for a client to manipulate the user's current selection. It also provides procedures that enable someone other than the originator of the selection to request information relating to the selection and to negotiate for a copy of the selection in a particular format.

SimpleTextDisplay provides facilities for displaying, measuring, and resolving strings of Xerox Character Code Standard text. It can handle only non-attributed single-font text.

SimpleTextEdit provides facilities for presenting short, editable pieces of text to the user.

SimpleTextFont provides access to the default system font that is used to display ViewPoint's text, such as the text in menus, the attention window, window names, containers, property sheet text items, and so forth.

SoftKeys provides for client defined function keys designated to be the isolated row of function keys at the top of the physical keyboard.

StarDesktop provides access to the user's desktop file and window.

StarWindowShell provides facilities for creating Star-like windows.

TIP provides basic user input facilities through a flexible mechanism that translates hardware level actions from the keyboard and mouse into higher-level client action requests.

TIPStar provides access to ViewPoint's normal set of **TIP** tables.

Undo provides facilities that allow an application to register undo opportunities, so that when the user requests that something be undone, the application is called to do so.

Window defines the low-level window management package used by ViewPoint.

XChar defines the basic character type as defined in the *Xerox Character Code Standard* as well as some operations on it.

XCharSetNNN enumerates the character codes in character set NNN.

XCharSets enumerates the character sets defined in the *Xerox Character Code Standard.*

XComSoftMessage defines messages for some commonly used strings, such as Yes, No, day-of-the-week, month, etc.

XFormat converts various TYPEs into **XStrings**.

XLReal supports manipulation of real numbers with greater precision than Mesa REALs.

XMessage supports the multinational requirements of systems that require the text displayed to the user be separable from the code and algorithms that use it.

XString provides the basic data structures for representing encoded sequences of characters as defined in the *Xerox Character Code Standard.* It also provides several operations on these data structures.

XTime provides facilities to acquire and edit times into **XStrings** and **XStrings** into times.

XToken parses **XStrings** into other TYPEs

4

ApplicationFolder

4.1 Overview

ApplicationFolder provides access to the folder that contains all the component files of an application. A full application is composed of one or more bcds, a message file, a description file, and other data files such as **.TIP** or **.Icons**. These components are all put together into a folder with a specific file type, called an **Application** (or **ApplicationFolder**).

When the application is loaded and started, one of the first things it does is get its data files. The actual file names of the data files are specified in the application's description file, which is a file that may be read by using the **OptionFile** interface. The application gets its data files by using **ApplicationFolder.FromName** to obtain the **ApplicationFolder** file, using **ApplicationFolder.FindDescriptionFile** to get the description file from the **ApplicationFolder** file, and then using **OptionFile.GetStringValue** to get the data files names. (See Usage/Examples.)

4.2 Interface Items

```
FromName: PROCEDURE [internalName: XString.Reader]
    RETURNS [applicationFolder: NSFile.Reference];
```

Returns the folder for the given application. **internalName** is the section name in the description file. Returns **NSFile.nullReference** if not found.

```
FindDescriptionFile: PROCEDURE [applicationFolder: NSFile.Handle]
    RETURNS [descriptionFile: NSFile.Reference];
```

Finds a file with file type = **OptionFile** in the **applicationFolder**. Returns **NSFile.nullReference** if not found.

```
EventData: TYPE = RECORD [
    applicationFolder: NSFile.Reference,
    internalName: XString.Reader];
```

The application loader also notifies the **ApplicationLoaded** event after loading and starting an application. **EventData** is passed as **Event.EventData** for this event.

4.3 Usage/Examples

This example code obtains the message file.

```
-- File: SampleMsgFileInitImpl.mesa - last edit:

-- Copyright (C) 1985 by Xerox Corporation. All rights reserved.

DIRECTORY
    ApplicationFolder USING [FindDescriptionFile, FromName],
    Heap USING [systemZone],
    NSFile USING [Close, Error, GetReference, Handle, nullHandle, nullReference, OpenByName,
    OpenByReference, Reference, Type],
    NSString USING [FreeString, String],
    OptionFile USING [GetStringValue],
    SampleBWSApplicationOps,
    XMessage USING [ClientData, FreeMsgDomainsStorage, Handle, MessagesFromReference,
    MsgDomains],
    XString USING [FromSTRING, NSStringFromReader, Reader, ReaderBody];

SampleMsgFileImpl: PROGRAM
    IMPORTS ApplicationFolder, Heap, NSFile, NSString, OptionFile, XMessage, XString
    EXPORTS SampleBWSApplicationOps = {

-- Data

h: XMessage.Handle ← NIL;

localZone: UNCOUNTED ZONE ← Heap.systemZone;

-- Procedures

DeleteMessages: PROCEDURE [clientData: XMessage.ClientData] = {};

GetMessageHandle: PUBLIC PROCEDURE RETURNS [XMessage.Handle] = {RETURN[h]};

InitMessages: PROCEDURE = {
    internalName: XString.ReaderBody ← XString.FromSTRING ["SampleBWSApplication"L];
    msgDomains: XMessage.MsgDomains ← NIL;
    msgDomains ← XMessage.MessagesFromReference [
        file: GetMessageFileRef [ApplicationFolder.FromName [@internalName]],
        clientData: NIL,
        proc: DeleteMessages ];
    h ← msgDomains[0].handle;
    XMessage.FreeMsgDomainsStorage [msgDomains];
    };

GetMessageFileRef: PROCEDURE [folder: NSFile.Reference]
    RETURNS [msgFile: NSFile.Reference ← NSFile.nullReference] = {
    folderHandle: NSFile.Handle ← NSFile.OpenByReference [folder];
    internalName: XString.ReaderBody ← XString.FromSTRING ["SampleBWSApplication"L];
    messageFile: XString.ReaderBody ← XString.FromSTRING ["MessageFile"L];

    FindMessageFileFromName: PROCEDURE [value: XString.Reader] = {
        nssName: NSString.String ← XString.NSStringFromReader [r: value, z: localZone];
        msgFileHandle: NSFile.Handle ← NSFile.nullHandle;
        msgFileHandle ← NSFile.OpenByName [directory: folderHandle, path: nssName !
            NSFile.Error = > {msgFileHandle ← NSFile.nullHandle; CONTINUE}];
        IF msgFileHandle = NSFile.nullHandle THEN ERROR; -- no message file!
        msgFile ← NSFile.GetReference [msgFileHandle];
        NSFile.Close [msgFileHandle];
        NSString.FreeString [z: localZone, s: nssName];
        };

    OptionFile.GetStringValue [section: @internalName, entry: @messageFile,
        callBack: FindMessageFileFromName,
        file: ApplicationFolder.FindDescriptionFile [folderHandle]];
    NSFile.Close [folderHandle];
    };

-- Mainline code

InitMessages[];

}...
```

4.4 Index of Interface Items

5

Atom

5.1 Overview

The **Atom** interface provides the definitions and proceduresfor creating and manipulating atoms. An atom is a one-word datum that has a one-to-one correspondence with a textual name. It is often convenient to name an object using a textual name, but **XStrings** are somewhat clumsy to compare and pass around. Using atoms, objects may be named textually without paying the expense of actually storing, copying, and comparing the strings themselves. Atoms were made popular by the Lisp language.

The textual name associated with an atom is called its PName, just as it is in Lisp. If two atoms are equal, they correspond to the same PName, and vice versa. An atom may also have properties associated with it; a property is a [name, value] pair.

5.2 Interface Items

5.2.1 Making Atoms

ATOM: TYPE[1];

null: ATOM = LOOPHOLE[0].

An **ATOM** is a one-word datum that has a one-to-one correspondence with a textual name, or PName. If two **ATOM**s are equal, they correspond to the same PName. If two PNames are equal, they correspond to the same **ATOM**.

Make: PROCEDURE [**pName:** XString.**Reader**] RETURNS [**atom: ATOM**];

MakeAtom: PROCEDURE [**pName:** LONG STRING] RETURNS [**atom: ATOM**];

MakeAtom and **Make** return the **ATOM** corresponding to **pName**, creating one if necessary. In **pName,** uppercase and lowercase characters are different, and will result in different **ATOM**s. The atom returned is valid for the duration of the boot session, and the **pName** will be remembered for the duration of the boot session.

GetPName: PROCEDURE [**atom: ATOM**] RETURNS [**pName:** XString.**Reader**];

GetPName returns the name of **atom**, returning NIL if **atom** is **null**. It raises the error **NoSuchAtom** if **atom** is not valid.

5.2.2 Error

NoSuchAtom: ERROR;

NoSuchAtom may be raised by **GetPName**, **PutProp**, **GetProp**, or **RemoveProp**. It is raised when an operation is presented with an **ATOM** for which no **Make** or **MakeAtom** operation has been done in the boot session. Such atoms are called invalid atoms.

5.2.3 Property Lists

Pair: TYPE = RECORD [prop: ATOM, value: RefAny];

RefAny: TYPE = LONG POINTER;

RefPair: TYPE = LONG POINTER TO READONLY Pair;

Pair defines the [name, value] pair for a property. Properties are named by atoms and have long pointers as values. Property pairs are referenced by a readonly pointer.

PutProp: PROCEDURE [onto: ATOM, pair: Pair];

PutProp adds a property pair to **onto**. If the property already exists, the value is updated. If **onto** is **null**, no action takes place. **PutProp** will raise the error **NoSuchAtom** if **onto** is not valid.

GetProp: PROCEDURE [onto, prop: ATOM] RETURNS [pair: RefPair];

GetProp returns the property pair, whose property name is the atom **prop**, from atom **onto**. If **onto** does not have a property whose name is **prop** or **onto** is **null**, NIL is returned. **GetProp** raises the error **NoSuchAtom** if **onto** is not valid. **Note:** The client may not change the property pair.

RemoveProp: PROCEDURE [onto, prop: ATOM];

RemoveProp removes the property pair, whose property name is the atom **prop**, from atom **onto**. If **onto** is **null**, no action takes place. **RemoveProp** raises the error **NoSuchAtom** if **onto** is not valid.

5.2.4 Enumerating Atoms and Property Lists

MapAtomProc: TYPE = PROCEDURE [ATOM] RETURNS [BOOLEAN];

MapAtomProc is used by **MapAtom** to enumerate atoms. When it returns TRUE, the enumeration stops.

MapAtoms: PROCEDURE [proc: MapAtomProc] RETURNS [lastAtom: ATOM];

MapAtoms enumerates the atoms, calling **proc** once for each atom. If **proc** returns TRUE, **MapAtoms** returns that atom. If **proc** never returns TRUE, **MapAtoms** returns **null**.

MapPListProc: TYPE = PROCEDURE [RefPair] RETURNS [BOOLEAN];

MapPListProc is used by **MapPList** to enumerate property lists. When it returns TRUE, the enumeration stops. **Note:** The client may not change the property pair.

MapPList: PROCEDURE [atom: ATOM, proc: MapPListProc] RETURNS [lastPair: RefPair];

MapPList enumerates the property list of **atom**, calling **proc** once for each pair. If **proc** returns TRUE, **MapPList** returns that pair. If **proc** never returns TRUE, **MapPList** returns NIL.

5.2 Usage/Examples

Two of the major uses of atoms are in the **Event** and **TIP** interfaces. In the **Event** interface, atoms name events. In the **TIP** interface they are used in **TIP** tables and **TIP** results to name actions. (See those interfaces for more information.)

The names of atoms are case sensitive. For example, **atom1** and **atom2** are not equal, while **atom1** and **atom3** are equal.

```
atom1: ATOM = MakeAtom["Atom"L];
atom2: ATOM = MakeAtom["ATOM"L];
atom3: ATOM = Make[GetPName[atom1]];
```

The value of an atom is a function of the characters of its name and the names of the atoms that have been previously created. Atoms may not be pickled (put in a permanent representation that may be filed and recovered later) or transmitted to another system. The atom is just a convenient way to represent and manipulate the name, which is the permanent representation.

5.4 Index of Interface Items

6 AtomicProfile

6.1 Overview

The **AtomicProfile** interface provides a general mechanism for storing and retrieving global values, such as user name and password. Values are named by atoms and may have a type of either boolean, long integer, or string. Only one value isassociated with each atom, regardless of type.

Boolean and long integer values are simple values, unlike string values, which are passed by reference. The value of strings may be gotten by calling the **GetString** routine, in which case they must be returned to the implementation using **DoneWithString**, or they may be gotten using a callback procedure in **EnumerateString**.

6.2 Interface Items

6.2.1 Boolean Values

GetBOOLEAN: PROCEDURE [atom: Atom.ATOM] RETURNS [BOOLEAN];

GetBOOLEAN returns the boolean value associated with **atom**. If there is no boolean value associated with **atom**, **GetBOOLEAN** returns FALSE.

SetBOOLEAN: PROCEDURE [atom: Atom.ATOM, boolean: BOOLEAN];

SetBOOLEAN associates the boolean value **boolean** with **atom**. If **atom** previously had another value associated with it, that value is replaced. The event **AtomicProfileChange** is notified, with event data being a long pointer to **atom**.

6.2.2 Integer Values

GetLONGINTEGER: PROCEDURE [atom: Atom.ATOM] RETURNS [LONG INTEGER];

GetLONGINTEGER returns the long integer value associated with **atom**. If there is no long integer value associated with **atom**, **GetLONGINTEGER** returns 0.

SetLONGINTEGER: PROCEDURE [atom: Atom.ATOM, int: LONG INTEGER];

SetLONGINTEGER associates the long integer value **int** with **atom**. If **atom** previously had another value associated with it, that value is replaced. The event **AtomicProfileChange** is notified, with event data being a long pointer to **atom**.

6.2.3 String Values

GetString: PROCEDURE [atom: Atom.ATOM] RETURNS [XString.Reader];

GetString returns the string value associated with **atom**. The string is reference counted, and the client must return the string by calling **DoneWithString**. If there is no string value associated with **atom**, **GetString** returns NIL.

DoneWithString: PROCEDURE [string: XString.Reader];

After obtaining a reader using **GetString**, it must be returned via **DoneWithString** so the implementation's use-count will be correct. Failure to do so will result in a storage leak if the value of the atom is replaced (see the example below).

**EnumerateString: PROCEDURE [
  atom: Atom.ATOM, proc: PROCEDURE [XString.Reader]];**

EnumerateString provides an alternate method of examining the string value of an atom. If **atom** has a string value, **proc** will be called with the string value. **proc** is called from within the monitor if the implementation. The reader is valid for the duration of the callback, but **proc** must not call any of the operations in the implementation. If **atom** has no string value, **proc** will not be called.

**SetString: PROCEDURE [atom: Atom.ATOM, string: XString.Reader,
  immutable: BOOLEAN ← FALSE];**

SetString associates the string value **string** with **atom**. If **atom** previously had another value associated with it, that value is replaced. If **immutable** is FALSE, **SetString** will copy **string**'s body and byte sequence, otherwise it only copies the reader body. The client must not deallocate the byte sequence in this case. The event **AtomicProfileChange** is notified with event data being a long pointer to **atom**.

6.3 Usage/Examples

AtomicProfile provides a general mechanism for storing and retrieving values. Actual use by a client depends on knowing the names and expected types of values. ViewPoint defines some basic values such as user name and password. Other systems may define other values.

The following example has a client keeping track of the user name, which depends on the **AtomicProfileChange** event. **UserNameChanged** is called when any **AtomicProfile** value is changed. By examining the event data of the agent procedure, the example can act on changes to the user name.

```
atomicProfileChange: Atom.ATOM = Atom.MakeAtom["AtomicProfileChange"L];
fullUserName: Atom.ATOM = Atom.MakeAtom["FullUserName"L];
debugging: Atom.ATOM = Atom.MakeAtom["Debugging"L];

UserNameChanged: Event.AgentProc = {
   atomChanged: LONG POINTER TO Atom.ATOM = eventData;
   IF atomChanged ↑ = fullUserName THEN {
   name: XString.Reader = GetString[fullUserName];
   << do processing of new name >>
   IF GetBOOLEAN[debugging] THEN {<< do debugging only code>>};
   DoneWithString[name]}};

Event.AddDependency[
   agent: UserNameChanged, myData: NIL, event: atomicProfileChange];
```

6.4 Index of Interface Items

7 Attention

7.1 Overview

The **Attention** interface provides a means of displaying messages to the user. It implements a single window into which messages are displayed. In addition to displaying messages, the **Attention** window has a menu to which clients can add system-wide commands.

There are three types of messages: simple messages, sticky messages, and confirmed messages. Simple messages have no special semantics. Sticky messages are redisplayed when a non-sticky message is cleared. **Attention** keeps track of one sticky message. Confirmed messages ask for confirmation by the user.

Attention allows messages to be logically appended. Each of the posting operations, **Post**, **PostSticky**, and **PostAndConfirm**, contain a boolean parameter **clear**. If **clear** is **TRUE**, the window is cleared before the message is displayed. If not, the message is appended to the currently displayed message. This allows the client to use **Attention** to construct complex messages.

The single global **Attention** window and construction of messages does not work well if multiple processes try to display messages simultaneously. To work around this conflict, the following restriction is imposed: The **Attention** interface may only be called from the notifier process. If another process wishes to post a message in the **Attention** window, it should use the periodic notification mechanism provided by the **TIP** interface. Following this rule guarantees that only well-formed messages will be displayed.

To facilitate construction of messages, an **XFormat.Handle** is provided whose format procedure will post a simple message without clearing the window. See the example below and the **XFormat** chapter for more information.

The **Attention** window has a global system menu. Operations are provided so clients may add menu items to this menu, remove items from the menu, or swap items in the menu.

7.2 Interface Items

7.2.1 Simple Messages

Post: PROCEDURE [s: XString.Reader, clear: BOOLEAN ← TRUE, beep: BOOLEAN ← FALSE,
blink: BOOLEAN ← FALSE];

Post displays the message **s** in the **Attention** window. If **clear** is TRUE, it clears the **Attention** window before displaying **s**; otherwise, it displays it after whatever text is currently showing. **Attention** makes its own copy of the reader body and bytes of **s**. **beep** and **blink** stipulate that the corresponding feedback be presented to the user.

Clear: PROCEDURE;

Clear clears the **Attention** window of any simple message. If a simple message is being displayed and there is a current sticky message, the sticky message will be displayed. **Clear** has no effect if a sticky message is being displayed.

formatHandle: XFormat.Handle;

formatHandle is an **XFormat.Handle** provided by the **Attention** window that clients can use to post simple messages. Its format procedure logically calls **Post** with clear being FALSE. (See below for an example.)

7.2.2 Sticky Messages

Sticky messages are redisplayed when a non-sticky message is cleared. **Attention** keeps track of one sticky message.

PostSticky: PROCEDURE [s: XString.Reader, clear: BOOLEAN ← TRUE],
beep: BOOLEAN ← FALSE, blink: BOOLEAN ← FALSE;

PostSticky appends **s** to, or replaces, the current sticky message, and then displays this new message in the window. Its operation is: (1) if the window has a simple message or **clear**, then clear the window; (2) if clear, then clear the current sticky message; (3) append **s** to the current sticky message; and (4) display the new current sticky message. **Attention** makes its own copy of the reader body and bytes of **s**. **beep** and **blink** are the same as in **Post** above.

ClearSticky: PROCEDURE;

ClearSticky clears any current sticky message. If a sticky message is being displayed, the window is cleared. **ClearSticky** has no effect if there is no sticky message.

7.2.3 Confirmation Messages

PostAndConfirm: PROCEDURE [
s: XString.Reader, clear: BOOLEAN ← TRUE, confirmChoices: ConfirmChoices ← [NIL, NIL],
timeout: Process.Ticks ← dontTimeout,

```
   beep: BOOLEAN ←FALSE, blink: BOOLEAN ←FALSE]
   RETURNS [confirmed, timedOut: BOOLEAN];
```

```
ConfirmChoices: TYPE = RECORD [yes, no: XString.Reader];
```

```
dontTimeout: Process.Ticks = 0;
```

PostAndConfirm acts like **Post** in displaying the message **s** but waits for confirmation by the user. The **confirmChoices** messages are displayed, and the user should select one of the choices with the mouse. If the user selects yes, **confirmed** is returned TRUE; if no is selected or the STOP key is depressed, **confirmed** is returned FALSE. If **confirmChoices.yes # NIL** and **confrmChoices.no = NIL**, then only **confirmChoices.yes** is posted and **confirmChoices.no** is ignored. This is useful for posting a message that the user must see, but for which the user gets no choice, such as "Unable to communicate with the printer: CONTINUE". **PostAndConfirm** absorbs all user input except the STOP key and mouse actions over the yes and no messages. The client may specify a **timeout** value, which will cause **PostAndConfirm** to return **confirmed** FALSE and **timedOut** TRUE if the user does not act within **timeout** ticks. The default value **dontTimeout** disables this timeout feature. **Attention** makes its own copy of the reader body and bytes of **s**.

7.2.4 System Menu

```
AddMenuItem: PROCEDURE [item: MenuData.ItemHandle];
```

AddMenuItem adds **item** to the global system menu.

```
RemoveMenuItem: PROCEDURE [item: MenuData.ItemHandle];
```

RemoveMenuItem removes **item** from the global system menu. There is no effect if **item** is not in the menu.

```
SwapMenuItem: PROCEDURE [old, new: MenuData.ItemHandle];
```

SwapMenuItem swaps **new** for **old** in the global system menu. **SwapMenuItem[old: NIL, new: item]** is equivalent to **AddMenuItem[item: item]** and **SwapMenuItem[old: item, new: NIL]** is equivalent to **RemoveMenuItem[item: item]**.

7.3 Usage/Examples

The following example has a client displaying the name and size of a file. It uses the **NSFile** interface to access the file and get the name and size attributes. See the *Services Programmer's Guide* (610E00180): *Filing Programmer's Manual* for documentation on the **NSFile** interface.

```
PostNameAndSize: PROCEDURE [file: NSFile.Handle ] = {
   nameSelections: NSFile.Selections = [interpreted: [name: TRUE]];
   attributes: NSFile.AttributesRecord;
   rb: XString.ReaderBody ← Message[theFile];
   Attention.Post[s: @rb, clear: TRUE]; -- start a new message
   XFormat.NSString[Attention.formatHandle, attributes.name];
   XFormat.ReaderBody[h: Attention.formatHandle, rb: Message[contains]];
   XFormat.Decimal[h: Attention.formatHandle, n: NSFile.GetSizeInBytes[file]];
```

```
  rb ← Message[bytes];
  Attention.Post[s: @rb]}; -- clear defaults to FALSE

Message: PROCEDURE [key: {theFile, contains, bytes}] RETURNS [XString.ReaderBody] = {
  ...};
```

An example of the resulting message displayed in the **Attention** window is

```
The file Foo contains 53324 bytes
```

The example intermixes use of the format handle and use of the **Post** procedure. A client could clear first, using the **Clear** procedure, and then display the message just using the format handle.

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8

BlackKeys

8.1 Overview

The **BlackKeys** interface provides the capability to change the interpretation of the main (central) section of the physical keyboard. Included are the data structures that define a keyboard record, as well as the procedures used to manipulate the keyboard stack.

The average client will use only the data structures that are provided by the **BlackKeys** interface. The procedures are reserved for a keyboard manager interested in interfacing between the user and the blackkeys stack of keyboards.

8.2 Interface Items

8.2.1 Keyboard Data Structures

The **BlackKeys** data structures provide the framework for client-defined keys in the main (central) section of the physical keyboard. This includes interface to a keyboard picture whose keytops may be selected with the mouse to simulate pressing of the physical key on the keyboard.

```
Keyboard: TYPE = LONG POINTER TO KeyboardObject ← NIL;

KeyboardObject: TYPE = RECORD [
   table: TIP.Table ← NIL,
   charTranslator: TIP.CharTranslator ← [proc: NIL, data: NIL],
   pictureProc: PictureProc ← NIL,
   label: XString.ReaderBody ← XString.nullReaderBody,
   clientData: LONG POINTER ← NIL];
```

KeyboardObject is the keyboard interpretation data structure. The client may provide its own **TIP.Table** or default it to **NIL**, in which case the **NormalKeyboard.TIP** table is used. (See Appendix A for productions returned by **NormalKeyboard.TIP**.) A **TIP.CharTranslator** may be provided to handle **CHAR** and **BUFFEREDCHAR** productions from a **TIP.Table**. A **PictureProc** may be provided to be called when installing or removing this keyboard. Absence of such a procedure assumes there is not a picture associated with this keyboard. **label** is the string that will appear in the SoftKeys window when the KEYBOARD key is pressed down. Pressing (or mousing) the key marked **label** will invoke this keyboard. **clientData** is provided to associate any other information the client might need to keep with the keyboard.

```
PictureProc: TYPE = PROCEDURE [
   keyboard: Keyboard,
   action: PictureAction]
   RETURNS [
   picture: Picture ← nullPicture,
   geometry: GeometryTable ←NIL];
```

PictureProc is a client-provided procedure that will be called by a keyboard window application when the client's keyboard is being installed (**action** = **acquire**) or removed (**action** = **release**) from the top of the blackkeys stack of active keyboards. The client may use this opportunity to map or unmap the picture and geometry table used by the keyboard window application.

```
PictureAction: TYPE = {acquire, release};
```

acquire = client's keyboard is being installed at the top of the keyboard stack (becoming the current keyboard)

release = client's keyboard is being removed from the top of the keyboard stack

```
PictureType: TYPE = {bitmap, text};

Picture: TYPE = RECORD [
 variant: SELECT type: PictureType FROM
   bitmap = > [bitmap: LONG POINTER],
   text = > [text: XString.Reader]
   ENDCASE];
```

The **variant** of the record, **Picture**, allows the client the choice of presenting his keyboard window in either bitmap or textual form. (See the **KeyboardWindow** interface for discussion of the structure behind a keyboard **bitmap**.) **text** is pointed to by an **XString.Reader**. The text will not be copied.

```
nullPicture: bitmap BlackKeys.Picture = [bitmap[NIL]];
```

The variable **nullPicture** represents a null entry to the keyboard window.

```
GeometryTable: TYPE = LONG POINTER;
```

A geometry table allows access to the data structure. (See the **KeyboardWindow** interface chapter for discussion of the structure of a geometry table.)

8.2.2 Getting a Handle to the Current Keyboard

```
BlackKeysChange: Event.EventType; -- ATOM defined as "BlackKeysChange"
```

Changing the keyboard at the top of the blackkeys stack of keyboards will result in the notification **BlackKeysChange** through the **Event** mechanism. The **eventData** supplied by the **Event.Notify** will be the current keyboard handle.

GetCurrentKeyboard: PROCEDURE RETURNS [current: Keyboard];

GetCurrentKeyboard returns the current keyboard from the top of the blackkeys stack.

8.2.3 Procedures

Push: PROCEDURE [keyboard: Keyboard];

The **Push** procedure installs a black key interpretation at the top of the blackkeys stack of keyboards. The **TIP.Table** and/or **TIP.CharTranslator** will be registered with **TIP** and the event **BlackKeysChange** will be broadcast.

Remove: PROCEDURE [keyboard: Keyboard];

The **Remove** procedure removes the keyboard from the stack of active keyboards and resets the **TIP.Table** and **TIP.CharTranslator** as applicable. The event **BlackKeysChange** will be broadcast if **keyboard** is on the top of the blackkeys stack.

May raise the **ERROR BlackKeys.InvalidHandle**.

Swap: PROCEDURE [old:Keyboard, new:Keyboard];

The **Swap** procedure is designed to change black keys' interpretations without returning to some previous or other default value in between. It is essentially the equivalent of a **Remove** followed by a **Push**. The event **BlackKeysChange** will be broadcast if the keyboard being removed was on top of the stack.

May raise the **ERROR BlackKeys.InvalidHandle**.

8.2.4 Errors

InvalidHandle: ERROR;

This error is raised if the **keyboard** passed to **Remove** or **Swap** (**old**) is not in the set of active **BlackKeys** keyboards.

8.3 Usage/Examples

8.3.1 Defining a Keyboard Record

```
DefineKeyboard: PROCEDURE =
BEGIN
 nameString: XString.ReaderBody ← XString.FromSTRING["Swahili"L]

 swahiliKeyboardRecord: BlackKeys.KeyboardObject ← [
  table: NIL,
  charTranslator: [MakeChar, NIL],
  pictureProc: MapBitmapFile,
  label: XString.CopyToNewReaderBody[@nameString, Heap.systemZone]];
 --save the pointer to the record somewhere for future use --
END; --DefineKeyboard --

MapBitmapFile: BlackKeys.PictureProc =
BEGIN
 pixPtr: BlackKeys.Picture.bitmap ← BlackKeys.nullPicture;
 SELECT action FROM
  acquire = >
{--Do the right thing to map the bitmap. Uses the default geometry table. --
   RETURN[pixPtr, KeyboardWindow.defaultGeometry] };
  release = > {--Do the right thing to unmap the bitmap --
   RETURN[BlackKeys.nullPicture, NIL] }
END; -- MapBitmapFile

MakeChar: TIP.KeyToCharProc =
BEGIN
 --map bufferedChar to desired XString.Character --
END; -- MakeChar
```

8.4 Index of Interface Items

9

BWSAttributeTypes

9.1 Overview

BWSAttributeTypes defines the **NSFile.ExtendedAttributeTypes** that are used by ViewPoint and defines the first **NSFile.ExtendedAttributeType** available for client use.

The only extended attributes defined here are the ones that can be attached to any file, such as mailing and filing application attributes. Attributes that are unique to a particular application's files should be defined privately within that application rather than defined here. It is acceptable for several applications to use the same extended attributes because application A should never be reading the attributes from application B's files and vice versa. Fine Point: Several application-specific attribute types are included in this interface for compatibility.

Here we define the extended attributes that can be attached to any file, leaving a few spare ones for future use. We also define the first available "application attribute" (**firstAvailableApplicationType**). **Caution:** No application should use an extended attribute smaller than this one! Nor should an application use an extended attribute larger than **lastBWSType**.

9.2 Interface Items

9.2.1 Available Application Types

firstAvailableApplicationType: NSFile.ExtendedAttributeType = . . . ;

lastBWSType: NSFile.ExtendedAttributeType = . . . ;

Applications should only use the types in the range **[firstAvailableApplicationType . . lastBWSType)**. **firstAvailableApplicationType** is the first extended attribute type that applications can use to store application-specific attributes. **Caution:** No application should use an extended attribute smaller than **firstAvailableApplicationType**. **lastBWSType** is the last extended attribute type that applications can use to store application-specific attributes. **Caution:** No application should use an extended attribute larger than **lastBWSType**.

If a Viewpoint client needs more attributes than the number in this range, the client should see the NSFiling group to obtain a range specific to that client.

9.2.2 Viewpoint Types

Please consult the Mesa interface for the exact assignment of ViewPoint-specific types.

9.3 Index of Interface Items

10

BWSFileTypes

10.1 Overview

BWSFileTypes defines several **NSFile.Type**s used by ViewPoint. These types should not be used by applications. (Also see the **Catalog** and **Prototype** interfaces.)

All file types used by ViewPoint clients must be managed by the client. Ranges of file types may be obtained from the Filing group.

10.2 Interface Items

root: NSFile.Type = ...;

The root file of the volume has this type. The root has children that are called (by convention) *catalogs*.

desktop, desktopCatalog: NSFile.Type = ...;

The desktop catalog contains all the desktops on a workstation. An individual desktop has the same type as the desktop catalog.

prototypeCatalog: NSFile.Type = ...;

The prototype catalog contains prototype files for each application. A prototype file is a blank application file that the user can make copies of, such as Blank Folder, Blank Document. (See the **Prototype** interface.)

systemFileCatalog: NSFile.Type = ...;

The system file catalog contains system files, such as the bcds for an application, message files, font files, TIP files, etc. (See the **Catalog** interface.)

10.3 Index of Interface Items

11

BWSZone

11.1 Overview

BWSZone defines several zones, each with different characteristics, that may be used by ViewPoint clients as appropriate.

11.2 Interface Items

All these zones are created at boot time and exist for the duration of the boot session.

permanent: UNCOUNTED ZONE;

Permanent: PROCEDURE RETURNS [UNCOUNTED ZONE];

permanent is intended for nodes that are never deallocated. It has infinite threshold. **Permanent** returns **permanent**.

logonSession: UNCOUNTED ZONE;

LogonSession: PROCEDURE RETURNS [UNCOUNTED ZONE];

logonSession is intended for nodes that last for a logon/logoff session. **logonSession** is emptied of all nodes at each logoff (i.e., **Heap.Flush**). **LogonSession** returns **logonSession**. **logonSession** is created at boot time, and is flushed at logoff.

shortLifetime: UNCOUNTED ZONE;

ShortLifetime: PROCEDURE RETURNS [UNCOUNTED ZONE];

shortLifetime is intended for nodes that are allocated for a very short time, such as during a notification. **ShortLifetime** returns **shortLifetime**.

semiPermanent: UNCOUNTED ZONE;

SemiPermanent: PROCEDURE RETURNS [UNCOUNTED ZONE];

semiPermanent is intended for nodes that are allocated for a very long time but that might occasionally have to be expanded. **SemiPermanent** returns **semiPermanent**.

11.3 Index of Interface Items

12 Catalog

12.1 Overview

Catalog manipulates files that are direct descendants of the root file on a NSFiling volume. These files are referred to as *catalogs*. Each catalog is uniquely identified by its file type. Files can be opened and created within a catalog. Catalogs can be opened, created, and enumerated.

Viewpoint creates a system file catalog and a prototype catalog (see the **Prototype** interface) at boot time. The system file catalog typically holds font files, **TIP** files, icon picture files, message files, etc.

12.2 Interface Items

12.2.1 Finding and Creating Files in a Catalog

```
GetFile: PROCEDURE [
    catalogType: NSFile.Type ← BWSFileTypes.systemFileCatalog,
    name: XString.Reader,
    readonly: BOOLEAN ← FALSE,
    session: NSFile.Session ← NSFile.nullSession]
    RETURNS [file: NSFile.Handle];
```

GetFile finds a file with name **name** in the catalog with type **catalogType**. If the file cannot be found, **NSFile.nullHandle** is returned.

```
CreateFile: PROCEDURE [
    catalogType: NSFile.Type ← BWSFileTypes.systemFileCatalog,
    name: XString.Reader,
    type: NSFile.Type,
    isDirectory: BOOLEAN ← FALSE,
    size: LONG CARDINAL ← 0,
    session: NSFile.Session ← NSFile.nullSession]
    RETURNS [file: NSFile.Handle];
```

CreateFile creates a file with the specified attributes (**name**, **type**, **isDirectory**, **size** in bytes) in the catalog with type **catalogType**.

12.2.2 Operating on Catalogs

```
Open: PROCEDURE [
    catalogType: NSFile.Type,
    session: NSFile.Session ← NSFile.nullSession]
    RETURNS [catalog: NSFile.Handle];
```

Opens the catalog with type **catalogType**. If the catalog cannot be opened, **NSFile.nullHandle** is returned.

```
Create: PROCEDURE [
    name: XString.Reader,
    catalogType: NSFile.Type,
    session: NSFile.Session ← NSFile.nullSession]
    RETURNS [catalog: NSFile.Reference];
```

Creates a catalog with the specified name and type. If the catalog already exists or cannot be created, **NSFile.nullReference** is returned. **Note:** Even though the file can be identified by type only, the name should be logical (e.g., "System Files") so that any tools written to manipulate catalogs can display these names.

```
Enumerate: PROCEDURE [proc: CatalogProc];
```

```
CatalogProc: TYPE = PROCEDURE [catalogType: NSFile.Type]
    RETURNS [continue: BOOLEAN ← TRUE];
```

Enumerate calls the client supplied **proc** for each existing catalog or until **proc** returns FALSE.

```
beforeLogonSession: NSFile.Session;
```

beforeLogonSession is a session that can be used when calling a **Catalog** procedure before any user has logged on, such as at boot time. It is set to be the default session until a user logs on.

12.3 Index of Interface Items

13

Containee

13.1 Overview

Containee is an application registration facility. An application is a software package that implements the manipulation of one type of file. **Containee** is a facility for associating an application with a file type.

13.1.1 Background

All **NSFiles** have:

- a name
- a file type (**LONG CARDINAL**)
- a set of attributes, such as create date
- either:
  - content, such as a document
  - children that are also **NSFiles**, such as a folder

An **NSFile** that has children is often called a directory. Fine Point: An **NSFile** can actually have both content and children, that is ignored for now to simplify this discussion. Since the children of an **NSFile** can themselves have children, **NSFile** supports a hierarchical file system.

A ViewPoint desktop is backed by an **NSFile** that has children. Each child file of the desktop's **NSFile** is represented on the screen by an iconic picture.

Each application operates on **NSFiles** of a particular file type. For example, ViewPoint documents operate on **NSFiles** with file type of 4353. Each document icon is actually an **NSFile** of type 4353. Each application needs a way to register its ability to operate on files of a particular type. **Containee** is such a facility.

13.1.2 Containee.Implementation

An application's ability to operate on files of a particular type includes such operations as:

- Display of the iconic picture (full size and tiny).
- Open, performed when the user selects an icon and presses OPEN.
- Properties, performed when the user selects an icon and presses PROPS.
- Take the current selection, performed when the user drops an object onto an icon by COPYing or MOVEing a selected object to an icon.

An application registers itself by calling **Containee.SetImplementation**, supplying a file type and a **Containee.Implementation**. A **Containee.Implementation** is a record that contains two important procedures:

- A procedure for displaying an icon picture (**Containee.PictureProc**).
- A procedure for performing various operations on an icon, such as open, create a property sheet, and take the current selection (**Containee.GenericProc**).

This application registration allows the ViewPoint desktop implementation to be open-ended. The desktop implementation itself does not know how any file behaves. Rather it depends on applications registering their ability to operate on particular file types. The desktop implementation, at logon, simply enumerates the child files of the desktop's **NSFile** (using **NSFile.List**), obtaining the file type for each child. For each child file, the desktop implementation gets an application's **Containee.Implementation** by using the child file's file type (and **Containee.GetImplementation**) and then calls that application's **Containee.PictureProc** to actually display an icon picture. Similarly, when the user selects an icon on the desktop and presses OPEN, the desktop implementation uses the file type of the file at that place on the desktop to get the application's **Containee.Implementation** and then calls the application's **Containee.GenericProc** to get a **StarWindowShell** created. The implementations of Folders and File Drawers are similar to the desktop implementation in this respect.

13.1.3 Containee.Data

An application needs to distinguish one file from another. Two different documents may be the same file type, but probably have different names and different contents. Whenever an application's **Containee.DisplayProc** or **Containee.GenericProc** is called, the particular file being operated on by the user is passed to the procedure through the **Containee.DataHandle** parameter. A **Containee.DataHandle** is a pointer to a **Containee.Data** that is simply a record with an **NSFile.Reference** in it. An **NSFile.Reference** uniquely identifies a particular file and allows the application to utilize various **NSFile** file-accessing procedures for manipulating the file.

13.2 Interface Items

13.2.1 Items for Application Implementors

SetImplementation: PROCEDURE [NSFile.Type, Implementation]
  RETURNS [Implementation];

SetImplementation associates an **Implementation** record with a particular file type and returns the previous **Implementation** that was associated with that file type. An application calls **SetImplementation** to register its ability to operate on files of a particular type.

```
Implementation: TYPE = RECORD [
   implementors: LONG POINTER ← NIL,
   name: XString.ReaderBody ← XString.nullReaderBody,
   smallPictureProc: SmallPictureProc ← NIL,
   pictureProc:PictureProc ← NIL,
   convertProc: Selection.ConvertProc ← NIL,
   genericProc:GenericProc ← NIL ];
```

When an application registers its ability to operate on files of a particular type (i.e, calls **SetImplementation**), it supplies an **Implementation** record. The **Implementation** record defines the behavior of all files of that type.

implementors is provided for the convenience of clients that may want to associate some application-specific data with the **Implementation** record. **Note:** This data is one per application, not one per file.

name is a user-sensible name for the objects that the **Implementation** manipulates, such as "Document" or "Spreadsheet." This string typically comes from **XMessage**. The bytes of **name** are not copied--the storage for name must be allocated forever (which is easy to do using **XMessage**).

smallPictureProc is a procedure of type **SmallPictureProc** that returns a character. This procedure is describe below.

pictureProc is called whenever the file's full-sized icon picture needs to be painted. (See **PictureProc**.)

convertProc is called to convert the file into another form, such as an Interpress master. This procedure is used when the owner of the current selection is a container, such as a folder, and the selection is actually a file (row) in the container. The owner of the selection (i.e., the container implementation) may be called to convert the selected file (row), but only the application that implements that file's type can do the conversion. The **convertProc** allows the owner of the selection to pass the conversion request along to the application. The **data** parameter to the **convertProc** is a **Containee.DataHandle**. This **convertProc** does not need to be able to convert to a target type of **file** or **fileType**, but rather should call **Containee.DefaultFileConvertProc** for these target types. If the application does not perform conversion to any target types, **Containee.DefaultFileConvertProc** should be provided as the **convertProc**.

genericProc is where most of the application's real implementation resides. **genericProc** is called, for example, to open an icon, to produce a property sheet for an icon, to drop something on an icon, etc. See **GenericProc**.

```
SmallPictureProc: TYPE = PROCEDURE [
   data: DataHandle ← NIL,
   type: NSFile.Type ← ignoreType,
   normalOrReference: PictureState]
   RETURNS [smallPicture: XString.Character];
```

```
PictureState: TYPE = { garbage, normal, highlighted, ghost,
   reference, referenceHighlighted };
```

```
ignoreType: NSFile.Type = LAST[LONG CARDINAL];
```

The **SmallPictureProc** should return a character for the application, which should be obtained by passing a 13x13-bit icon picture to **SimpleTextFont.AddClientDefinedCharacter**. This character is used when the file is inside a folder. **normalOrReference** will be either **normal** or **reference**, and the appropriate small picture should be returned. The **SmallPictureProc** should try to use the **type** parameter first if it is not **Containee.ignoreType**. If it is **ignoreType**, the **SmallPictureProc** should use the **data** parameter. This change is necessary for allowing the reference icon application to work properly. Fine Point: The picture for **normalOrReference = reference/referenceHighlighted** will not normally be used by the folder application directly, but rather would be used by a generic reference icon application.

```
Data: TYPE = RECORD [
  reference: NSFile.Reference ← NSFile.nullReference ];

DataHandle: TYPE = LONG POINTER TO Data;

nullData:Data;
```

Data uniquely identifies a file. An application needs to distinguish one file from another. Two documents may be the same file type, but probably have different names and different contents. Whenever an application's **PictureProc** or **GenericProc** or **Implementation.convertProc** is called, the particular file being operated on by the user is passed to the procedure through the **DataHandle** parameter. An **NSFile.Reference** uniquely identifies a particular file and allows the application to utilize various **NSFile** file-accessing procedures for manipulating the file. **nullData** is a constant that should be used to represent a null **Containee.Data**.

```
GenericProc: TYPE = PROCEDURE [
  atom: Atom.ATOM,
  data:DataHandle,
  changeProc:ChangeProc ← NIL,
  changeProcData: LONG POINTER ← NIL]
  RETURNS [LONG UNSPECIFIED];
```

A **GenericProc** is a procedure supplied by an application as part of an **Implementation**. The **GenericProc** will be called to perform one of several operations that a user can invoke. **atom** tells the **GenericProc** what operation to perform. For example, when the user selects an icon and presses the OPEN key, the application's **GenericProc** is called with an **atom** of Open.

data identifies the particular **NSFile** to be operated on. The **NSFile**'s file type will be the one for which this application has registered its **Implementation**.

A **GenericProc** must return a value. The type of the return value depends on the **atom** passed in. Some atoms, their meaning to the **GenericProc**, and the expected return values are as follows:

Atom	Return Value and Meaning
CanYouTakeSelection	LONG POINTER TO BOOLEAN If the application is willing to have the current selection dropped onto it, the **GenericProc** should return TRUE. This

occurswhen the user has selected something, pressed COPY or MOVE, and then selected one of this application's files. While the user has the mouse button down, the cursor changes to a question mark if the **GenericProc** returns **FALSE**; otherwise, the cursor stays the same and the icon picture flashes. This operation should be efficient and usually involves calling **Selection.CanYouConvert** or **Selection.HowHard** or **Selection.Query** to determine what **Selection.Targets** the selected object can be converted to. For example, the printing application's **GenericProc** returns **TRUE** if the current selection can be converted to an Interpress Master.

Open	**StarWindowShell.Handle** The application should create a **StarWindowShell**. Usually, the content displayed in the **StarWindowShell** will be derived from the contents of the file. For example, the ViewPoint document editor application displays the text and graphics contained in the file, thus making the file ready for viewing and/or editing.
Props	**StarWindowShell.Handle** The application should create a PropertySheet. Usually, the properties shown reflect some attributes of the file. For example, the Folder property sheet shows the name of the folder, how it is sorted, and how many objects it contains. These properties are all **NSFile** attributes of the file.
TakeSelection	**LONG POINTER TO BOOLEAN** The action performed for this atom is highly dependent on the particular application. This atom is passed when the user has selected something, pressed MOVE, then selected one of this application's files. For some applications, this means the selected object should be moved into this application; for example, the Folder application converts the selected object to a file and adds the file to the folder. For other applications, this means the selected object should be operated on in some application-specific fashion; for example, the printing application converts the selected object to an Interpress Master (file or stream) and then sends the master to a printer. The **GenericProc** should return **TRUE** if the operation was successful, **FALSE** otherwise.
TakeSelectionCopy	**LONG POINTER TO BOOLEAN** This atom has the same meaning as **TakeSelection**, except it corresponds to the COPY key being pressed rather than MOVE. Again, the meaning of this is highly application dependent.

If the execution of the **GenericProc** causes any change to the **NSFile**'s attributes, the **changeProc** should be called. This allows containers (such as Desktop, Folders) to update the display to reflect the changes. For example, when the **atom** is Props, the **GenericProc** must save the **changeProc** and return the **StarWindowShell.Handle** for the property sheet. Then later, if the user changes the file's name, for example, the application's

FormWindow.MenuItemProc gets control when the user is done and must then retrieve the changeProc and call it. (See the section on Usage/Examples for more detail.)

If the client's GenericProc is called with an atom that it does not recognize, it should call the previous GenericProc (using the old Implementation that was returned when it called Containee.SetImplementation). The original system-supplied GenericProc acts to backstop all possible atoms.

```
ChangeProc: TYPE = PROCEDURE [
   changeProcData: LONG POINTER ← NIL,
   data:DataHandle,
   changedAttributes: NSFile.Selections ← []
   noChanges: BOOLEAN ← FALSE];
```

A ChangeProc is a callback procedure that is passed to a GenericProc. It must always be called by the client regardless of whether an attribute of the file being operated has changed. The reason for always calling the changeProc is to allow deallocation of the changeProcData. The noChanges boolean indicates the effect on the relevant file's attributes. The changeProcData parameter must be correctly supplied even for the noChanges = TRUE case. This is used, for example, when the user changes the name of a file by using a property sheet. When the property sheet is taken down, the application changes the file's name and the ChangeProc that was passed to the GenericProc must then be called by the application. (See more detail in the section on Usage/Examples).

```
PictureProc: TYPE = PROCEDURE [
   data:DataHandle,
   window: Window.Handle,
   box: Window.Box,
   old, new: PictureState ];

PictureState: TYPE = {garbage, normal, highlighted, ghost, reference, referenceHighlighted};
```

A PictureProc is a procedure supplied by an application as part of an Implementation. The PictureProc is called whenever the desktop implementation needs to have the application's icon picture repainted or painted differently.

data identifies the particular NSFile whose picture should be painted. The NSFile's file type will be the one for which this application has registered its Implementation. Even though all files of the same type will have the same PictureProc and therefore the same-shaped picture, each picture will differ because the name of the NSFile is often displayed on the picture. An application's PictureProc can obtain an NSFile's name by using NSFile operations, but may more easily obtain it using Containee.GetCachedName. This is one of the primary intended uses for GetCachedName. (See the section on Attribute Cache).

window and box should be passed to any display procedures used to paint the icon picture, such as Display.Bitmap and SimpleTextDisplay.StringIntoWindow.

The old and new arguments describe the current and desired states of the icon picture. garbage is the unknown state. PictureProc will be called with new = garbage before moving or otherwise altering the icon; this lets an application remember an icon's placement. The application can thus continually update the icon (for example, to represent time-of-day) or can force a repaint by using Window.Invalidate (to change the shape of an InBasket icon, for example), normal is the picture displayed when the icon is not selected.

highlighted is the picture displayed when the icon is selected. **ghost** is the picture displayed when the icon is currently open. **reference** is the picture displayed to represent a remote file. **referenceHighlighted** is the highlighted version of **reference**. The desktop implementation will never use these last two states, but a generic reference icon application might.

DefaultFileConvertProc: Selection.ConvertProc;

DefaultFileConvertProc is a **Selection.ConvertProc** that knows how to convert to **Selection.Targets** of **file** and **fileType**. **DefaultFileConvertProc** should be called from an application's **Implementation.convertProc** for these targets, or should be provided as the application's **Implementation.convertProc** if the application has no **convertProc** of its own. No file-backed application's **convertProc** should need to worry about these target types.

13.2.2 Items for Application Consumers

These items would not ordinarily be used by an application implementation (provider), but rather by a consumer such as the Desktop or Folder implementation.

GetImplementation: PROCEDURE [NSFile.Type] RETURNS [Implementation];

GetImplementation returns the current **Implementation** for a particular file type.

13.2.3 DefaultImplementation

Containee supports a single global default **Implementation**. This default **Implementation** is used when the user operates on an **NSFile** for which no **Implementation** has yet been registered.

GetDefaultImplementation: PROCEDURE RETURNS [Implementation];

GetDefaultImplementation returns the current default **Implementation**.

SetDefaultImplementation: PROCEDURE [Implementation]
RETURNS [Implementation];

The default implementation provides a dummy display and appropriate "Sorry, Desktop is Unable to Open That Object" complaints in the absence of a particular implementation. Most clients will not call **SetDefaultImplementation**.

13.2.4 Attribute Cache

Clients often want to use several common **NSFile.Attributes**, but it is awkward to pass the attributes around in calls, because the attributes are long, of variable length, and frequently not needed by the called routine. Therefore, **Containee** provides a cache mechanism that can remember and supply popular attributes. Currently, the name and file type attributes are supported. **Containee** decouples the management of in-memory copies of a file's name from parameter-passing arrangements.

GetCachedName: PROCEDURE [data:DataHandle]
RETURNS [name: XString.ReaderBody, ticket:Ticket];

GetCachedName returns the name attribute of the**NSFile** referred to by **data**. If the name is not in the cache, it is looked up and added to the cache. **ticket** must be returned (by using **ReturnTicket**) when the client is through with the name. The **ticket** is to prevent one client from changing the name while another is looking at it.

GetCachedType: PROCEDURE [data:DataHandle]
RETURNS [type:NSFile.Type];

GetCachedType returns the type attribute of the **NSFile** referred to by **data**. If the type is not in the cache, it is looked up and added to the cache.

InvalidateCache: PROCEDURE [data:DataHandle] ;

InvalidateCache clears any information about the **NSFile** from the cache. It is typically called when the attributes of an **NSFile** are changed by an application.

InvalidateWholeCache: PROCEDURE ;

InvalidateWholeCache clears the entire cache. Information about all files is cleared.

ReturnTicket: PROCEDURE [ticket: Ticket];

ReturnTicket should be called after calling **GetCachedName**, when the client no longer needs the string.

SetCachedName: PROCEDURE [data:DataHandle, newName: XString.Reader];

SetCachedName allows a client to change a cached name. Care should be taken to keep the filed name consistent with the cached name.

SetCachedType: PROCEDURE [data:DataHandle, newType:NSFile.Type];

SetCachedType allows a client to change a cached type. Care should be taken to keep the filed type consistent with the cached type.

Ticket: TYPE[2];

A **Ticket** is returned when **GetCachedName** is called. When the client is done using the cached name, the ticket must be returned by calling **ReturnTicket**. This is to prevent one client from changing the name while another is looking at it.

13.3 Errors and Signals

```
Error: ERROR [msg: XString.Reader ← NIL, error: ERROR ← NIL,
    errorData: LONG POINTER TO UNSPECIFIED ← NIL];

Signal: SIGNAL [msg: XString.Reader ← NIL, error: ERROR ← NIL,
    errorData: LONG POINTER TO UNSPECIFIED ← NIL];
```

An application's **GenericProc** (and **PictureProc** and **ConvertProc**) should never assume that it has been called by a desktop, and therefore should never call such facilities as **Attention.Post** or **UserTerminal.BlinkDisplay**. (The application might be called by CUSP, for example.) Rather, the application should raise **Containee.Error** or **Signal** with an appropriate message. **Containee** will not catch these errors. The caller of the application's **GenericProc** should catch them and do the appropriate thing. In the typical case, the ViewPoint desktop calls the application's **GenericProc**; it catches the error and calls **Attention.Post** with the passed message. CUSP could catch the error and log the message in a log file.

msg is the message to display to the user. **error** is the actual lower-level error that ocurred that caused **Error** or **Signal** to be raised. **errorData** points to any additional data that accompanied the lower-level error.

13.4 Usage/Examples

13.4.1 Sample Containee

The folder application is used as an example of a simple application that implements a particular file type.

```
-- Constants and global data

folderFileType: NSFile.Type = ...;
oldImpl, newImpl: Containee.Implementation ← [];

-- Containee.Implementation procedures

FolderGenericProc: Containee.GenericProc =
<<[atom: Atom.ATOM,
   data: Containee.DataHandle,
   changeProc: Containee.ChangeProc ← NIL,
   changeProcData: LONG POINTER ← NIL]
   RETURNS [LONG UNSPECIFIED]>>
   BEGIN
   SELECT atom FROM
      open => RETURN [MakeFolder[data, changeProc, changeProcData] ];
      props => RETURN [MakePropertySheet[data, changeProc, changeProcData] ];
      canYouTakeSelection => RETURN [ IF CanITake[] THEN @true ELSE @false];
      takeSelection => RETURN [IF Take[data, move, changeProc, changeProcData] THEN
         @true ELSE @false ];
      takeSelectionCopy = > RETURN [IF Take[data, copy, changeProc, changeProcData]
         THEN @true ELSE @false ];
      ENDCASE = > RETURN [
         oldFolder.genericProc [atom, data, changeProc, changeProcData] ];
   END;

MakeFolder: PROCEDURE [
   data: Containee.DataHandle,
   changeProc: Containee.ChangeProc ←NIL,
   changeProcData: LONG POINTER ←NIL]
   RETURNS [shell: StarWindowShell.Handle] = {...};

Take: PROCEDURE [
   data: Containee.DataHandle,
   copyOrMove: Selection.CopyOrMove,
   changeProc: Containee.ChangeProc ←NIL,
   changeProcData: LONG POINTER ←NIL]
   RETURNS [ok: BOOLEAN] = {...};

-- Initialization procedures

InitAtoms: PROCEDURE = {
   open ←Atom.MakeAtom["Open"L];
   props ←Atom.MakeAtom["Props"L];
   canYouTakeSelection ←Atom.MakeAtom["CanYouTakeSelection"L];
   takeSelection ←Atom.MakeAtom["TakeSelection"L];
   takeSelectionCopy ←Atom.MakeAtom["TakeSelectionCopy"L];
   };

SetImplementation: PROCEDURE = {
   newImpl.genericProc ← FolderGenericProc;
   newImpl.pictureProc ← PictureProc;
   oldImpl ←Containee.SetImplementation [ folderFileType, newImpl ];
   };

-- Mainline code
InitAtoms[];
SetImplementation[];
```

13.4.2 ChangeProc example

The folder property sheet is used to demonstrate a callback to a **ChangeProc**.

```
DataObject: TYPE = RECORD [
   fh: NSFile.Handle,
   changeProc: Containee.ChangeProc ←NIL,
   changeProcData: LONG POINTER ←NIL];

Data: TYPE = LONG POINTER TO DataObject;

MakePropertySheet: PROCEDURE [
   data: Containee.DataHandle,
    changeProc: Containee.ChangeProc ← NIL,
    changeProcData: LONG POINTER ← NIL]
    RETURNS [pSheetShell: StarWindowShell.Handle] = {

    -- Pass changeProc to MakeItems through clientData.

    mydata: DataObject ← [
       fh: NSFile.OpenByReference[@data.reference],
       changeProc: changeProc,
       changeProcData: changeProcData];

    pSheetShell ← PropertySheet.Create [
       formWindowItems: MakeItems,
       menuItemProc: MenuItemProc,
       menuItems: [done: TRUE, cancel: TRUE, defaults: TRUE],
       title: XMessage.Get [...],
       formWindowItemsLayout: DoLayout,
       display: FALSE,
       clientData: @mydata];
    };

MakeItems: FormWindow.MakeItemsProc = {
    -- Make property sheet items with calls to FormWindow.MakeXXXItem.
    };

MenuItemProc: PropertySheet.MenuItemProc = {
    << [shell: StarWindowShell.Handle, formWindow: Window.Handle,
       menuItem: PropertySheet.MenuItemType, clientData: LONG POINTER]
       RETURNS [destroy: BOOLEAN ← FALSE] >>
    mydata: Data = clientData;
    SELECT menuItem FROM
       done => RETURN[destroy: ApplyAnyChanges[formWindow, mydata].ok];
       cancel => RETURN[destroy: TRUE];
       defaults => . . .
       ENDCASE;
    RETURN[destroy: FALSE];
    };

ApplyAnyChanges: PROC [fw: Window.Handle, mydata: Data] RETURNS [ok: BOOLEAN] = {
    -- Collect any changes in the property sheet items.
    NSFile.ChangeAttributes [mydata.fh, ...];

    BEGIN -- Call the changeProc.
    data: Containee.Data ← [ NSFile.GetReference [mydata.fh] ];
    IF mydata.changeProc # NIL THEN
       mydata.changeProc[mydata.changeProcData, @data, changedAttributes];
    END;

    RETURN [ok: TRUE];
    };
```

13.4.3 Error and Signal Usage

This client catches an NSFile.Error and raises Containee.Error, passing along the ERROR and the NSFile.ErrorRecord:

```
message: XString.ReaderBody;
   errorRecord: NSFile.ErrorRecord;
   signal: --GENERIC-- SIGNAL ← NIL;
   file ← NSFile.OpenByReference [reference: ... !
      NSFile.Error = > {
   errorRecord ← error;
   signal ← LOOPHOLE[NSFile.Error, SIGNAL];
   GOTO ErrorExit}];
   << Operate on the file.>>
   NSFile.Close[file];
   EXITS
      ErrorExit = > {
   message ← XString.FromSTRING["NSFile.Error"L];
   Containee.Error [msg: @message, error: signal, errorData: @errorRecord];
```

13.5 Index of Interface Items

14

ContainerCache

14.1 Overview

The **ContainerCache** interface provides the writer of a **ContainerSource** with a cache for the container's items. **ContainerCache** supports storing strings and client data with each item.

14.2 Interface Items

14.2.1 Cache Allocation and Management

```
Handle: TYPE = LONG POINTER TO Object;
```

```
Object: TYPE;
```

```
AllocateCache: PROCEDURE RETURNS [Handle];
```

AllocateCache returns handle on a cache that can be filled with **BeginFill**. The client should call **ResetCache** before calling **BeginFill**.

```
ResetCache: PROCEDURE [Handle];
```

ResetCache clears the cache so that, for example, the cache can be refilled by calling **BeginFill**.

```
FreeCache: PROCEDURE [Handle];
```

Frees the resources used by a cache.

14.2.2 Filling the Cache

The client initially fills a cache with items by calling **BeginFill** with a **FillProc**. The **FillProc** adds items to the cache by repeatedly calling **AppendItem**.

```
FillProc: TYPE = PROCEDURE [cache: Handle]
  RETURNS [errored: BOOLEAN ←FALSE];
```

The client provides a **FillProc** to the **BeginFill** procedure. The **FillProc** should fill the cache using **AppendItem**. **errored** is an indication of whether an error occurred during the filling of the cache (**errored** = TRUE).

```
BeginFill: PROCEDURE [
   cache: Handle,
   fillProc: FillProc,
   clients: LONG POINTER,
   fork: BOOLEAN ← TRUE ];
```

```
Clients: PROCEDURE [cache: Handle]
   RETURNS [clients: LONG POINTER];
```

BeginFill begins filling the cache. **fillProc** is called to actually add items to the cache. If **fork** is TRUE, then **fillProc** is forked as a separate process. **clients** is stored with the cache and may be retrieved by calling **Clients**.

```
CacheFillStatus: TYPE = {no, inProgress, inProgressPendingAbort,
  inProgressPendingJoin, yes, yesWithError, spare };
```

```
StatusOfFill: PROCEDURE [cache: Handle]
   RETURNS [CacheFillStatus];
```

StatusOfFill returns the current status of the cache fill. **yes** indicates that the fill has sucessfully completed; **no** means the cache has not been filled yet, **inProgress** indicates that the fill is running right now. **inProgressPendingAbort** indicates that an abort has been received but the **fillProc** has not yet returned. **inProgressPendingJoin**, **yesWithError**, and **spare** are not currently used.

14.2.3 Item Operations

```
ItemHandle: TYPE = LONG POINTER TO ItemObject;
```

```
ItemObject: TYPE;
```

```
AddData: TYPE = RECORD[
   clientData: LONG POINTER, -- TO ARRAY [0..0) OF WORD
   clientDataCount: CARDINAL,
   clientStrings: LONG DESCRIPTOR FOR ARRAY OF XString.ReaderBody];
```

An **AddData** record is passed to the **AppendItem**, **InsertItem**,and **ReplaceItem** procedures. **clientData** should contain any data that the client wants to cache with the item, usually some type of reference to the actual item. **clientDataCount** is the size (in words) of the **clientData**. **clientData** is copied into the cache; therefore the **clientData** should contain no pointers to other data. **clientStrings** should contain the strings to be displayed for the item. **clientStrings** are also copied into the cache, allowing them to be freed by the client.

The standard use of **clientStrings** is to implement the **ContainerSource.StringOfItemProc**, which can be accessed efficiently using **ItemNthString**. See the section on item content operations for more details on accessing the contents of items. **Caution:** There are restrictions on the total length of an item (strings plus client data) that may be added to a cache. Currently, no item should be longer than 512 bytes.

```
AppendItem: PROCEDURE [
   cache: Handle,
   addData: AddData]
   RETURNS [handle:ItemHandle];
```

AppendItem appends an item to the end of **cache**. It is usually called repeatedly from within a **FillProc**. **handle** is a pointer that can be used to access the new item.

```
DeleteNItems: PROCEDURE [
   cache: Handle,
   item: CARDINAL,
   nitems: CARDINAL ← 1];
```

DeleteNItems deletes one or more consecutive items from **cache**, starting at **item**. Fine Point: Since the cache is maintained as a contiguous string of bits, this operation is likely to be slow compared to **AppendItem** and **GetNthItem**.

```
GetNthItem: PROCEDURE [cache: Handle, n: CARDINAL]
   RETURNS [ItemHandle];
```

GetNthItem returns the **n**th item in **cache**. The items are numbered from zero. Returns NIL if no such item exists. The **ItemHandle** returned is not guaranteed to be valid after any operation that modifies the cache (**DeleteNItems, InsertItem, ReplaceItem**). If the cache status is **inProgress** (someone is in the process of filling the cache), **GetNthItem** will not return until the **n**th item has been appended to the cache or until the fill is complete.

```
InsertItem: PROCEDURE [
   cache: Handle,
   before: CARDINAL,
   addData: AddData]
   RETURNS [handle: ItemHandle];
```

InsertItem inserts an item in **cache**. The new item is inserted before item **before**. Note that all the items after this item will be renumbered. Fine Point: Since the cache is maintained as a contiguous string of bits, this operation is likely to be slow compared to **AppendItem** and **GetNthItem**.

```
ReplaceItem: PROCEDURE [
   cache: Handle,
   item: CARDINAL,
   addData: AddData]
   RETURNS [handle: ItemHandle];
```

ReplaceItem replaces the contents of **item** in **cache** with the information in **addData**. Fine Point: This operation is implemented as **DeleteNItems** followed by **InsertItem**, and so is likely to be slow compared to **AppendItem** and **GetNthItem**.

14.2.4 Item Content Operations

ItemIndex: PROCEDURE [item: ItemHandle] RETURNS [index: CARDINAL];

Given the handle item, ItemIndex returns its index in the cache.

ItemClients: PROCEDURE [item: ItemHandle] RETURNS [clientData: LONG POINTER];

Returns the client data associated with item. If the client data passed in was NIL, clientData will be NIL.

ItemClientsLength: PROCEDURE [item: ItemHandle] RETURNS [dataLength: CARDINAL];

Returns the length of the client data passed in with item.

ItemStringCount: PROCEDURE [item: ItemHandle] RETURNS [strings: CARDINAL];

Returns the number of client strings associated with item.

ItemNthString: PROCEDURE [item: ItemHandle, n: CARDINAL] RETURNS [XString.ReaderBody];

Returns the nth client string associated with item. This operation can be used to implement a ContainerSource.StringOfItemProc .

14.2.5 Marking Items in the Cache

Whenever items are deleted or inserted in a ContainerCache, all the items are renumbered. This allows a client to keep track of items by marking them. ContainerCache keeps track of the marked items across any changes to the cache. A mark is a handle on a cache item that tracks the item when the item number changes. This facility is handy for container source implementations that use ContainerCache and want to perform all the various combinations of moving and copying items within the source.

```
Mark: TYPE = LONG POINTER TO MarkObject;
MarkObject: TYPE;

SetMark: PROCEDURE [
    cache: ContainerCache.Handle, index: CARDINAL]
    RETURNS [mark: Mark];
    -- set a mark at index

IndexFromMark: PROCEDURE [mark: Mark]
    RETURNS [index: CARDINAL];
    -- get the current value of this mark

MoveMark: PROCEDURE [mark: Mark, newIndex: CARDINAL];
    -- allows the resetting of a mark without using a new one

FreeMark: PROCEDURE [mark: Mark];
    -- mark no longer needed
```

14.3 Usage/Examples

After the client allocates a cache, the client starts filling the cache by calling **BeginFill** with a **FillProc**. **BeginFill** immediately calls the **FillProc**. Inside the **FillProc**, the client will usually do some kind of enumeration on the source backing (for example, if the source is backed by files, the client would do an NSFile.List). For each item enumerated by the **FillProc**, the client builds the required strings for that item and then passes the strings along with any item data to **AppendItem**. The item data is usually some information that is needed to uniquely identify the item (for the file example, this might be a fileID). This process continues until all the items in the source have been enumerated, at which time the **FillProc** returns.

The call to **BeginFill** may indicate that the **FillProc** should be forked into a separate process. This allows the enumeration of the source's items to go on in the background, an advantage if the source has a large number of items. If the source is being displayed in a **ContainerWindow** while this background fill is taking place, the window displays each new item as it is appended to the cache. Fine Point: **ContainerWindow** can display the items as they are added because during the filling of the cache, **GetNthItem** will wait until the requested item is in the cache instead of returning with an indication that the requested item isn't available.

Once the cache has been created, operations on the container source that owns the cache may cause items in the cache to become invalid. One way to bring the cache back into synch is to invoke **BeginFill** and rebuild the cache. If reenumerating the items in the source is expensive, items in the cache can be updated with the operations **DeleteNItems**, **InsertItem**, and **ReplaceItem**. The disadvantage of these operations is that they may cause performance degradation. Fine Point: The current implementation tries to maintain the cache as a contiguous series of strings of bits to minimize swapping. Using these operations may force large amounts of data to be moved around or fragment the cache data. If a large number of changes are to be made, it may pay to rebuild the cache.

Use of **ContainerCache** may not always be appropriate. In some cases, the structure of items in a source may be simple enough that a simple data structure in the source may suffice to hold all the information necessary to respond to source operations.

14.3.1 Example of ContainerCache Use

The following example is taken from the implementation of **FileContainerSource** and gives an example **FillProc** that uses **AppendItem** to build the cache.

```
ReaderSeq: TYPE = RECORD [SEQUENCE length: CARDINAL OF XString.ReaderBody];
ReaderSeqPtr: TYPE = LONG POINTER TO ReaderSeq;

WriterSeq: TYPE = RECORD [SEQUENCE length: CARDINAL OF XString.WriterBody];
WriterSeqPtr: TYPE = LONG POINTER TO WriterSeq;

FillCacheInBackground: ContainerCache.FillProc =
  <<[cache: Handle] RETURNS [errored: BOOLEAN ← FALSE]>>
  BEGIN
  fs: FS ← ContainerCache.Clients[cache]; -- get container source context
  parentHandle: NSFile.Handle;
  writers: WriterSeqPtr ← AllocateWriters [fs.columns.length];
```

```
    readers: ReaderSeqPtr ← z.NEW [ReaderSeq[fs.columns.length]];

    Enumerator: NSFile.AttributesProc =
      BEGIN
      itemData: ItemFileData;
      addData: ContainerCache.AddData;

      addData ← BuildRow [fs, writers, readers, @itemData, attributes];
      [] ← ContainerCache.AppendItem [cache, addData];
      RETURN;
      END;

    BEGIN
      parentHandle ← NSFile.OpenByReference [fs.parentReference];
      Process.SetPriority [Process.priorityBackground];
      NSFile.List [ directory: parentHandle, proc: Enumerator,
        selections: fs.selections, scope: fs.scope ];
      NSFile.Close [parentHandle];
    END;
    z.FREE [@readers];
    FreeWriters [writers];

    RETURN;
    END;

  BuildRow: PROCEDURE [
    fs: FS,
    writers: LONG POINTER TO WriterSeq,
    readers: LONG POINTER TO ReaderSeq,
    itemData: ItemFileDataHandle,
    attributes: NSFile.Attributes]
    RETURNS [addData: ContainerCache.AddData] =
    BEGIN
    attr: NSFile.Attribute;
    ci: Containee.Implementation;

    ci ← Containee.GetImplementation [attributes.type];
    FOR i: CARDINAL IN [0..fs.columns.length) DO
      XString.ClearWriter [@writers[i]];
      -- decide the type of column we have (passed in as Column info to
          FileContainerSource.Create) and call proper format proc to format attribute(s)
          into a string --
      WITH column: fs.columns[i] SELECT FROM
        attribute => {
          attr ← AttributeFromAttributeRecord [
            attributes, column.attr];
          column.formatProc [ci, attr, @writers[i]];};
        extendedAttribute => {
          attr ← ExtendedAttributeFromAttributeRecord [
            attributes, column.extendedAttr];
          column.formatProc [ci, attr, @writers[i]];};
        multipleAttributes =>
```

```
            column.formatProc [ci, attributes, @writers[i]];
          ENDCASE;
        ENDLOOP;

    itemData↑ ←[id: attributes.fileID, type: attributes.type];

    FOR i: CARDINAL IN [0..writers.length) DO
        readers[i] ←(XString.ReaderFromWriter [@writers[i]])↑;
        ENDLOOP;

    addData ←[
        clientData: itemData,
        clientDataCount: SIZE[ItemFileData],
        clientStrings: DESCRIPTOR[readers]];

    RETURN[addData];
    END;
```

14.4 Index of Interface Items

15

ContainerSource

15.1 Overview

The Container interfaces (**ContainerSource**, **ContainerWindow**, **FileContainerSource**, **FileContainerShell**, and **ContainerCache**) provide the services needed to implement an application that appears as an ordered list of items to be manipulated by the user. ViewPoint Folders are a typical example of such an application. **ContainerWindow** provides the user interface for containers. It displays each item as a list of strings and handles selection highlighting, scrolling, and so forth. When a **ContainerWindow** is created, a record of procedures is passed in. **ContainerWindow** obtains the strings of each item by calling one of these procedures. **ContainerWindow** also performs user operations on items, such as open, props, delete, insert, take the current selection, and selection conversion by calling other procedures in the record. This record of procedures and their implementation is called a container source. A container source can be thought of as a supply (source) of items for a **ContainerWindow**. A container source is responsible for implementing container source operations on its underlying representation of the items in the source.

The **ContainerSource** interface contains the procedure TYPEs that make up the record of procedures that a container source must implement. These procedure definitions encompass all the operations that a source of items must be able to perform. **ContainerSource** also provides a place to save data specific to a particular container source.

The procedure TYPEs defined by **ContainerSource** fall into two categories. **ActOnProc**, **CanYouTakeProc**, **GetLengthProc**, and **TakeProc** are operations on the source as a whole. **ConvertItemProc**, **DeleteItemsProc**, **ItemGenericProc**, and **StringOfItemProc** are operations on the individual items within the source.

Note that the items in a container must exhibit behavior similar to the behavior defined by the **Containee** interface, such as open, props, take selection, convert. However, also note that the **Containee** interface defines the behavior of **NSFiles**, whereas **ContainerSource** is totally independent of **NSFile**. The items in a container may be backed by anything. The **FileContainerSource** interface is an example of a container source that is backed by **NSFiles**. The ViewPoint Directory application contains examples of container sources that are backed by Clearinghouse entries (such as the Filing and Printing dividers) and by simple strings in virtual memory (such as a domain divider).

The **ContainerCache** interface provides a mechanism for caching the strings and item-specific data for the items in a container source. The implementor of a container source might find **ContainerCache** to be handy.

15.2 Interface Items

15.2.1 Handle, Procedures, and ProceduresObject

```
Handle: TYPE = LONG POINTER TO Procedures;

Procedures: TYPE = LONG POINTER TO ProceduresObject;

ProceduresObject: TYPE = RECORD [
  actOn: ActOnProc,
  canYouTake: CanYouTakeProc,
  columnCount: ColumnCountProc,
  convertItem: ConvertItemProc,
  deleteItems: DeleteItemsProc,
  getLength: GetLengthProc,
  itemGeneric: ItemGenericProc,
  stringOfItem: StringOfItemProc,
  take: TakeProc];
```

Handle identifies a particular container source. **Handle** is a pointer to a pointer (**Procedures**) to a record of procedures (**ProceduresObject**) that are implemented by the container source. A container source typically EXPORTs a **Create** procedure that return a **Handle**. This **Handle** is then passed to **ContainerWindow.Create**. Whenever **ContainerWindow** needs the container source to do something, it calls the appropriate procedure in the **ProceduresObject** by using **Handle ↑ ↑**, and passing in the **Handle**. **Note:** Every procedure in the **ProceduresObject** takes a **Handle** as its first parameter. Fine Point: Actually, **ContainerWindow** will call the **INLINE** procedures described in the INLINE section, which in turn call the procedures in the **ProceduresObject**.

Handle is a pointer to a pointer (rather than just a pointer to the **ProceduresObject**) to allow a container source to save data specific to the source. For example, a file-backed source would need to keep a pointer to the file. See the section on Usage/Examples for an explanation of how this is done.

15.2.2 Procedures That Operate on Individual Items

```
ItemIndex: TYPE = CARDINAL;

nullItem: ItemIndex = ItemIndex.LAST;
```

All the procedures that operate on individual items take a **Handle** and an **ItemIndex**. An **ItemIndex** is simply a CARDINAL that uniquely identifies an item in the source. **Note:** A container source is an *ordered* list of items. An **ItemIndex** of "n" indicates the "nth" item in the source. An **ItemIndex** of zero corresponds to the first source item. An **ItemIndex** should be thought of as a loose binding: the index of a particular item may change as a result of changes to the source. For example, if an item is deleted, all the items below it will be renumbered. **nullItem** is a constant used to represent no item or unknown item.

```
StringOfItemProc: TYPE = PROCEDURE [
   source: Handle,
   itemIndex: ItemIndex,
   stringIndex: CARDINAL]
   RETURNS [XString.ReaderBody];
```

The source's **StringOfItemProc** should return the string **stringIndex** of item **itemIndex** in **source**. Each item's display is composed of strings, one for each column of the container window. For example, an open Folder shows four columns: the icon picture, the name, the size, and the date. **stringIndex** will be **IN [0..source.columnCount[])** (see also **ColumnCountProc** in the next section). If there is no such item or string, **StringOfItemProc** should return **XString.nullReaderBody**. **StringOfItemProc** is used extensively and its implementation should be efficient.

```
ItemGenericProc: TYPE = PROCEDURE [
   source: Handle,
   itemIndex: ItemIndex,
   atom: Atom.ATOM,
   changeProc: ChangeProc ← NIL,
   changeProcData: LONG POINTER ← NIL]
   RETURNS [LONG UNSPECIFIED];
```

The source's **ItemGenericProc** is invoked to perform an operation on one of the items in the container. **itemIndex** indicates which item to operate on. The operation, specified by **atom**, may be any one of the following set: Open, Props, CanYouTakeSelection, TakeSelection, TakeSelectionCopy. This procedure is just like the **genericProc** that a **Containee.Implementation** must provide (see the **Containee** interface for a complete description of the atoms and their return values.) **changeProc** must be called if the **ItemGenericProc** causes the source to change. **changeProc** and **changeProcData** are described in more detail below in the section on **changeProc** types.

```
ConvertItemProc: TYPE = PROCEDURE [
   source: Handle,
   itemIndex: ItemIndex,
   n: CARDINAL ← 1,
   target: Selection.Target,
   zone: UNCOUNTED ZONE,
   info: Selection.ConversionInfo ← [convert[]],
   changeProc: ChangeProc ← NIL,
   changeProcData: LONG POINTER ← NIL]
   RETURNS [value: Selection.Value];
```

The source's **ConvertItemProc** is invoked to convert one or more of the items in **source**, just as if the item was the current selection and **Selection.Convert** had been called. **itemIndex** indicates the first item to convert. **n** indicates how many consecutive items to convert. **target, zone, info,** and **value** are all identical to the parameters for **Selection.ConvertProc** (see the **Selection** interface). If $n > 1$, then **info** is the **enumeration** variant; otherwise, it is the **convert** variant. **changeProc** must be called if the **ConvertItemProc** causes the source to change, for example, when an item is moved out of the source. **changeProc** and **changeProcData** are described in more detail in the section on **changeProc** types.

```
DeleteItemsProc: TYPE = PROCEDURE [
   source: Handle,
   itemIndex: ItemIndex,
   n: CARDINAL ← 1,
   changeProc: ChangeProc ← NIL,
   changeProcData: LONG POINTER ← NIL];
```

The source's **DeleteItemsProc** is invoked to delete consecutive items from **source**. **itemIndex** is the first item to delete. **n** is the number of items to delete. **changeProc** must be called if the **DeleteItemsProc** causes the source to change, that is, if the deletion is successful. **changeProc** and **changeProcData** are described in more detail in the section on **changeProc** types.

15.2.3 Procedures That Operate on the Entire Source

```
ColumnCountProc: TYPE = PROCEDURE [ source: Handle] RETURNS [columns: CARDINAL];
```

The source's **ColumnCountProc** should return the number of columns in **source**, that is, the number of strings in each item. Fine point: typically, the number of columns is the same as **COUNT [ContainerWindow.ColumnHeaders]**.

```
GetLengthProc: TYPE = PROCEDURE [ source: Handle]
RETURNS [length: CARDINAL, totalOrPartial: TotalOrPartial ← total];

TotalOrPartial: TYPE = {total, partial};
```

The source's **GetLengthProc** should return the total number of items currently in the source. This operation is performed often and should be efficient. Some container sources have indeterminate length until after an initial enumeration has completed (for example, clearinghouse enumerations). These sources may return **[totalOrPartial: partial]** while the initial enumeration is in progress. This lets the **ContainerWindow** display mechanism know that there are more items coming, while giving it some information along the way. Once a source knows how many items are in the source, (or for those sources that know right from the start how many items are in the source, (such as **NSFile**-backed sources), the **GetLengthProc** should return **[totalOrPartial: total]**.)

```
ActOnProc: TYPE = PROCEDURE [ source: Handle, action: Action];

Action: TYPE = {destroy, reList, sleep, wakeup};
```

The source's **ActOnProc** is invoked to request some action of the source. **Action** indicates what the source should or can do.

destroy	The term **destroy** means that the source should destroy itself, freeing all storage and releasing all resources associated with the container source instance.

sleep	The term **sleep** means that the source should release whatever resources it can without losing information; it is a hint that the container source will not be used for a while.
wakeup	The term **wakeup** means that the source is going to be used and should resume its normal state, undoing whatever was done for **sleep**.
reList	The term **reList** means that the source should re-enumerate itself because its backing store has been changed.

```
CanYouTakeProc: TYPE = PROCEDURE [
   source: Handle,
   selection: Selection.ConvertProc ←NIL]
   RETURNS [yes: BOOLEAN];
```

The source's **CanYouTakeProc** is invoked to determine if the container source can take the selection. If **selection** is NIL, the current selection should be used (call **Selection.Convert**.) Otherwise the **Selection.ConvertProc** is used to obtain an arbitrary selection. If the **CanYouTakeProc** returns **yes** = TRUE, then the source's **TakeProc** may be called. Fine point: The **Selection** interface does not support passing in an arbitrary **ConvertProc**. It is the responsibilty of clients who pass in arbitrary selections to make sure the source can properly handle this case. This routine is intended to provide an efficient check on the compatibility of the objects being copied or moved. The common use of this routine is to provide feedback to the user. If a **CanYouTakeProc** returns TRUE, the client may choose to highlight the target. This is normally at the level of a file-type check. More elaborate checking is not necessary; for example, a file-backed container source would not want to check the source for protection or uniqueness violations. These should be handled by the **TakeProc**.

```
TakeProc: TYPE = PROCEDURE [
   source: Handle,
   copyOrMove: Selection.CopyOrMove,
   afterHint: ItemIndex ← nullItem,
   withinSameSource: BOOLEAN ←FALSE,
   changeProc: ChangeProc ←NIL,
   changeProcData: LONG POINTER ←NIL,
   selection: Selection.ConvertProc ←NIL]
   RETURNS [ok: BOOLEAN];

beforeItemZero: ItemIndex = ItemIndex.LAST - 1;
```

The source's **TakeProc** is invoked to add items to the container source. **copyOrMove** tells the source whether to do a move or a copy of the selection. **afterHint** indicates the item the new item should be inserted after. Fine point: This is only a hint to the container source, since the ultimate position of the new item may depend on a sort order built in to the source. **afterHint** defaults to **nullItem**, which indicates that the caller doesn't care where the new item goes. If **afterHint** = **beforeItemZero**, the source should insert the new item before the first item. **changeProc** must be called if the **TakeProc** causes the source to change. **withinSameSource** = TRUE indicates to the source that the item(s) being moved or copied into the source are also in that same source; such as when the user moves or copies something from one place in a container to another place in the same container. This case usually involves some special case processing by the source (especially for move). **changeProc** and **changeProcData** are described in more detail in the next section.

selection indicates the objects to be moved or copied. If **selection** is NIL, the current selection should be used(call **Selection.Convert**.) Otherwise the **Selection.ConvertProc** is used to obtain an arbitrary selection. Fine Point: Refer to the **CanYouTakeProc** description for further discussion of arbitrary selections. **ok** indicates whether the **TakeProc** was successful or not. The use of this routine is usually be preceded by a call to the source's **CanYouTakeProc**.

15.2.4 ChangeProc Types

A source's **ConvertProc**, **DeleteItemsProc**, **ItemGenericProc**, and **TakeProc** all take a **ChangeProc** as an input parameter. This **ChangeProc** must be called by the source whenever any item or items in the source changes. This allows the **ContainerWindow** display code to keep the display up to date with the source. For example, a call to the source's **ItemGenericProc** with an atom of Props will cause a property sheet to be displayed for an item. If the user then edits, for example, the name of the item, and then closes the property sheet, the source must detect this change, update its backing, and call the **ChangeProc** that was passed into the **ItemGenericProc**. This **ChangeProc** (supplied by **ContainerWindow**) then causes the changed item(s) to be redisplayed.

```
ChangeProc: TYPE = PROCEDURE [
  changeProcData: LONG POINTER,
  changeInfo: ChangeInfo ];
```

A **ChangeProc** and **changeProcData** are passed to a source's **ConvertProc**, **DeleteItemsProc**, **ItemGenericProc**, and **TakeProc** . Since the **changeProcData** had to be allocated from someplace the **changeProc** must always be called, even if there were no changes to the source. The source must call the **ChangeProc** with the **changeProcData** and any **changeInfo**.

```
ChangeInfo: TYPE = RECORD [
  var: SELECT changeType: ChangeType FROM
    replace = > [item: ItemIndex],
    insert = > [insertInfo: LONG DESCRIPTOR FOR ARRAY OF EditInfo],
    delete = > [deleteInfo: EditInfo],
    all, noChanges = > NULL,
    ENDCASE ];

ChangeType: TYPE = { replace, insert, delete, all, noChanges};
```

ChangeInfo is passed to the **ChangeProc** to tell the display code exactly what changed. A container source can be smart and pass specific **ChangeInfo** (for example, "3 items were inserted after item 4 and 2 items were inserted after item 6" may be constructed with the **insert** variant), or be dumb and simply pass the **all** variant, which causes a total repaint of the container display. **replace** indicates that a single item has changed. **insert** indicates that one or more items have been inserted. **delete** indicates that one or more items have been deleted. **all** indicates that the entire source has been changed.

```
EditInfo: TYPE = RECORD [
  afterItem: ItemIndex,
  nItems: CARDINAL];
```

EditInfo is used with the **insert** and **delete** variants of **ChangeInfo** to indicate how many items have been inserted or deleted, and where they were inserted at or deleted from.

15.2.5 Errors

A container source may raise **Error** or **Signal** as appropriate.

```
Error: ERROR [code: ErrorCode, msg: XString.Reader ← NIL,
  error: ERROR ← NIL, errorData: LONG POINTER TO UNSPECIFIED ← NIL];

Signal: SIGNAL [code: ErrorCode, msg: XString.Reader ← NIL,
  error: ERROR ← NIL, errorData: LONG POINTER TO UNSPECIFIED ← NIL];
```

A source's **ItemGenericProc** (and **ConvertItemProc** and **DeleteItemsProc**) should never assume that it has been called by a **ContainerWindow**, and therefore should never call such facilities as **Attention.Post** or **UserTerminal.BlinkDisplay**. (The application might be called by CUSP, for example.) Rather, the source should raise **ContainerSource.Error** or **Signal** with an appropriate message. The caller of the source's **ItemGenericProc** should catch these errors and do the appropriate thing. In the typical case, the **ContainerWindow** will call the source's **ItemGenericProc** and catch the error and call **Attention.Post** with the passed message. CUSP could catch the error and log the message in a log file. **msg** is the message to display to the user. **error** is the actual lower-level error that ocurred that caused **Error** or **Signal** to be raised. **errorData** points to any additional data that accompanied the lower level error.

```
ErrorCode: TYPE = MACHINE DEPENDENT {invalidParameters(0), accessError, fileError,
noSuchItem, other, last(15)};
```

invalidParameters	indicates that some parameters were invalid; for example, the **source** was not the correct type (the Procedures did not match).
accessError	indicates an attempt to perform an operation that violates the created access option (for sources that implement access controls).
fileError	indicates a file system error (for sources that are backed by files).
noSuchItem	A container source implementation should raise **Error[noSuchItem]** if one of the container source's procedures is called with an **ItemIndex** for an item that is not in the source.
other	may be raised to indicate any other problem.

Fine point: **Error** and **Signal** are **EXPORTed** by the **FileContainerSource** implementation since **ContainerSource** has no implementation.

15.2.6 INLINES

The following INLINE procedures are provided as a convenience to clients who wish to use object notation when calling a container source. **ContainerWindow** is the only typical client of these procedures.

```
ActOn: ActOnProc = INLINE {...};
CanYouTake: CanYouTakeProc = INLINE {...};
ColumnCount: ColumnCountProc = INLINE {...};
ConvertItem: ConvertItemProc = INLINE {...};
DeleteItems: DeleteItemsProc = INLINE {...};
GetLength: GetLengthProc = INLINE {...};
ItemGeneric: ItemGenericProc = INLINE {...};
StringOfItem: StringOfItemProc = INLINE {...};
Take: TakeProc = INLINE {...};
```

15.3 Usage/Examples

The reason that **Handle** is a pointer to a pointer (rather than just a pointer to the **ProceduresObject**) is to allow a container source to save data specific to the source. For example, a file-backed source would need to keep a pointer to the file. This is done in the following example.

15.3.1 ContainerSource Example

1. Declare a **ContainerSource.ProceduresObject** in the global frame of the module and fill it with the appropriate procedures.

```
mySourceProcs: ContainerSource.ProceduresObject ← [
  actOn: MyActOn,
  canYouTake: CanITake,
  columnCount: MyColumnCount,
  convertItem: ConvertMyItem,
  deleteItems: DeleteMyItems,
  getLength: GetMyLength,
  itemGeneric: MyItemGeneric,
  stringOfItem: StringOfMyItem,
  take: MyTake];
```

2. Declare a record that has a **ContainerSource.Procedures** (**Procedures**, not **ProceduresObject**!) as its first field and initialize this field to point to the **ProceduresObject** declared in the global frame. The rest of the record should contain whatever data the source needs in order to perform all the operations it will be requested to perform. Also declare a pointer to this record.

```
MySource: TYPE = LONG POINTER TO MySourceObject;

MySourceObject: TYPE = RECORD [
  procs: ContainerSource.Procedures ← @mySourceProcs,
  otherStuff: . . . ];
```

3. When creating the source, allocate the **MySourceObject** record and fill it with any relevant data. Return a pointer to the **Procedures** field of the record (**@ms.procs** below). **Note:** This return value is a pointer to a **ContainerSource.Procedures**, which is a **ContainerSource.Handle**.

```
Create: PUBLIC PROCEDURE [otherStuff: . . . ] RETURNS [source: ContainerSource.Handle] = {
   ms: MySource ← z.NEW [MySourceObject [otherStuff: otherStuff]];
   RETURN[@ms.procs];
   };
```

4. The first thing that every procedure in the ProceduresObject should do is LOOPHOLE the **ContainerSource.Handle** that was passed in into a pointer (**MySource**) to the source's data record (**MySourceObject**). After the LOOPHOLE, the fields of the source's data record can be directly accessed, e.g., **ms.otherStuff**. This all works because the first field in the source's data record is a **Procedures**. Note that the LOOPHOLE is actually performed in a procedure that also checks to be sure that the **Procedures** field of the passed source actually points to this source's procedures (IF **source ↑ # @mySourceProcs** THEN).

```
ActOnFile: ContainerSource.ActOnProc = {
   ms: MySource = ValidMySource[source];
   .
   . . . ms.otherStuff. . .
   .
   };

ValidMySource: PROCEDURE [source: ContainerSource.Handle] RETURNS [ms: MySource] = {
   IF source = NIL THEN ContainerSource.Error [invalidParameters] ;
   IF source ↑ # @mySourceProcs THEN ContainerSource.Error[invalidParameters];
   };
```

15.3.2 Errors and Signals

For example, this client catches an **NSFile.Error** and raises **Containee.Error**, passing along the ERROR and the **NSFile.ErrorRecord**:

```
message: XString.ReaderBody;
errorRecord: NSFile.ErrorRecord;
signal: --GENERIC-- SIGNAL ←NIL;
file ←NSFile.OpenByReference [reference: ... !
  NSFile.Error = > {
    errorRecord ← error;
    signal ←LOOPHOLE[NSFile.Error, SIGNAL];
    GOTO ErrorExit}];
-- Operate on the file.--
NSFile.Close[file];
EXITS
  ErrorExit = > {
    message ←XString.FromSTRING["NSFile.Error"L];
    ContainerSource.Error [
  code: fileError, msg: @message, error: signal, errorData: @errorRecord];
```

15.4 Index of Interface Items

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ContainerWindow

16.1 Overview

The **ContainerWindow** interface supports the creation of ViewPoint-like container windows. A container window provides a user interface that operates on a list of objects. The objects are displayed in rows. Each container window has one or more columns, with all rows displaying the same number of columns.

The **ContainerWindow** implementation maintains the display and manages user-invoked actions such as scrolling, selection, notifications, open within, show next/previous, and so forth. **ContainerWindow** takes a body window, a **ContainerSource**, and a specification of the columns and makes the window behave like a container. **Note:** This interface does not depend on **NSFile**: the objects represented by rows in the container do not have to be backed by **NSFiles**.

16.2 Interface Items

16.2.1 Create and Destroy a ContainerWindow

```
Create: PROCEDURE [
   window: Window.Handle,
   source: ContainerSource.Handle,
   columnHeaders: ColumnHeaders,
   firstItem: ContainerSource.ItemIndex ← 0]
   RETURNS [ regularMenuItems, topPusheeMenuItems: MenuData.ArrayHandle];

ColumnHeaders: TYPE = LONG DESCRIPTOR FOR ARRAY OF ColumnHeaderInfo;

ColumnHeaderInfo: TYPE = RECORD [
   width: CARDINAL,
   wrap: BOOLEAN,
   heading: XString.ReaderBody];
```

Create turns an ordinary window into a container window. **window** must be a **StarWindowShell** body window. **source** supplies a source of items to be displayed and manipulated (see the **ContainerSource** and **FileContainerSource** interfaces).

columnHeaders describes the column widths and supplies column headings. The columns will be displayed in the order given by this array. For each column, **width** is the number of bits the column should take, and **heading** is a string that will be displayed at the top of the column. **wrap** indicates what to do when a string that the container window wants to display is wider than **width.** If **wrap** = TRUE , the string should be wrapped around, otherwise, it will be truncated. Fine Point: **columnHeaders** is copied by **Create**, so this structure may be in the client's local frame.

firstItem indicates the item that should be displayed first when the container window is initially displayed.

regularMenuItems and **topPusheeMenuItems** are the menu items that the container window needs to have in the **StarWindowShell**. They should be added (by the client) to the menu that is installed in the **StarWindowShell** which this container window is a part of (these contain menu items such as Show Next and Show Previous).

Destroy: PROCEDURE [window: Window.Handle];

Destroys the data associated with the container window. Does *not* destroy the window itself. May raise **Error [notAContainerWindow]**.

16.2.2 Item operations

The individual containees in a container window are referred to as *items* (from **ContainerSource.ItemIndex**) They are sequentially numbered starting with zero.

```
DeleteAndShowNextPrevious: PROCEDURE [
  window: Window.Handle,
  item: ContainerSource.ItemIndex,
  direction: Direction ← next];
```

Direction: TYPE = {next, previous};

Deletes **item** from the container source and the display, then displays the next or previous item. May raise **Error[notAContainerWindow]** or **Error[noSuchItem]**.

```
GetOpenItem: PROCEDURE [window: Window.Handle]
  RETURNS [item: ContainerSource.ItemIndex ← ContainerSource.nullItem];
```

Returns the item that is currently open within the container. If no item is open, returns **ContainerSource.nullItem**. May raise **Error[notAContainerWindow]**.

**GetSelection: PROCEDURE [window: Window.Handle]
RETURNS [first, lastPlusOne: ContainerSource.ItemIndex];**

Returns the items currently selected in the **ContainerWindow**. **first = last = ContainerSource.nullItem** means there is no selection.

**SelectItem: PROCEDURE [window: Window.Handle,
item: ContainerSource.ItemIndex];**

Selects the specified item and implicitly calls **MakeItemVisible**. **MakeItemVisible** is in a friends-level interface. **Note: MakeItemVisible** Forces **item** to be visible in window. If there is more than a screenful of items left following **item**, it is put at the top of the window. If less than a screenful remains, item is put at the bottom of the window with as many items as will fit before it. May raise **Error[notAContainerWindow]** or **Error[noSuchItem]**.

16.2.3 Operations on a ContainerWindow

IsIt: PROCEDURE [window: Window.Handle] RETURNS [yes: BOOLEAN];

Returns TRUE if the window passed in is a **ContainerWindow**.

**GetSource: PROCEDURE [window: Window.Handle]
RETURNS [source: ContainerSource.Handle];**

Returns the **ContainerSource** associated with this window. May raise **Error[notAContainerWindow]**. **SetSource** allows the client to change the source and the **SourceModifyProc** allows the client to modify the source.

**SetSource: PROCEDURE [
window: Window.Handle, newSource: ContainerSource.Handle]
RETURNS [oldSource: Handle];**

**SourceModifyProc: TYPE = PROCEDURE [
window: Window.Handle, source: ContainerSource.Handle]
RETURNS [changeInfo: ChangeInfo];**

ModifySource: PROCEDURE [window: Window.Handle, proc: SourceModifyProc];

ModifySource calls the source modification proc from within its monitor.

Update: PROCEDURE [window: Window.Handle];

Called when the correspondence between the source and the display is invalid. Items in the display will be redisplayed to reflect any changes in the source. May raise **Error[notAContainerWindow]**. Fine Point: Clients will not normally need to call this routine unless they manipulate the source directly. All user-initiated operations on a **ContainerWindow** cause the display to be updated automatically.

16.2.4 Errors

```
Error: ERROR [code: ErrorCode];

ErrorCode: TYPE = MACHINE DEPENDENT {notAContainerWindow(0), noSuchItem, last(7)};
```

Any operations that operate on a container window may raise this error. **notAContainerWindow** is raised if the window passed in is not a container window (i.e., was not passed to **Create**). **noSuchItem** may be raised if an operation specifies a non-existent item.

16.3 Usage/Examples

The following example is taken from the implementation of the **FileContainerShell** interface. It illustrates the steps involved in creating a container window: creating a container source, creating a **StarWindowShell**, creating a body window inside the shell, creating the container window, and finally merging the menu items returned by **ContainerWindow.Create** with its own menu commands and installing those commands in the shell. It also gives a sample **StarWindowShell** transition procedure that will destroy the container source and the container window.

```
-- From FileContainerShellImpl.mesa

MenuItemSeq: TYPE = RECORD [
  SEQUENCE length: CARDINAL OF MenuData.ItemHandle];

Create: PUBLIC PROCEDURE [
  file: NSFile.Reference,
  columnHeaders: ContainerWindow.ColumnHeaders,
  columnContents: FileContainerSource.ColumnContents,
  regularMenuItems, topPusheeMenuItems: MenuData.ArrayHandle ← NIL,
  scope: NSFile.Scope ← [],
  position: ContainerSource.ItemIndex ← 0,
  options: FileContainerSource.Options ← []]
  RETURNS [shell: StarWindowShell.Handle] =

  BEGIN
  body: Window.Handle ← NIL;
  source: ContainerSource.Handle ← NIL;
  cwRegularMenuItems, cwTopPusheeMenuItems: MenuData.ArrayHandle;
  mergedMenuItems: LONG POINTER TO MenuItemSeq ← NIL;
  menu: MenuData.MenuHandle;
  name: XString.ReaderBody;
  ticket: Containee.Ticket;
  data: Containee.Data ← [file];
  type: NSFile.Type;
  smallPicture: XString.Character;

  IF file = NSFile.nullReference THEN RETURN [ [NIL] ];
  source ← FileContainerSource.Create [
    file: file,
        columns: columnContents,
        scope: scope,
        options: options];

    [name, ticket] ← Containee.GetCachedName [@data];
    type ← Containee.GetCachedType[@data];
    smallPicture ← Containee.GetImplementation[type].smallPicture;

    shell ← StarWindowShell.Create [
        name: @name,
        namePicture: smallPicture,
        sleeps: FALSE,
        transitionProc: DestroyProc ];

    Containee.ReturnTicket [ticket];

    body ← StarWindowShell.CreateBody [sws: shell, box: [[0,0],[700, 29999]]];

    [cwRegularMenuItems, cwTopPusheeMenuItems] ← ContainerWindow.Create [
        window: body,
        source: source,
        columnHeaders: columnHeaders,
        firstItem: position];

    mergedMenuItems ← MergeMenuArrays [cwRegularMenuItems, regularMenuItems];
    IF mergedMenuItems # NIL THEN
        BEGIN
        menu ← MenuData.CreateMenu [
            zone: StarWindowShell.GetZone[shell],
            title: NIL,
            array: DESCRIPTOR[mergedMenuItems],
            copyItemsIntoMenusZone: TRUE ];
        StarWindowShell.SetRegularCommands [shell, menu];
        z.FREE[@mergedMenuItems];
        END;

    mergedMenuItems ← MergeMenuArrays [cwTopPusheeMenuItems,
    topPusheeMenuItems];
    menu ← MenuData.CreateMenu [
        zone: StarWindowShell.GetZone[shell],
        title: NIL,
        array: DESCRIPTOR[mergedMenuItems],
        copyItemsIntoMenusZone: FALSE ];
    StarWindowShell.SetTopPusheeCommands [shell, menu];
    RETURN [shell];
    END;

DestroyProc: StarWindowShell.TransitionProc =
<<[sws: StarWindowShell.Handle, state: StarWindowShell.State]>>
    BEGIN
    IF state = dead THEN {
        cw: Window.Handle ← GetContainerWindow[sws];
        source: ContainerSource.Handle ← GetContainerSource[sws];
        ContainerSource.ActOn [source, destroy];
        ContainerWindow.Destroy[cw]; };
    RETURN;
    END;

MergeMenuArrays: PROC [itemArray1, itemArray2: MenuData.ArrayHandle]
RETURNS [mergedSeq: LONG POINTER TO MenuItemSeq] =
    BEGIN
    i: CARDINAL ← 0;
    IF itemArray1 = NIL AND itemArray2 = NIL THEN RETURN[NIL];
    mergedSeq ← z.NEW [MenuItemSeq[itemArray1.LENGTH + itemArray2.LENGTH]];
    FOR j: CARDINAL IN [0..itemArray1.LENGTH) DO
        mergedSeq[i] ← itemArray1[j];
        i ← i + 1;
        ENDLOOP;
    FOR j: CARDINAL IN [0..itemArray2.LENGTH) DO
        mergedSeq[i] ← itemArray2[j];
        i ← i + 1;
        ENDLOOP;
    RETURN[mergedSeq];
    END;
```

16.4 Index of Interface Items

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Context

17.1 Overview

In performing various functions, an application may wish to save and retrieve state from one notification to the next. This is an immediate consequence of the notification scheme, for a tool cannot keep its state in the program counter without stealing the processor after responding to an event. Thus, it becomes necessary for the application to explicitly store its state in data. Because most notification calls to the application provide a window handle, it is natural to associate these *contexts* with windows. The context mechanism is provided as an alternative to the application's having to build its own associative memory to retrieve its context, given a window handle.

Typically, an application obtains a unique **Type** for its context data by calling **UniqueType** in the start-up code for the application. Then whenever a window is created, the client allocates some context data and calls **Create** to associate that data with the window. Whenever the client is called to perform some operation on the window (For example, to display the contents of the window or to handle a notification), it calls **Find** to retrieve the data saved with the window. Finally, when the window is being destroyed, the client (orViewPoint) calls **Destroy**, which calls the client's **DestroyProcType** to give the client an opportunity to free the data.

17.2 Interface Items

17.2.1 Creating/Destroying a Context

UniqueType: PROCEDURE RETURNS [type: Type];

The procedure **UniqueType** is called if a client needs a unique **Type** not already in use by either Viewpoint or another client. If no more unique **type**s are available, the **ERROR** **Error[tooManyTypes]** is raised.

```
Create: PROCEDURE [
 type: Type, data: Data, proc: DestroyProcType, window: Window.Handle];
```

The procedure **Create** creates a new context of type **type** that contains **data**. The context is associated with **window**; it is said to "hang" on the window. If **window** already possesses a context of the specified type, the ERROR **Error[duplicateType]** is raised. If the **window** is NIL, the ERROR **Error[windowIsNIL]** is raised. The **proc** is supplied so that when the window is destroyed is all of the context data can be destroyed (deallocated).

Type: TYPE = MACHINE DEPENDENT{
all(0), first(1), lastAllocated(37737B), last(37777B)};

Type is unique for each client of the context mechanism. An argument of this type is passed to most of the procedures in this interface so that the correct client data can be identified.

Data: TYPE = LONG POINTER TO UNSPECIFIED;

Data is the value that a client may associate with each window. It is typically a pointer to a record containing the client's state for some window.

DestroyProcType: TYPE = PROCEDURE [Data, Window.Handle];

A **DestroyProcType** is passed to **Create** so that the client can be notified when the context should be destroyed. This may be the result of the window being destroyed.

Destroy: PROCEDURE [type: Type, window: Window.Handle];

The procedure **Destroy** destroys a context of a specific **type** on **window**. If the context exists on the window, it will call the **DestroyProcType** for the context being destroyed.

DestroyAll: PROCEDURE [window: Window.Handle];

The procedure **DestroyAll** destroys all the contexts on **window**. Fine Point: **DestroyAll** can be very dangerous because ViewPoint keeps its window-specific data in contexts on the window. **DestroyAll** should not be used except in special circumstances. It is called by the routines that destroy windows.

NopDestroyProc: DestroyProcType;

The procedure **NopDestroyProc** does nothing. It is provided as a convenience to clients that do not want to create their own do-nothing **DestroyProcType** to pass to **Create**.

SimpleDestroyProc: DestroyProcType;

The procedure **SimpleDestroyProc** merely calls the system heap deallocator on the **data** field. It is provided for clients whose context data is a simple heap node in the system zone.

17.2.2 Finding a Context on a Window

Find: PROCEDURE [type: Type, window: Window.Handle] RETURNS [Data];

The procedure **Find** retrieves the **data** field from the specified context for **window**. NIL is returned if no such context exists on the window.

FindOrCreate: PROCEDURE [
 type: Type, window: Window.Handle, createProc: CreateProcType] RETURNS [Data];

The procedure **FindOrCreate** solves the race that exists when creating new contexts in a multi-process environment. If a context of type **type** exists on **window**, it returns the context's **data**; otherwise, it creates a context of **type** by calling **createProc** and then returns **data**. If the **window** is NIL, the ERROR **Error[windowIsNIL]** is raised.

CreateProcType: TYPE = PROCEDURE RETURNS [Data, DestroyProcType];

CreateProcType is used by **FindOrCreate**. The procedure passed in as an argument to **FindOrCreate** is called to create a context only if a context of the appropriate type cannot be found.

Set: PROCEDURE [type: Type, data: Data, window: Window.Handle];

The procedure **Set** changes the actual data pointer of a context. Subsequent **Finds** will return the new data. **Note:** The client can change the data pointed to by the data field of a context at any time. This could lead to race conditions if multiple processes are doing **Find**'s for the same context and modifying the data. It is the client's responsibility to MONITOR the data in such cases. If the **window** is NIL, the ERROR **Error[windowIsNIL]** is raised.

17.2.3 Acquiring/Releasing the Context

Acquire: PROCEDURE [type: Type, window: Window.Handle] RETURNS [Data];

The procedure **Acquire** retrieves the **data** field from the specified window. NIL is returned if no such context exists on the window. It also locks the context object so that no other calls on **Acquire** or **Destroy** with the same **type** and **window** will complete until the context is freed by a call on **Release**.

Release: PROCEDURE [type: Type, window: Window.Handle];

The procedure **Release** releases the lock on the specified context object for **window** that was locked by the call on **Acquire**. If the specified context cannot be found or it is not locked, **Release** is a no-op.

17.2.4 Errors

ErrorCode: TYPE = {duplicateType, windowIsNIL, tooManyTypes, other};

duplicateType	is raised by **Create** if a context of the given type already exists on the window passed as an argument.
windowIsNIL	is raised if the client has passed in a NIL window.
tooManyTypes	is raised if **UniqueType** has been called too many times.

Error: ERROR [code: ErrorCode];

Error is the only error raised by any of the **Context** procedures.

17.3 Usage/Examples

Acquire and **Release** can be used in much the same manner as a Mesa **MONITOR** (See *Mesa Language Manual*: 610E00150). It is important that the client call **Release** for every context that has been obtained by **Acquire**; this is not done automatically. The cost of doing an **Acquire** is barely more than entering a **MONITOR** and doing a **Find**. Using this technique allows the client to monitor his data rather than his code.

If it is necessary for several tools to share global data, it is possible to place a context on **Window.rootWindow** that is never destroyed, even when the bitmap is turned off. To share a **Type** without having to **EXPORT** a variable, it is possible to use one in the range **(lastAllocated..last]**. Contact the support organization to have one allocated to you.

17.3.1 Example

```
myContextType: Context.Type ← Context.UniqueType[];

MyContext: TYPE = LONG POINTER TO MyContextObject;

MyContextObject: TYPE = RECORD [...];

sysZ: UNCOUNTED ZONE ← Heap.systemZone;

MakeShellAndBodyWindow: PROCEDURE = {
  myContext: MyContext ← sysZ.NEW [MyContextObject ← [
  -- initialize fields of MyContextObject --] ];
  -- Note: If some field of MyContextObject was a pointer to some more allocated
  storage, then the Context.SimpleDestroyProc would not be used, but rather a client
  supplied DestroyProcType would have to be provided that freed both
  MyContextObject and the storage pointed to by MyContextObject.
  ...
  shell: StarWindowShell.Create [...];
  body: StarWindowShell.CreateBody [sws: shell,
    repaintProc: MyRepaint,
    bodyNotifyProc: MyNotify];
  Context.Create [type: myContextType,
    data: myContext,
    proc: Context.SimpleDestroyProc,
    window: body];
  ...
  };
```

```
MyRepaint: PROCEDURE [window: Window.Handle] = {
   myContext: MyContext ← FindContext [window];
   ...
   };

MyNotify: TIP.NotifyProc = {
   myContext: MyContext ← FindContext [window];
   ...
   };

FindContext: PROCEDURE [window: Window.Handle]
   RETURNS [myContext: MyContext] = {
   myContext ← Context.Find [myContextType, window];
   IF myContext = NIL THEN ERROR;
   };
```

17.4 Index of Interface Items

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Cursor

18.1 Overview

The **Cursor** interface provides a procedural interface to the hardware mechanism that implements the cursor on the screen. Several cursor shapes are defined in this interface, as well as operations for client-defined cursors. Because there is a single global cursor, it should be manipulated only through this interface and only from the notifier process.

The major data structure defined in this interface is the **Object,** which defines not only the array of bits that defines the picture of the cursor, but also its hot spot. The hot spot of a cursor consists of the coordinates within the 16-by-16 array that are meant to indicate the screen position pointed to by the mouse. The hardware position of the cursor is always in the upper-left corner of the bit array. For many cursor shapes, this position is not where the cursor points. For example, the **pointRight** cursor shape is a right-pointing arrow and has its hot spot at the tip of the arrow.

There can be up to 256 different cursors, limited by the size of the **Type** enumeration. The first several types are system-defined. Clients may call **UniqueType** to allocate an unused type for their own use.

The typical use of this interface is to change the cursor either by calling **Set** to set it to one of the system-defined cursors or by calling **Store**. The cursor may be restored by saving it into an **Object** by calling **Fetch** before it is changed.

18.2 Interface Items

18.2.1 Major Data Structures

Handle: TYPE = LONG POINTER TO **Object;**

Object: TYPE = RECORD **[info: Info, array:** UserTerminal.**CursorArray];**

Info: TYPE = RECORD **[type: Type, hotX: [0..16), hotY: [0..16)];**

Type: TYPE = MACHINE DEPENDENT{
blank(0), bullseye(1), confirm(2), ftpBoxes(3), hourGlass(4), lib(5), menu(6), mouseRed(7), pointDown(8), pointLeft(9), pointRight(10), pointUp(11), questionMark(12), scrollDown(13), scrollLeft(14), scrollLeftRight(15), scrollRight(16), scrollUp(17), scrollUpDown(18), textPointer(19), groundedText(20), move(21), copy(22), sameAs(23), adjust(24), row(25), column(26), last(377B)};

Object defines the type and hot spot of the cursor as well as the 16-by-16 array of bits that represent the cursor's picture.

The cursors in the subrange **Type[blank..column]** are system-defined.

Info contains the type and the hot spot of a cursor.

Defined: TYPE = **Type[blank..column];**

Defined is the subrange of **Type** that contains the system-defined cursors.

18.2.2 Setting the Cursor Picture

Set: PROCEDURE **[type: Defined];**

Set sets the displayed cursor to be one of the system-defined cursors.

Store: PROCEDURE **[h: Handle];**

Store sets the displayed cursor to the cursor described by **h**.

StoreCharacter: PROCEDURE **[c:** XChar.**Character];**

StoreCharacter stores the system font picture of character **c** into the cursor. The info is set to **[type: column.SUCC, hotX: 8, hotY: 8]**.

StoreNumber: PROCEDURE **[n:** CARDINAL**];**

StoreNumber sets the cursor picture to be the number **n** MOD **100**. If **n** is less than 10, the single digit is centered in the cursor. The info is set to **[type: column.SUCC.SUCC, hotX: 8, hotY: 8]**.

18.2.3 Getting Cursor Information

Fetch: PROCEDURE **[h: Handle];**

Fetch copies the current cursor object into the object pointed to by **h**.

GetInfo: PROCEDURE RETURNS **[info: Info];**

GetInfo returns the hot spot and type of the current cursor.

FetchFromType: PROCEDURE **[h: Handle, type: Defined];**

FetchFromType copies the system-defined cursor object corresponding to **type** into the object pointed to by **h**.

18.2.4 Miscellaneous Operations

```
MoveIntoWindow: PROCEDURE [
   window: Window.Handle, place: Window.Place];
```

MoveIntoWindow moves the cursor to the window-relative **place** in **window**.

```
Swap: PROCEDURE [old, new: Handle];
```

Swap places the displayed cursor object in **old ↑** and **Store**s the **new**. It is equivalent to **Fetch[old]; Store[new]**.

18.2.5 Client-Defined Cursors

```
UniqueType: PROCEDURE RETURNS [Type];
```

UniqueType lets clients assign a unique type to their defined cursors. It returns a **Type** that is different from all predefined types and from any that has previously been returned by **UniqueType**. The value is only valid during the current boot session.

18.2.6 Cursor Picture Manipulation

```
Invert: PROCEDURE RETURNS [BOOLEAN];
```

Invert inverts each bit of the cursor picture and inverts the positive/negative state of the picture. It returns TRUE if the new state of the cursor is positive.

```
MakeNegative: PROCEDURE;
```

MakeNegative is equivalent to **MakePositive** followed by **Invert**. It sets the positive/negative state of the cursor to negative.

```
MakePositive: PROCEDURE;
```

MakePositive sets the positive/negative state of the cursor to positive. The state is set to positive whenever **Set** or **Store** is invoked.

18.3 Usage/Examples

The following example shows a client setting the cursor to an hourglass while performing some time-consuming action. It first saves the current cursor and restores it when it is done, if the action did not change the cursor. If the client knew what the cursor should be, it would not have to be saved, but could be unconditionally set .

```
savedCursor: Cursor.Object;

Cursor.Fetch[@savedCursor];
Cursor.Set[hourglass]
```

```
-- do action --
IF Cursor.GetInfo[].type = hourglass THEN Cursor.Store[@savedCursor];
```

StoreCharacter is typically used to put small pictures in the cursor by using characters obtained from SimpleTextFont.AddClientDefinedCharacter.

18.4 Interface Item Index

19 Directory

19.1 Overview

Directory provides a mechanism for clients to add dividers to the directory icon. **Directory** maintains a directory divider containing three top-level dividers, the workstation divider, containing those objects that exist on a per-workstation basis; the user divider, containing those objects that exist on a per-user or per-desktop basis; and the network divider, containing those objects that exist in the internet. See the **Divider** and **CHDivider** interfaces for more information about dividers .

19.1.1 Predefined Divider Structure

Directory automatically creates a top-level divider, which backs the directory icon. To this divider it adds the workstation divider, the user divider, and the network divider. It adds three entries to the workstation divider: the prototype folder, the office aids divider, and the local devices divider. The user divider is emptied at each logout. Clients of the user divider should add their entries at each logon. **Directory** also automatically adds the organization divider to the network divider, and the domain divider to the organization divider. Clients can add entries to the domain divider, (see Figure 19.1). See the **Prototype** interface for details of how to add prototype icons to the prototype folder, and the **Divider** interface for details of how to add entries to the office aids, local devices, and user dividers.

19.2 Interface Items

19.2.1 Adding Items to a Predefined Divider

```
DividerType: TYPE = {top, ws, user, domain, localDevices, officeAids};
```

A parameter of type **DividerType** is passed to **AddDividerEntry**to specify one of the predefined dividers. A value of **top** specifies adding a new top-level divider.

```
AddDividerEntry: PROCEDURE [
    divider: DividerType,
    type: NSFile.Type,
    label: XString.Reader,
data: LONG POINTER ← NIL,
convertProc: Divider.ConvertProc ← NIL,
genericProc: Divider.GenericProc ← NIL];
```

AddDividerEntry adds an entry to the divider specified by **divider**. If **divider** is equal to **top**, a new top-level divider is added. **type** specifies the **NSFile.Type** of the entry and is used to obtain the **Containee.Implementation** for the entry. **label** is used to label the entry when it appears in the divider's container window. The **XString.Reader** bytes will be copied. **data** is an optional data pointer to be supplied in subsequent calls to the **GenericProc** and the **ConvertProc**. **convertProc** is a **Divider.ConvertProc** for the entry and **genericProc** is a **Divider.GenericProc** for the entry. (See the **Divider** interface for details.) Fine Point: The predefined dividers are actually implemented using the **Divider** interface. **AddDividerEntry** is actually the same as **Divider.AddEntry** with the **handle** arguement replaced by a **Directory.DividerType**.

19.2.2 GetDividerHandle

```
GetDividerHandle: PROCEDURE [divider: DividerType] RETURNS [handle: Divider.Handle];
```

GetDividerHandle returns the **Divider.handle** for the predefined divider specified by **divider**. Clients can use this handle to manipulate the predefined divider with the **Divider** interface. (See the **Divider** chapter for more information.)

19.3 Usage/Examples

See the **Divider** and **CHDivider** interfaces for examples of how to add entries to the directory. The **Divider** interface also shows the implementation of **AddDividerEntry**.

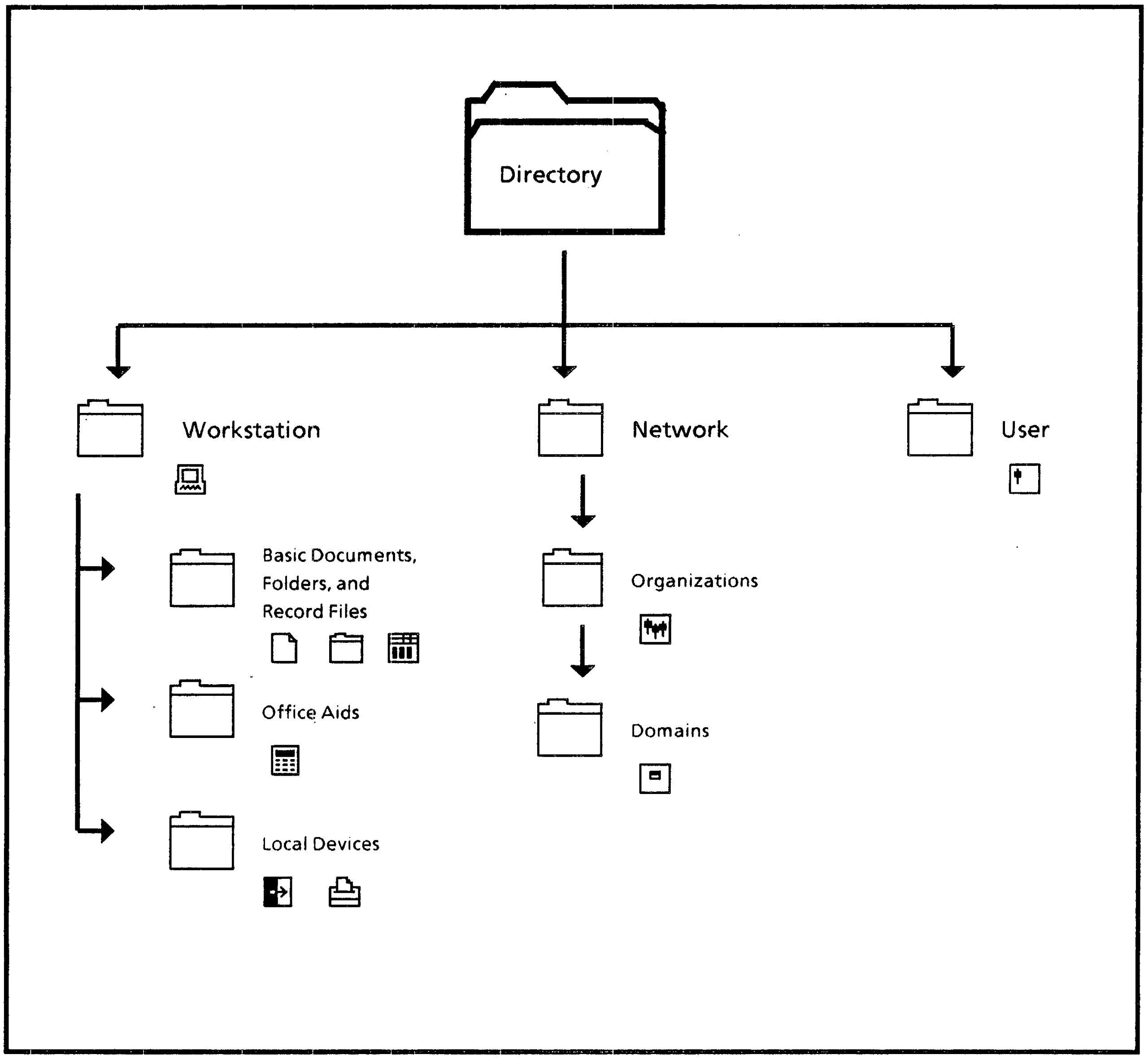

Figure 19.1 Predefined Divider Structure

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Display

20.1 Overview

The **Display** interface provides elementary routines for painting into windows on the display screen. Procedures are provided for painting points, lines, bitmaps, repeating patterns, boxes filled with black, gray, white, or small patterns, circles, circular arcs, ellipses, conics, and for painting a brush as it moves along an arbitrary trajectory. Another procedure allows shifting the current content of a window. Procedures for painting text are available in the **SimpleTextDisplay** interface.

The **Window** interface supplies facilities for managing windows, and the introduction section of the **Window** chapter describes the window coordinate system and the process of painting into a window. The reader should be familiar with that material.

As described in the **Window** chapter, the display background color, which is represented by a pixel value of zero, is commonly called *white* and a value of one called *black*. Note however, that the display hardware also has the ability to render the picture using zero for black and one for white. *Clearing* or *erasing* an area of the screen means setting all of its pixels to zero, or "white."

The **Display** interface currently contains procedures that apply to text, namely **Block**, **MeasureBlock, ResolveBlock, Character, Text, TextInline**. *They are not supported.* Text painting operations are provided by the **SimpleTextDisplay** interface.

As described in the **Window** chapter, the standard way for a client to paint into its window is to update its data structures, invalidate the portion of its window that needs to be painted, and then call a **Window.Validate** routine. **Window** will respond by calling back into the client's display procedure to do the painting. Nonstandard ways of painting are discussed in the Usage/Examples section of this chapter.

20.2 Interface Items

20.2.1 Painting Filled Boxes, Horizontal Lines, and Vertical Lines

Handle: TYPE = Window.Handle;

Black: PROCEDURE [window: Window.Handle, box: Window.Box];

Invert: PROCEDURE [window: Window.Handle, box: Window.Box];

White: PROCEDURE [window: Window.Handle, box: Window.Box];

Black and **White** paint black and white boxes. **Invert** changes all black pixels to white and all white pixels to black in the box. These procedures perform their operation on the specified **box** in **window**. Horizontal and vertical black lines can be painted by using **Black** with a box that is one pixel wide or tall.

Display.Handle is provided for backward compatibility.

20.2.2 Painting Bitmaps and Gray Bricks

The procedures in this section allow the client to paint bitmaps and gray bricks into a window. Bitmaps and gray bricks are described in the *Mesa Processor Principles of Operation.*

The first items below define some convenience types and constants that are used in conjunction with bitmaps and painting.

BitAddress: TYPE = Environment.BitAddress;

DstFunc: TYPE = BitBlt.DstFunc;

BitBltFlags: TYPE = BitBlt.BitBltFlags;

A BitBlt.BitBltFlags is an argument of the **Bitmap** and **Trajectory** operations. These flags control how source pixels and existing display pixels are combined to produce the final display pixels. The flag constants defined below cover most of the common cases. BitBlt.BitBltFlags are described in detail in the *Mesa Processor Principles of Operation.*

```
replaceFlags: BitBltFlags = [
    direction: forward, disjoint: TRUE, disjointItems: TRUE, gray: FALSE,
    srcFunc: null, dstFunc: null, reserved: 0];
```

replaceFlags is used to paint opaque black and opaque white from a bitmap. Source pixels from the bitmap overwrite the previous display pixels.

```
textFlags, paintFlags: BitBltFlags = [
    direction: forward, disjoint: TRUE, disjointItems: FALSE, gray: FALSE,
    srcFunc: null, dstFunc: or, reserved: 0];
```

textFlags and its synonym **paintFlags** are used to paint opaque black and transparent white from a bitmap source. Black source pixels cause black display pixels. White source pixels leave display pixels unchanged.

```
xorFlags: BitBltFlags = [
    direction: forward, disjoint: TRUE, disjointItems: FALSE, gray: FALSE,
    srcFunc: null, dstFunc: xor, reserved: 0];
```

xorFlags is used with a source bitmap to selectively *video invert* existing display pixels. Video inverting is the process of changing white to black and black to white. Black source pixels cause the existing display pixels to be inverted. White source pixels leave display pixels unchanged.

```
paintGrayFlags, bitFlags: BitBltFlags = [
    direction: forward, disjoint: TRUE, disjointItems: TRUE, gray: TRUE,
    srcFunc: null, dstFunc: or, reserved: 0];
```

paintGrayFlags is used to paint opaque black and transparent white from a gray brick source. Black source pixels cause black display pixels. White source pixels leave display pixels unchanged.

```
replaceGrayFlags, boxFlags: BitBltFlags = [
    direction: forward, disjoint: TRUE, disjointItems: TRUE, gray: TRUE,
    srcFunc: null, dstFunc: null, reserved: 0];
```

replaceGrayFlags is used to paint opaque black and opaque white from a gray brick source. Source pixels overwrite the previous display pixels.

```
xorGrayFlags, xorBoxFlags: BitBltFlags = [
    direction: forward, disjoint: TRUE, disjointItems: TRUE, gray: TRUE,
    srcFunc: null, dstFunc: xor, reserved: 0];
```

xorGrayFlags is used with a source gray brick to selectively *video invert* existing display pixels. Black source pixels cause the existing display pixels to be inverted. White source pixels leave display pixels unchanged.

```
eraseFlags: BitBltFlags = [
    direction: forward, disjoint: FALSE, disjointItems: FALSE, gray: FALSE,
    srcFunc: complement, dstFunc: and, reserved: 0];
```

eraseFlags is used to erase objects. Previous display pixels are overwritten.

```
Bitmap: PROCEDURE [
    window: Window.Handle, box: Window.Box, address: Environment.BitAddress,
    bitmapBitWidth: CARDINAL, flags: BitBlt.BitBltFlags ← paintFlags];
```

Bitmap paints the bitmap described by **address** and **bitmapBitWidth** into **box** in **window**, using **flags** to control the interaction with pixels already being displayed. **Bitmap** may be used to display a gray pattern that is not aligned relative to the window origin. **box.dims.w** must be less than or equal to **bitmapBitWidth**; this is not checked. **flags.gray** is ignored.

```
BitAddressFromPlace: PROCEDURE [
    base: Environment.BitAddress, x, y: NATURAL, raster: CARDINAL]
    RETURNS [Environment.BitAddress];
```

BitAddressFromPlace returns the **Environment.BitAddress** of the pixel at coordinates **x** and **y** in the bitmap described by **base**. **raster** is the number of pixels per line in the bitmap. This procedure is useful for calculating the **address** parameter of **Bitmap**.

Brick: TYPE = LONG DESCRIPTOR FOR ARRAY OF CARDINAL;

Bricks are used by **Gray** and **Trajectory** to describe a repeating pattern with which to fill an area. The maximum size of a **Brick** is 16 words; each word is one row of the pattern.

fiftyPercent: Brick;

fiftyPercent is a brick containing a 50% gray pattern.

Gray: PROCEDURE [
  window: Window.Handle, box: Window.Box, gray: Brick ← fiftyPercent,
  dstFunc: BitBlt.DstFunc ← null];

Gray uses the source **gray** brick to completely fill **box** in **window**. If the content of the brick to be displayed is not aligned with the window origin, use **Bitmap** instead. The table below describes the effect of **dstFunc**.

dstFunc	resulting display pixels
null	Source pixels overwrite display pixels.
or	Black source pixels cause black display pixels. White source pixels leave display pixels unchanged.
xor	Black source pixels cause the existing display pixels to be inverted. White source pixels leave display pixels unchanged.
and	Black source pixels cause black display pixels wherever the display pixels are already black. All other display pixels will be made white.

20.2.3 Painting points, slanted lines, and curved lines

The procedures below paint points, oblique straight lines, and circular arcs and conics.

Point: PROCEDURE [window: Window.Handle, point: Window.Place];

Point makes the single pixel at **point** in **window** black.

LineStyle: TYPE = LONG POINTER TO LineStyleObject;

LineStyleObject: TYPE = RECORD [
  widths: ARRAY [0..DashCnt) OF CARDINAL,
  thickness: CARDINAL];

DashCnt: CARDINAL = 6;

LineStyle describes the style of lines for the **Line**, **Circle**, **Ellipse**, **Arc** and **Conic** operations. **thickness** defines how many pixels wide the line is. **widths** defines what the dash structure is. Each pair of elements is number of pixels of black followed by number of pixels of white. For example **[widths: [4,2,0,0,0,0], thickness: 2]** defines the style for a dashed line, two pixels thick where the dashes are four pixels on, and two off.

```
Line: PROCEDURE [
  window: Window.Handle, start, stop: Window.Place, lineStyle: LineStyle ←NIL,
  bounds: Window.BoxHandle ←NIL];
```

Line paints a line from **start** to **stop** in **window**. If **bounds** # NIL, the line is clipped to the box **bounds**. If **lineStyle** is defaulted the line is solid and a single pixel wide.

```
Circle: PROCEDURE [
   window: Window.Handle, place: Window.Place, radius: INTEGER,
   lineStyle: LineStyle ←NIL, bounds: Window.BoxHandle ←NIL];
```

Circle paints a circle centered at **place** in **window**, with the given **radius**. If **bounds** # NIL, the circle is clipped to the box **bounds**. If **lineStyle** is defaulted the circle is solid and a single pixel wide.

```
Ellipse: PROCEDURE [
   window: Window.Handle, center: Window.Place, xRadius, yRadius: INTEGER,
   lineStyle: LineStyle ←NIL, bounds: Window.BoxHandle ←NIL];
```

Ellipse paints an ellipse with axes centered at **center** with an x radius of **xRadius** and a y radius of **yRadius** in **window**. The axes of the ellipse are parallel to the x-y coordinate system. Ellipses with oblique axes may be displayed using **Conic**. If **bounds** # NIL, the ellipse is clipped to the box **bounds**. If **lineStyle** is defaulted the ellipse is solid and a single pixel wide.

```
Arc: PROCEDURE [
   window: Window.Handle, place: Window.Place, radius: INTEGER,
   startSector, stopSector: CARDINAL, start, stop: Window.Place,
   lineStyle: LineStyle ←NIL, bounds: Window.BoxHandle ←NIL];
```

Arc paints a portion of a circular arc centered at **place** in **window**, with the given **radius**. The arc goes from the angle defined by **start** in the **startSector** to **stop** in the **stopSector**. Sectors are simply octants numbered from 1 to 8, with northeast being one and increasing clockwise. If **bounds** # NIL, the arc is clipped to the box **bounds**. If **lineStyle** is defaulted the arc is solid and a single pixel wide.

```
Conic: PROCEDURE [
   window: Window.Handle, a, b, c, d, e, errorTerm: LONG INTEGER,
   start, stop, errorRef: Window.Place,
   sharpCornered, unboundedStart, unboundedStop: BOOLEAN,
   lineStyle: LineStyle ←NIL, bounds: Window.BoxHandle ←NIL];
```

Conic paints the portion of the curve of the equation $\mathbf{a}x^2 + \mathbf{b}y^2 + \mathbf{c}xy + \mathbf{d}x + \mathbf{e}y + f = 0$ in **window** from **start** to **stop**. Instead of passing in the last coefficient f, this procedure takes the **errorTerm** resulting from substituting **start** into the equation. If the conic contains points whose radius of curvature is less than or equal to two pixels, it must be displayed using multiple calls with **sharpCornered** set to TRUE; otherwise **sharpCornered** should be FALSE. These "sharp-cornered" conics must be broken up into segments where the corners become a new segment's start and stop points. For example, a very long skinny ellipse must be displayed in two pieces. **errorRef**, **unboundedStart** and **unboundedStop** are ignored. If **bounds # NIL**, the conic is clipped to the box **bounds**. If **lineStyle** is defaulted the conic is solid and a single pixel wide.

20.2.3 Painting parallelograms and trapezoids

These types and procedures are used to paint parallelograms and trapezoids:

```
FixdPtNum: TYPE = MACHINE DEPENDENT RECORD [
    SELECT OVERLAID * FROM
        wholeThing = > [li: LONG INTEGER],
        parts = > [frac: CARDINAL, int: INTEGER],
        ENDCASE];
```

A **FixdPtNum** is a fixed-point integer with 16 bits of fraction and 16 bits of integer part. These numbers can be added and subtracted in a straightforward manner; while division and multiplication are more difficult. By using the overlaid record, the fraction and integer part may be obtained without shifting or dividing. **FixdPtNum** can express all practical slopes with only small errors.

```
Interpolator: TYPE = RECORD [
    val, dVal: FixdPtNum];
```

Interpolator is used to define parallelograms and trapezoids. The **dVal** term is the derivative with respect to y; for example, **x.dVal** is dx/dy.

```
BlackParallelogram: PROC [
    window: Handle, p: Parallelogram, dstFunc: DstFunc _ null];
```

```
Parallelogram: TYPE = RECORD [
    x: Interpolator, y: INTEGER, -- upper left
    w: NATURAL, -- across top, must be positive
    h: NATURAL];
```

BlackParallelogram paints the parallelogram defined by **p** in **window**. **dstFunc** acts as in the procedure **Gray**. The parallelogram is defined as below with the slope of the parallelogram being **p.x.dVal**. In Figure 20.1 the slope is two fifths. **BlackParallelogram**

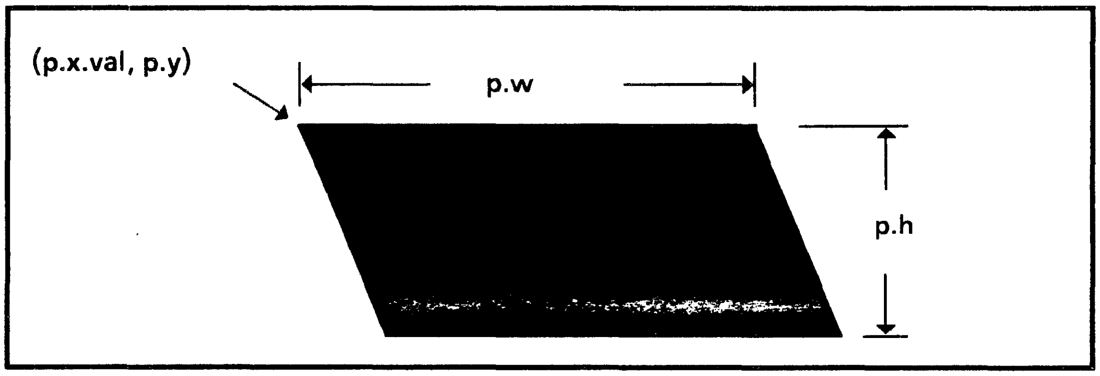

Figure 20.1Parallelogram definition

optimizes a common case (e.g., diagonal lines) and runs about twice as fast as

GrayTrapezoid by avoiding the second interpolation, the non-integer width, and the gray alignment calulations

```
GrayTrapezoid: PROC [
    window: Handle, t: Trapezoid, gray: Brick ← fiftyPercent, dstFunc: DstFunc ← null];

Trapezoid: TYPE = RECORD [
    x: Interpolator, y: INTEGER, -- upper left
    w: Interpolator, -- across top; must be positive
    h: NATURAL];
```

GrayTrapezoid paints the trapezoid defined by **t** in **window**. **gray** and **dstFunc** act as in the procedure **Gray**. The trapezoid is defined in Figure 20.2 with the slope of the left side of the trapezoid being **t.x.dVal** and the slope of the right side of the trapezoid being **t.x.dVal** minus **t.w.dVal**. In Figure 20.2, **t.x.dVal** is minus one half and **t.w.dVal** is nine tenths.

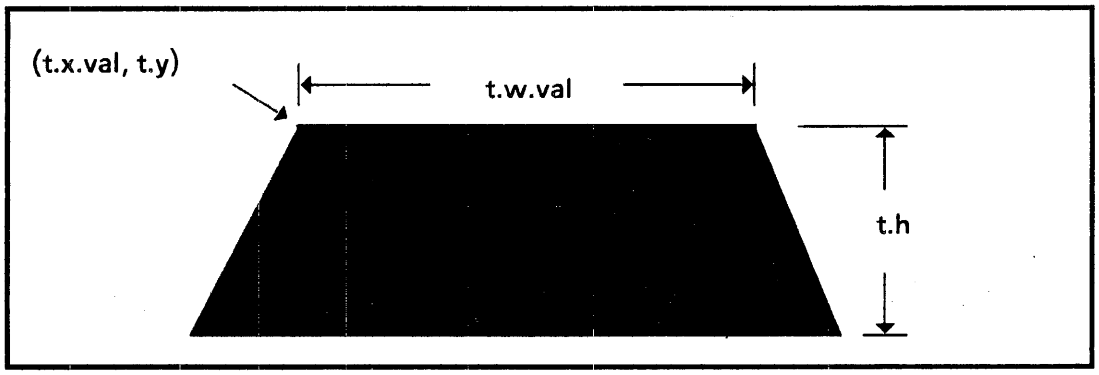

Figure 20.2 Trapezoid definition

20.2.5 Painting along trajectories, shifting window contents

```
Shift: PROCEDURE [window: Window.Handle, box: Window.Box, newPlace: Window.Place];
```

Shift does a block move of a rectangular portion of **window**'s current content. No client display procedures are invoked by this operation. **box** describes the region of **window** to be moved to **newPlace**. If **Display** does not have the pixels for a visible area of the destination box, that area is filled with trash and marked invalid. The client should validate the window when it has finished altering the window content. **Shift** does not invalidate the areas vacated by the move; if they should be repainted, the client should invalidate them. If **Shift** is executed from within a display procedure, it nevertheless does not clip the region painted to window's invalid area list. Invalid area lists are explained in the **Window** chapter.

```
Trajectory: PUBLIC PROCEDURE [
   window: Window.Handle, box: Window.Box ←Window.nullBox, proc: TrajectoryProc,
   source: LONG POINTER ← NIL, bpl: CARDINAL ← 16, height: CARDINAL ← 16,
   flags: BitBlt.BitBltFlags ← bitFlags, missesChildren: BOOLEAN ← FALSE,
   brick: Brick ←NIL];

TrajectoryProc: TYPE = PROCEDURE [Handle] RETURNS [Window.Box, INTEGER];
```

Trajectory repeatedly calls **proc** and paints a brush where **proc** specifies. The brush may be either a gray **brick** or a portion of the bitmap **source**. **Trajectory** is designed to avoid much of the overhead of successive calls to the normal **Display** routines. **box** is the window region in which painting may occur. The client must not try to paint outside **box**; this is not checked. **flags** controls the type of painting performed. If **flags.gray** = TRUE, the gray **brick** is painted; otherwise a bitmap is painted. **Trajectory** repeatedly calls **proc** for instructions. If **proc** returns a box having **dims.w** = **0** (e.g. **Window.nullBox**), iteration ceases and **Trajectory** returns. Otherwise **dims.w # 0**; **Trajectory** will paint the brush and then loop to call **proc** again. The returned **Box** in the window is painted with the brush as follows. If a gray brick is being painted, the brick is used to fill completely the returned **Box**. If a bitmap is being painted, the bitmap starts at a bit offset of <INTEGER> from **source**, is **Box.dims.h** high, and has **bpl** pixels per line. The client may wish to alter the brush content along the trajectory. It can do this by having **source** be a large bitmap containing several different brush patterns, and having **proc** return the bit offset and **Box.dims** of the desired portion. **BitBlt.BitBltFlags** are described in §21.2.2. **height** and **missesChildren** are unused. **proc** must not call any procedures in **Display** or **Window**; doing so will result in a deadlock.

20.3 Usage/Examples

20.3.1 Special topic: Direct painting

As described in the **Window** chapter, the standard way for a client to paint into its window is to update its data structures, invalidate the portion of its window that needs to be painted, and then call a **Window.Validate** routine. **Window** will respond by calling back into the client's display procedure to do the painting.

The client may also paint directly into a window without going through **Window.Validate**. However, this *direct painting* approach is subject to several pitfalls and system bugs. Clients commonly choose direct painting only when high painting performance is required, such as dynamically extending an inverted selection while tracking the mouse or in implementing a blinking caret.

Pitfall 1: One consequence of doing direct painting is that *the window's display procedure must not depend on* **Window** *clearing invalid areas for it.* As described in the Window chapter, if **clearingRequired** = TRUE, **Window** guarantees that when the display procedure is called to paint the window, all of the window's pixels that should be white indeed are white. In that situation, the window might contain any combination of its previous contents and erased areas. Notice that the following sequence of events might occur: **Window** clears invalid area; then client direct paints into some part of the invalid area; then **Window** calls the window's display procedure. In this situation, **Window**'s guarantee of the content of the invalid area has been voided by the parallel direct-paint activity. To handle this case, the display routine must erase or otherwise completely overpaint the invalid areas itself.

Pitfall 2: A client can get into trouble when it wishes to change the state of the backing data being displayed *within* a display procedure—and attempts to render the change by painting from the display procedure rather than invalidating the affected area and painting later. The display procedure's paint will be clipped to its invalid area list and thus will fail to achieve the desired effect. There are several ways to solve this problem:

- Do not change backing data inside a display procedure. This approach matches nicely with the intended function of a display procedure. One does not expect a display procedure to change data—its job is to repaint.
- Have the display procedure just invalidate the areas affected by the data being changed. Since a validate is already in progress, it is not necessary to call Window.Validate; when the display procedure returns, it will be called back with any new invalid areas that are waiting for it.
- Have the display procedure call Window.FreeBadPhosphorList before changing the data. This will allow paint from the display procedure to affect the entire window, not just the invalid areas.

20.3.2 Example 1

The program fragments below demonstrate the use of Display in a window's display procedure.

```
-- Enumerated TYPEs for displaying the games background.
Background: TYPE = {gray, white};
background: Background ← gray;

DisplayBoardSW: PROC [window: Window.Handle] = {
    -- This is the body window's display procedure.
    vLine, hLine: Window.Box;
    left, right, top, bottom: INTEGER;

    FindBounds: PROC [window: Window.Handle, box: Window.Box] = {
        left ← MIN[left, box.place.x];
        top ← MIN[top, box.place.y];
        right ← MAX[right, box.place.x + box.dims.w];
        bottom ← MAX[bottom, box.place.y + box.dims.h]};

    -- paint borders and background.
    Display.Black[window: window, box: boardAndBorderBox];
    PaintBackground[window: window, box: boardBox];
    vLine ← [upperLeft, [lineWidth, (boardSize - 1)*unitH + 1]];
    hLine ← [upperLeft, [(boardSize - 1)*unitW + 1, lineWidth]];
    THROUGH [firstDimboardSize] DO
        Display.Black[window, vLine];
        Display.Black[window, hLine];
        vLine.place.x ← vLine.place.x + unitW;
        hLine.place.y ← hLine.place.y + unitH;
        ENDLOOP;

    .
    .
    left ← top ← INTEGER.LAST;
    right ← bottom ← INTEGER.FIRST;
    window.EnumerateInvalidBoxes[FindBounds]
    .
    .
    };

PaintBackground: PROC [window: Window.Handle, box: Window.Box] = {
    SELECT background FROM
        gray => Display.Gray[window, box];
        white => Display.White[window, box];
        ENDCASE
    };

PaintStone: PUBLIC PROC [who: BlackWhite, u, v: Dim, play: CARDINAL] = {
    center: Window.Place;
    stoneBox: Window.Box;
    numStr: STRING ← [3];

    IF ~ValidCoords[u, v] THEN RETURN;
    center ← BoardToPlace[u, v];
    stoneBox ← [
    place: [center.x - stoneRadius, center.y - stoneRadius],
    dims: [stoneSize, stoneSize]];

    -- paint a bitmap that represents game pieces.
    Display.Bitmap[
        window: boardSW, box: stoneBox, address: outerStone,
        bitmapBitWidth: stoneBpl, flags: Display.paintFlags];
    IF who = white THEN
    Display.Bitmap[
        window: boardSW, box: stoneBox, address: innerStone,
        bitmapBitWidth: stoneBpl, flags: eraseFlags];
    .
    .
    };

CreateGoSWS: PUBLIC PROCEDURE [
    reference: NSFile.ReferenceRecord, name: Environment.Block ]
    RETURNS [StarWindowShell.Handle] = {
    -- This procedure is invoked via a system menu.
    sz: StarWindowShell.Handle;
    .
    .
    StarWindowShell.SetPreferredDims [ sz, [592, 661] ];
    -- The display procedure is set here.
    boardSW ← StarWindowShell.CreateBody [
        sws: sz,
    repaintProc: DisplayBoardSW,
    bodyNotifyProc: TIPMe ];
.
.
};
```

20.4 Index of Interface Items

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Divider

21.1 Overview

Divider maintains a table of entries in memory, each representing an icon. The entries may or may not be backed by files. Divider does not operate on these entries directly; it uses a Divider.ConvertProc and a Divider.GenericProc associated with each entry to operate on the entry.

Also associated with each entry is an NSFile.Type used to identify the entry's Containee.Implementation, a label, and a pointer to instance-specific data for the entry.

Associated with each divider when it is created is an NSFile.Type. Divider automatically sets a Containee.Implementation for this file type that supports converting the divider to a file and opening the divider as a container window displaying the entries.

Also associated with each divider is a CH.Pattern specifing a clearinghouse domain and organization. This is inherited from a parent divider and is passed to all entries through the Divider.ConvertProc and the Divider.GenericProc associated with each entry. When the divider is converted to a file, the pattern is automatically encoded in an attribute of the file.

21.2 Interface Items

21.2.1 Creating and Destroying

```
Handle: TYPE = LONG POINTER TO Object;

Object: TYPE;

Create: PROCEDURE [
    type: NSFile.Type,
    name: XString.Reader,
    initialSize: CARDINAL ← Divider.defaultInitialSize,
    increment: CARDINAL ← Divider.defaultIncrement,
    zone: UNCOUNTED ZONE ← NIL]
    RETURNS [handle: Handle];
```

Create creates a divider. **type** specifies the **NSFile.Type** the divider will have if it is converted to a file. A **Containee.Implementation** is automatically set for this type. **name** specifies the name of the divider. It will appear in the window header when the divider is opened, and it is the name of the file if the divider is converted to a file. The **XString.Reader** bytes will be copied. The divider is created with a table large enough to hold **initialSize** entries. When the table becomes full, it grows by **increment** entries. Storage for the divider is allocated from **zone**. If **zone** is defaulted, the storage is allocated from a heap maintained by **Divider**.

```
Destroy: PROCEDURE [handle: Handle];
```

This releases all storage associated with the given **divider**. **handle** is no longer valid when this procedure returns.

21.2.2 ConvertProc and GenericProc

```
Divider.ConvertProc: TYPE = PROCEDURE [
    data: LONG POINTER,
    pattern: CH.Pattern,
    target: Selection.Target,
    zone: UNCOUNTED ZONE,
    info: Selection.ConversionInfo ← [convert[]]]
    RETURNS [value: Selection.Value];
```

A **ConvertProc** is the same as a **Selection.ConvertProc** except that it has the extra argument, **pattern**, that specifies a clearinghouse domain and organization. See the **Selection** interface for the definition of the other arguments. The divider calls the **ConvertProc** associated with an entry, with **pattern** set to the domain and organization associated with the divider, whenever the divider is requested to convert one of its entries.

```
GenericProc: TYPE = PROCEDURE [
    atom: Atom.ATOM,
    data: LONG POINTER,
    pattern: CH.Pattern,
    changeProc: Containee.ChangeProc ← NIL,
    changeProcData: LONG POINTER ← NIL]
    RETURNS [LONG UNSPECIFIED];
```

A **GenericProc** is the same as a **Containee.GenericProc** except that it has the extra argument, **pattern**, that specifies a clearinghouse domain and organization. See the **Containee** interface for the definition of the other arguments. The divider calls the **GenericProc** associated with an entry, with **pattern** set to the domain and organization associated with the divider, whenever the divider is requested to operate on one of its entries.

```
DividerConvertProc: ConvertProc;

DividerGenericProc: GenericProc;
```

These procedures may be associated with entries that themselves are dividers. In this case the **Handle** associated with the divider should be provided as the instance-specific data handle. See below for an example of a divider contained in another divider.

21.2.3 Adding Entries

```
AddEntry: PROCEDURE [
    handle: Handle,
    type: NSFile.Type,
    label: XString.Reader,
    data: LONG POINTER ← NIL,
    convertProc: ConvertProc ← NIL,
    genericProc: GenericProc ← NIL];
```

AddEntry adds an entry to the divider specified by **handle**. **type** is used to obtain the **Containee.Implementation** for the entry. **label** is used to label the entry in the divider's container window. The **XString.Reader** bytes will be copied. **data** is item-specific data for the entry that will be passed to the **ConvertProc** and **GenericProc** associated with the entry. If **convertProc** or **genericProc** is defaulted, the divider uses the corresponding procedure in the entry's **Containee.Implementation**.

21.3 Usage/Examples

21.3.1 Fragment from DirectoryImpl.mesa

This fragment is from **DirectoryImpl.mesa**, which implements the **Directory** interface. It shows the implementation of **Directory.AddDividerEntry** and the mainline code to create the top-level directory dividers. See the **CHDivider** interface for more examples.

```
-- File types for the directory implementation --
directory: StarFileTypes.FileType = ...;
folder: StarFileTypes.FileType = ...;
workstation: StarFileTypes.FileType = ...;
user: StarFileTypes.FileType = ...;
domain: StarFileTypes.FileType = ...;

-- The reference for the prototype folder --
prototypeReference: NSFile.Reference ← ...;

-- Handles for the top-level dividers --
dividers: ARRAY Directory.DividerType OF Divider.Handle ← ALL [NIL];

AddDividerEntry: PUBLIC PROCEDURE [
    divider: Directory.DividerType,
    type: NSFile.Type,
    label: XString.Reader,
    data: LONG POINTER ← NIL,
    convertProc: Divider.ConvertProc ← NIL,
    genericProc: Divider.GenericProc ← NIL] =
BEGIN
    Divider.AddEntry [
          handle: dividers[divider],
          type: type,
          label: label,
          data: data,
          convertProc: convertProc,
          genericProc: genericProc];
END;

-- Create the top-level dividers (top will back the directory icon) --
dividers[top] ← Divider.Create [directory, stringDirectory];
dividers[ws] ← Divider.Create [workstation, stringWorkstation];
dividers[user] ← Divider.Create [user, stringUser];

-- Insert the workstation divider into the directory --
Directory.AddDividerEntry [
     divider: top,
     type: workstation,
     label: stringWorkstation,
     data: dividers[ws],
     convertProc: Divider.DividerConvertProc,
     GenericProc: Divider.DividerGenericProc];


-- Insert the user divider into the directory --
Directory.AddDividerEntry [
     divider: top,
     type: user,
     label: stringUser,
     data: dividers[user],
     convertProc: Divider.DividerConvertProc,
     genericProc: Divider.DividerGenericProc];


-- Insert the prototype folder into the workstation divider --
-- (Note: this is an actual file that will use the folder implementation) --
Directory.AddDividerEntry [
     divider: ws,
     type: folder,
     label: stringPrototypes,
     data: @prototypeReference];
```

21.4 Index of Interface Items

22

Event

22.1 Overview

ViewPoint provides a facility that permits clients to register procedures that are to be called when specified events occur. For example, a client may wish to be notified whenever a document is closed, or perhaps just the next time a document is closed. Clients need not know which module can cause the event.

22.2 Interface Items

22.2.1 Registering Dependencies

A client wishing to be notified of some future event calls either **AddDependency** or **AddDependencies**, specifying the **EventType** and a procedure to be called when the event occurs, an **AgentProcedure**. **Note:** ViewPoint need not know in advance what **EventType** is implemented, nor which modules implement them.

```
AddDependency: PROCEDURE [
  agent: AgentProcedure,
  myData: LONG POINTER TO UNSPECIFIED,
  event: EventType,
  remove: FreeDataProcedure ← NIL]
  RETURNS [dependency: Dependency];

AddDependencies: PROCEDURE [
  agent: AgentProcedure,
  myData: LONG POINTER TO UNSPECIFIED,
  events: LONG DESCRIPTOR FOR ARRAY OF EventType,
  remove: FreeDataProcedure ← NIL]
  RETURNS [dependency: Dependency];

AgentProcedure: TYPE = PROCEDURE [
  event: EventType,
  eventData, myData: LONG POINTER TO UNSPECIFIED]
  RETURNS [remove, veto: BOOLEAN ← FALSE];
```

FreeDataProcedure: TYPE = PROCEDURE [mydata: LONG POINTER TO UNSPECIFIED];

Dependency: TYPE [2]; -- *Opaque* --

A dependency may be added to an event or an entire set of events by calling **AddDependency** or **AddDependencies** Both of these procedures return a private type, **Dependency**, that uniquely identifies that set of dependencies. The value returned may be saved and subsequently used in a call to **RemoveDependency**, which will remove the dependency(ies) associated with the earlier **AddXXX** call. The **AgentProcedure** may also remove the dependency as discussed below.

When the specified **event** occurs, **agent** is called with the **EventType**, the **eventData** for the event, and the client data passed as **myData**. If a client wishes to "veto" the event (for instance, to disallow a world-swap), its **AgentProcedure** should return **veto: TRUE**. This aborts the notification; that is, no other clients dependent on the event will be notified. However, there is no guarantee as to the order in which multiple clients are notified. If any client vetoes the event, the call to **Notify** returns **TRUE**. There is no way to prevent a client from vetoing; instead, implementors of events that should not be vetoed should raise an **ERROR** if **Notify** returns **TRUE**. To remove its dependency on an **event** a client's **AgentProcedure** should return **remove: TRUE**. If the dependency is removed and a **FreeDataProcedure** was provided, it is called at this time to allow the client to free any private data.

EventType: TYPE = Atom.ATOM;

The **ATOM** (strings) used to identify different events must of course be distinct. The following examples are possibilities of how this could be managed. (1) There is a central authority whose job it is to guarantee uniqueness of **EventTypes**. This could be the same person in charge of other such allocations, such as **NSFile** types. (2) There is a hierarchical naming structure, managed by a distributed authority. (3) There could be a file that lists all known **EventTypes** within a given system; this file would be managed by the Librarian to ensure against parallel allocation of new **EventTypes**. (In effect, this is the same as case 1, but the Librarian takes the place of the central authority.)

RemoveDependency: PROC [dependency: Dependency];

NoSuchDependency: ERROR;

If **RemoveDependency** is called with a **Dependency** that is invalid (possibly because the dependency has already been removed), it raises the error **NoSuchDependency**.

22.2.2 Notification

Notify: PROCEDURE [event: EventType, eventData: LONG POINTER TO UNSPECIFIED ← NIL]
RETURNS [veto: BOOLEAN];

When the event occurs, the implementor calls **Notify**, giving it the **EventType** for the event and any implementation-specific data (**eventData**) required by the client. (Presumably it is uncommon for a single operation to wish to **Notify** more than one event; this is why **Notify** does not take an **ARRAY** argument.) The **Event** interface then invokes each **AgentProcedure** that is dependent on the **EventType**. Each **AgentProcedure** is given the **EventType** causing the notification, the client data provided when the dependency was created, and the **eventData** given by the implementor in the call to **Notify**.

22.3 Usage/Examples

The **Event** database is monitored to disallow changes while a **Notify** is in progress. An **AgentProcedure** is allowed to call **Notify**; that is, one event may trigger another. However, an **AgentProcedure** must *not* call **AddDependency** or **RemoveDependency**, or deadlock will result. Since it is relatively common for an **AgentProcedure** to wish to remove its own dependency, this facility is provided by allowing the **AgentProcedure** to return **remove: TRUE** to cause the dependency to be removed. If the dependency was added via **AddDependencies**, then all of the dependencies created by that call are removed. The dependency is removed even though some later client of the same event might choose to veto the event. (If an earlier client has already vetoed, of course, then this **AgentProcedure** never gets called.) If an application requires that a dependency be removed only if the event is not vetoed, this can be handled by having the implementor notify a second event that informs clients whenever the first event is vetoed.

Three notes regarding the preceding paragraph: First, it is possible for an **AgentProcedure** to get called twice even if it always returns **remove: TRUE**. This is because two separate processes may be doing parallel calls to **Notify** Once an **AgentProcedure** returns **remove: TRUE**, no subsequent calls to **Notify** will invoke that dependency, but any parallel calls in progress will complete normally. Second, since an **AgentProcedure** might be invoked at any time, it is a bad idea to call **Add/RemoveDependency** from within a private monitor, lest it lock trying to modify the **Event** database while a **Notify** is inside your **AgentProcedure** trying to grab your lock. On the other hand, the **Notify** call may very well be within the implementor's monitor, which means the **AgentProcedure** will typically be limited as to what use it can make of the **eventData**. Finally, if an **AgentProcedure** really needs to call **Add/RemoveDependency**, it may be possible to get the desired effect by **FORK**ing the call, such that it will take place shortly after the completion of the **Notify** already in progress.

22.3.1 Example 1

```
-- Module interested in an event
eventType: Event.EventType ← Atom.MakeAtom ["SampleEvent"L];

EventAction: Event.AgentProcedure = {
   -- Do appropriate thing for eventType -- };

Event.AddDependency [
   agent: EventAction,
   myData: NIL,
   event: eventType];

-- Module that signals the event
eventType: Event.EventType ← Atom.MakeAtom ["SampleEvent"L];
eventData: -- relevant info, a record, a window handle, etc. --;
 .
 .
```

```
.
[] ← Event.Notify [event: eventType, eventData: eventData];
```

22.3.2 Example 2

```
-- Declare event and eventData --
desktopWindowAvailable: Event.EventType;
desktopWindowHandle: Window.Handle ← NIL;

-- Declare AgentProcedure --
StarUp: Event.AgentProcedure = {
   If eventData = NIL THEN RETURN [veto: TRUE];
   desktopWindowHandle ← eventData };

-- Register event  this is mainline code --
[] ← Event.AddDependency [StarUp, NIL, desktopWindowAvailable];

-- In Desktop code, another module, notify occurrence of the event --
[] ← Event.Notify [desktopWindowAvailable, window];
 -- window is desktop window --
```

22.4 Index of Interface Items

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FileContainerShell

23.1 Overview

FileContainerShell provides a simple way to implement a container application thatis backed by an **NSFile**. **FileContainerShell** takes an **NSFile** and column information (such as headings, widths, formatting), and creates a **FileContainerSource**, a **StarWindowShell**, and a **ContainerWindow** body. (See also the **FileContainerSource**, **ContainerSource**, **StarWindowShell**, and **ContainerWindow** interfaces). Most **NSFile**-backed container applications can use this interface, thereby greatly simplifying the writing of applications such as Folders and FileDrawers.

23.2 Interface Items

23.2.1 Create a FileContainerShell

```
Create: PROCEDURE [
   file: NSFile.Reference,
   columnHeaders: ContainerWindow.ColumnHeaders,
   columnContents: FileContainerSource.ColumnContents,
   regularMenuItems, topPusheeMenuItems: MenuData.ArrayHandle ← NIL,
   scope: NSFile.Scope ← [],
   position: ContainerSource.ItemIndex ← 0,
   options: FileContainerSource.Options ← []]
   RETURNS [shell: StarWindowShell.Handle];
```

Create creates a **StarWindowShell** with a container window as the body window. **file** is the backing for the container; it must be an **NSFile** with children. **columnHeaders** and **columnContents** specify all the necessary information about the columns to be displayed for the open container. (See the **ContainerWindow** and **FileContainerSource** interfaces for the specifics of the headers and contents.) **scope** specifies ordering, filtering, and direction, if any. **position** indicates the item that should be displayed first. **regularMenuItems** and **topPusheeMenuItems** are the menu items that the client would like to be put in the header of the **StarWindowShell**. **Create** puts these items in the header along with its own menu items, such as Show Next and Show Previous. Fine point: The client is responsible for putting any **bottomPusheeCommands** in the window header.

23.2.2 Operations on the Shell

```
GetContainerWindow: PROCEDURE [shell: StarWindowShell.Handle]
  RETURNS [window: Window.Handle];
```

Returns the container window that was created by the **Create** procedure. May raise ContainerWindow.Error[notAContainerWindow] if the shell does not have a container window in it.

```
GetContainerSource: PROCEDURE [shell: StarWindowShell.Handle]
  RETURNS [source:ContainerSource.Handle];
```

Returns the container source that was created by the **Create** procedure. May raise ContainerWindow.Error[notAContainerWindow] if the shell does not have a container window in it.

23.3 Usage/Examples

23.3.1 Example: Creating a FileContainerShell and Specifying Columns

The following example presents the procedure **CreateFileSWS**, which takes an NSFile.Reference and creates a file container shell with two columns: the name of the file and a version date. See the **ContainerSource** interface for details on columns. The name column uses the predefined ContainerSource.NameColumn; the version column is given in the example. The version column differs from the standard ContainerSource.DateColumn in that it displays the lastModifiedDate for directories instead of ---.

```
ContentSeq: TYPE = RECORD [
  SEQUENCE cols: CARDINAL OF FileContainerSource.ColumnContentsInfo];
HeaderSeq: TYPE = RECORD [
  SEQUENCE cols: CARDINAL OF ContainerWindow.ColumnHeaderInfo];
NumberOfColumns: CARDINAL = 2;
z: UNCOUNTED ZONE = ...;

CreateFileSWS: PROCEDURE [reference: NSFile.Reference]
  RETURNS [StarWindowShell.Handle] =
  BEGIN
  shell: StarWindowShell.Handle;
  headers: LONG POINTER TO HeaderSeq ← MakeColumnHeaders[];
  contents: LONG POINTER TO ContentSeq ← MakeColumnContents[];
  shell ← FileContainerShell.Create[
    file: reference,
    columnHeaders: DESCRIPTOR[headers],
    columnContents: DESCRIPTOR[contents]];
  z.FREE[@headers];
  z.FREE[@contents];
  RETURN[shell];
  END;

DateFormatProc: FileContainerSource.MultiAttributeFormatProc =
  BEGIN
```

```
    -- If non-directory, show createdOn date. For directory, show last date modified
         (the last time anything was changed in directory) --
    template: XString.ReaderBody ←
        XString.FromSTRING["<2>-<6>-<4> <8>:<9>:<10>"L];
    XTime.Append[
        displayString,
        IF attrRecord.isDirectory THEN attrRecord.modifiedOn ELSE attrRecord.createdOn,
        @template]};
    END;

MakeColumnContents: PROCEDURE
    RETURNS [columnContents: LONG POINTER TO ContentSeq] =
    BEGIN
    dateSelections: NSFile.Selections ← [interpreted: [
        isDirectory: TRUE, createdOn: TRUE, modifiedOn: TRUE]];

    columnContents ← z.NEW[ContentSeq[NumberOfColumns];
    columnContents[0] ← FileContainerSource.NameColumn[];
    columnContents[1] ← [multipleAttributes [attrs: dateSelections, formatProc:
DateFormatProc]];
    RETURN [columnContents];
    END;

MakeColumnHeaders: PROCEDURE
    RETURNS [columnHeaders: LONG POINTER TO HeaderSeq] =
    BEGIN
    columnHeaders ← z.NEW[HeaderSeq[NumberOfColumns]];
    columnHeaders[0] ← [
        width: 367,
        heading: XString.FromSTRING["NAME"] ];
    columnHeaders[1] ← [
        width: 135,
        heading: XString.FromSTRING["VERSION OF"] ];
    RETURN [columnHeaders];
    END;
```

23.4 Index of Interface Items

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FileContainerSource

24.1 Overview

FileContainerSource supports the creation of **NSFile**-backed container sources (see **ContainerSource**). It also provides facilities for specifying the columns that will be displayed for each item in the source.

FileContainerSource implements all of the procedure types described in the **ContainerSource** interface, as well as all the procedures described below.

24.2 Interface Items

24.2.1 Creation

```
Options: TYPE = RECORD [
   readOnly: BOOLEAN ← FALSE];

Create: PROCEDURE [
   file: NSFile.Reference,
   columns: ColumnContents,
   scope: NSFile.Scope ← [],
   options: Options ← [] ]
   RETURNS [source: ContainerSource.Handle];
```

Creates a container source backed by **file**, which must be an **NSFile** with children. **columns** describes the information that should be displayed for each entry in the container. **columns** is copied by this procedure, so the client may release any storage associated with **columns** after calling **Create**. **scope** specifies the range of files that will be displayed. **options** specifies global information about the container source. Display formatting is managed by the container window. (See the **ContainerWindow** and **FileContainerShell** interfaces.)

24.2.2 Specifiying Columns

When a file container source is created, columns may be specified. Each column represents information that will be displayed for each item. The container window requests the columns one at a time in the form of strings. In a file container source, each column must be based on some combination of **NSFile** attributes. For each column, the creator of file container source specifies which attributes are required to format a string for that column and supplies a procedure that will be called with the specified attributes. When the files in the source are enumerated, the procedure for a particular column is called with the values of the specified attributes for each file, which should be used to generate the string for that file.

```
ColumnContents: TYPE =
  LONG DESCRIPTOR FOR ARRAY OF ColumnContentsInfo;
```

ColumnContents describes a set of columns, where each column is some information that is displayed for each item in the container display. The columns are displayed in the order given by this array.

```
ColumnType:TYPE = {attribute, extendedAttribute, multipleAttributes};
```

```
ColumnContentsInfo: TYPE = RECORD [
  info: SELECT type: ColumnType FROM
    attribute = > [
      attr: NSFile.AttributeType,
      formatProc: AttributeFormatProc ← NIL],
    needsDataHandle: BOOLEAN ← FALSE],
      extendedAttribute = > [
      extendedAttr: NSFile.ExtendedAttributeType,
      formatProc: AttributeFormatProc ← NIL,
    extendedAttribute = > [
      extendedAttr: NSFile.ExtendedAttributeType,
      formatProc: AttributeFormatProc ← NIL],
     multipleAttributes = > [
      attrs: NSFile.Selections,
      formatProc: MultiAttributeFormatProc ← NIL],
    ENDCASE];
```

ColumnContentsInfo describes a single column of information that can be displayed for each item in a container display. Each column may be backed by one of three things: an **NSFile** interpreted attribute (the **attribute** variant), and **NSFile** extended attribute (the **extendedAttribute** variant), or some combination of several attributes (the **multipleAttributes** variant). The **attribute** and **extendedAttribute** variants both take a specification of what attribute is being described (**attr** and **extendedAttr**) and an **AttributeFormatProc** that is called to render the attribute as a string. If **needsDataHandle** = TRUE, then a valid **Containee.DataHandle** is passed to the format procedure as the **containeeData** parameter, else the **containeeData** parameter is NIL. If the column needs a **Containee.DataHandle** in order to format it, then **needsDataHandle** should be TRUE. This addition is for performance: obtaining a **Containee.DataHandle** requires an extra access to the file, thus slowing up the enumeration. The **multipleAttributes** variant is for columns that may require more than one attribute. (The typical example is the **SIZE** column in folders, in which some items display the **numberOfChildren** attribute and others display the **sizeInPages** attribute, depending on the **isDirectory** attribute.) **attrs** specifies all the attributes required for this column. **formatProc** is the procedure that will be called to format the column.

See the common types of columns provided below in the section on commonly used columns.

```
AttributeFormatProc: TYPE = PROCEDURE [
   containeeImpl: Containee.Implementation,
   containeeData: Containee.DataHandle,
   attr: NSFile.Attribute,
   displayString: Xstring.Writer];
```

When the container display mechanism displays a column that represents an **NSFile** attribute, it calls the **AttributeFormatProc** specified for that column. **attr** contains the attribute to be formatted for display. **displayString** is used to return a formatted string that represents the desired attribute. **containeeImpl** may be used to make calls on the underlying implementation of the item being displayed.

```
MultiAttributeFormatProc: TYPE = PROCEDURE [
   containeeImpl: Containee.Implementation,
   containeeData: Containee.DataHandle,
   attrRecord: NSFile.Attributes, -- LONG POINTER TO NSFile.AttributesRecord
   displayString: Xstring.Writer];
```

When the container display mechanism displays a column that represents multiple **NSFile** attributes, it calls the **MultiAttributeFormatProc** specified for that column. **attrRecord** contains the attributes to be formatted for display. **displayString** is used to return a formatted string that represents the desired attribute. **containeeImpl** may be used to make calls on the underlying implementation of the item being displayed.

24.2.3 Operations on Sources

```
GetItemInfo: PROCEDURE [
   source: ContainerSource.Handle, itemIndex: ContainerSource.ItemIndex]
   RETURNS [file:NSFile.Reference, type: NSFile.Type];
```

Returns an **NSFile.Reference** and type for the specified item.

```
Info: PROCEDURE [source: ContainerSource.Handle]
   RETURNS [
   file: NSFile.Reference,
   columns: ColumnContents,
   scope: NSFile.Scope,
   options: Options];
```

The **Info** procedure returns information about a file container source; the information returned is the same information that was used to create the source (see the **Create** procedure).

```
IsIt: PROCEDURE [source: ContainerSource.Handle] RETURNS [BOOLEAN];
```

IsIt returns TRUE if **source** is a file container source.

```
ChangeScope: PROCEDURE [source: ContainerSource.Handle, newScope: NSFile.Scope];
```

Allows the scope (passed in to **Create**) to be changed. A call to **ChangeScope** is typically followed by a **source.ActOn[relist]**, then a **ContainerWindow.Update**.

24.2.4 Commonly Used Columns

These predefined procedures can be used in building a **ColumnContents** array.

```
IconColumn: PROCEDURE
  RETURNS [attribute ColumnContentsInfo];
```

IconColumn represents a column with a small icon picture in it. The small picture is obtained from the **containeeImpl.smallPicture** that is passed in.

```
NameColumn: PROCEDURE
  RETURNS [attribute ColumnContentsInfo];
```

NameColumn represents a column with the file's name in it.

```
SizeColumn: PROCEDURE
  RETURNS [multipleAttributes ColumnContentsInfo];
```

SizeColumn represents a column with the file's size in it, as follows: If the file has the **isDirectory** attribute, the **numberOfChildren** attribute is displayed with the label "Objects"; if the file does not have the **isDirectory** attribute, the **sizeInPages** attribute is displayed with the label "Disk Pages".

```
DateColumn: PROCEDURE
  RETURNS [multipleAttributes ColumnContentsInfo];
```

DateColumn represents a column with the file's creation date in it, as follows: If the file has the **isDirectory** attribute, dashes (---) are displayed; if the file does not have the **isDirectory** attribute, the **createDate** attribute is displayed.

24.3 Usage/Examples

24.3.1 Example: Specifying Columns using FileContainerSource

The following example presents the procedure **MakeFolderLikeShell**, which takes an **NSFile.Reference** (**Containee.DataHandle**) and creates a file container shell with the number of columns dependent on some internal procedures. (See the **ContainerSource** interface for details on columns.) The columns use the predefined columns such as **ContainerSource.NameColumn**.

```
Columns: TYPE = {icon, name, version, nameAndVersion, size, createDate};
HeaderSeq: TYPE = RECORD [SEQUENCE cols: CARDINAL OF ContainerWindow.ColumnHeaderInfo];
ContentSeq: TYPE = RECORD [
  SEQUENCE cols: CARDINAL OF FileContainerSource.ColumnContentsInfo];
ColumnArray:TYPE = ARRAY {icon, name, version, size, date} OF CARDINAL;
columnWidths: LONG POINTER TO ColumnArray ← z.NEW[ColumnArray ← NULL];
```

```
ClientsGenericProc: Containee.GenericProc =
  <<[atom: Atom.ATOM,
  data: Containee.DataHandle,
  changeProc: Containee.ChangeProc ← NIL,
  changeProcData: LONG POINTER ← NIL]
  RETURNS [LONG UNSPECIFIED] >>
  BEGIN
    SELECT atom FROM
      open => RETURN [
          MakeFolderLikeShell [
              data: data,
              changeProc: changeProc,
              changeProcData: changeProcData] ];
    .
    .
    .
      ENDCASE => RETURN [ oldFolder.genericProc [atom, data] ];
    END;

FreeColumnContents: PUBLIC PROCEDURE [columnContents: LONG POINTER TO ContentSeq] =
  BEGIN
  z.FREE[@columnContents];
  END;

FreeColumnHeaders: PUBLIC PROCEDURE [columnHeaders: LONG POINTER TO HeaderSeq] =
BEGIN
z.FREE[@columnHeaders];
END;

MakeFolderLikeShell: PROCEDURE [
  data: Containee.DataHandle,
  changeProc: Containee.ChangeProc ← NIL,
  changeProcData: LONG POINTER ← NIL]
  RETURNS [shell: StarWindowShell.Handle] = {
  file: NSFile.Reference;
  columnHeaders: LONG POINTER TO HeaderSeq ← MakeColumnHeaders[];
  columnContents: LONG POINTER TO ContentSeq ← MakeColumnContents[];
  .
  .
  .
  mydata: Data ← z.NEW [DataObject ← [
    cd: data,
    changeProc: changeProc,
    changeProcData: changeProcData]];
  isLocal: BOOLEAN;
  BEGIN ENABLE
    UNWIND => {
      z.FREE[@mydata];
      FreeColumnHeaders [columnHeaders];
      FreeColumnContents [columnContents];
      };
  .
.
.
shell ← FileContainerShell.Create [
   file: file,
   columnHeaders: DESCRIPTOR[columnHeaders],
   columnContents: DESCRIPTOR[columnContents],
   regularMenuItems: IF ~isLocal THEN remoteRegularMenuItems ELSE NIL];

IF shell = NIL THEN RETURN [shell];

StarWindowShell.SetIsCloseLegalProc [shell, Closing];
Context.Create[context, mydata, DestroyContext, shell];
FreeColumnHeaders [columnHeaders];
FreeColumnContents [columnContents];
StarWindowShell.SetPreferredDims [ shell, [700, 0] ];

RETURN [shell];
END; -- ENABLE
}

MakeColumnContents: PUBLIC PROCEDURE RETURNS [columnContents: LONG POINTER TO
ContentSeq] =
  BEGIN
  i: INTEGER ← -1;
  columnContents ← z.NEW[ContentSeq[CountColumns[]]];
  IF ShowIcon[] THEN
     columnContents[i ← i + 1] ← FileContainerSource.IconColumn[];
  -- Procedures called below are not neccessary to the example.
  columnContents[i ← i + 1] ←
     IF ShowNameAndVersion[]
        THEN FileContainerSourceExtra.NameAndVersionColumn[]
     ELSE FileContainerSource.NameColumn[];
  IF ShowVersion[] THEN
     columnContents[i ← i + 1] ← FileContainerSourceExtra.VersionColumn[];
  IF ShowSize[] THEN
     columnContents[i ← i + 1] ← FileContainerSource.SizeColumn[];
  IF ShowCreateDate[] THEN
     columnContents[i ← i + 1] ← FileContainerSource.DateColumn[];
  RETURN [columnContents];
  END;
```

24.4 Index of Interface Items

25 FormWindow

25.1 Overview

The **FormWindow** interface provides clients the ability to create and manipulate form items in a window.

There are several types of items, each of which serves a different purpose and behaves differently for the user. All items except **tagonly** and **command** have a current value that can be obtained and set by the client and user. The user obtains the current value of an item by simply looking at it and sets the current value of an item by pointing at it appropriately with the mouse. The client obtains and sets the value of items by calling appropriate **FormWindow** procedures.

A **boolean** item is an item with two states (on and off, or TRUE and FALSE). A boolean item's value is of type **BOOLEAN**.

A **choice** item has an enumerated list of choices, only one of which can be selected at any point in time. A choice item's value is of type **FormWindow.ChoiceIndex**.

A **multiplechoice** item is a **choice** item that can have an initial value of more than one choice selected, but any succeeding values can have only one choice selected. A **multiplechoice** item's value is of type **LONG DESCRIPTOR FOR ARRAY OF CARDINAL**.

A **text** item is a user-editable text string. It contains nonattributed text only. A text item's value is of type **XString.ReaderBody**.

A **decimal** item is a text item that has a value of type **XLReal.Number**.

An **integer** item is a text item that has a value of type **LONG INTEGER**.

A **command** item allows a user to invoke a command. When the user clicks over a command item, a client procedure is called.

A **tagonly** item is an uneditable, nonselectable text string.

A **window** item is a window that is a child of the **FormWindow**. It can contain whatever the client desires. A window item's value is a **Window.Handle**. A client must provide its own **TIP.NotifyProc** and window display proc for the window item.

25.1.1 Creating a FormWindow

A client creates a **FormWindow** by calling **FormWindow.Create**. **Create** does not actually create a window, but rather it takes an already .existing window and turns it into a **FormWindow**. **Windows** are usually created by calling **StarWindowShell.CreateBody**.

The client supplies a **MakeItemsProc** and optionally a **LayoutProc** to **FormWindow.Create**. **Create** calls these two client procedures, first the **MakeItemsProc**, then the **LayoutProc**. In the **MakeItemsProc**, the client creates the individual items in the form by calling FormWindow procedures that make items (see §25.1.2 and §25.2.2). In the **LayoutProc**, the client specifies where each created item should be positioned in the window by calling FormWindow procedures that specify layout (see the sections labeled Layout in this chapter).

25.1.2 Making Form Items

There is a procedure for making each type of item: **MakeBooleanItem**, **MakeChoiceItem**, **MakeCommandItem**, **MakeDecimalItem**, **MakeIntegerItem**, **MakeMultipleChoiceItem**, **MakeTagOnlyItem**, **MakeTextItem**, **MakeWindowItem**. Each item must have a unique "key", a **FormWindow.ItemKey**. This is a **CARDINAL** supplied by the client to each **MakeXXXItem** call. This key is then used in any future calls to manipulate that item, such as to get the value of the item. The key must be unique within the **FormWindow**.

All items have some common characteristics and some type-unique characteristics. The common ones are described here. Every item can have a tag that will appear to the left of the item and a suffix that will appear to the right of the item. An item can have a box drawn around it or not. The default is to draw the box. Items can be read-only, that is the user cannot change the value of the item. Items can be visible or invisible, and invisible items can either take up white space in the window or not. See §25.2.2 for more details.

25.1.3 Getting and Setting Values

Every item that has a value that the user can change (all except tagonly and command items) also has procedures for the client to get and set the value. These are:

GetBooleanItemValue	**DoneLookingAtTextItemValue**
GetChoiceItemValue	**SetBooleanItemValue**
GetDecimalItemValue	**SetChoiceItemValue**
GetIntegerItemValue	**SetDecimalItemValue**
GetMultipleChoiceItemValue	**SetIntegerItemValue**
GetTextItemValue	**SetMultipleChoiceItemValue**
GetWindowItemValue	**SetTextItemValue**
LoookAtTextItemValue	

Note: All allocation of storage for values of items is handled by **FormWindow**. The client need not keep copies of item values while the **FormWindow** exists. Obtaining the current value of an item is a simple call to one of the **GetXXXItemValue** procedures. This makes it easy to ensure that the internal value of an item is always in sync with the display. (See §25.2.3 for more details.) Fine Point: This storage allocation scheme is opposite to the one used by XDE's FormSW, where the client owns the storage for items.

25.1.4 "Changed" BOOLEAN

Every item that has a value that the user can change (all except **tagonly**, **command**, and **window items**) has a "changed" boolean associated with it. All items are created with this boolean set to FALSE. **FormWindow** automatically sets this boolean to TRUE whenever the user changes the item. This allows the client to determine which items have changed when, for example, the user selects "Done" or "Apply" on a property sheet. The client is responsible for resetting the changed boolean to false by calling **ResetChanged** or **ResetAllChanged** after examining the changed boolean with **HasBeenChanged** or **HasAnyBeenChanged**. See §25.2.1 for more detail.

Boolean and choice items can have a client-supplied procedure that will be called whenever the item's value changes (see **BooleanChangeProc** and **ChoiceChangeProc** in §25.2.1 and 25.2.2. The client may also supply a **GlobalChangeProc** that will be called whenever any item changes (see §25.2.1).

25.1.5 Visibility

Each item is either displayed in the form window or not. If an item is displayed in the form window, it is visible. If an item is not currently displayed, it is either invisible or **invisibleGhost**. If it is invisible, it does not take up any space on the screen, that is any items below it move up to take its screen space. If an item is **invisibleGhost**, the space that it would occupy were it visible is white on the screen. An item's visibility can be changed at any time by calling **SetVisibility** (see §25.2.5.)

25.1.6 Layout

The exact layout of items in a form window is done by calling various layout procedures after creating the items to be laid out. If an item is not explicitly laid out, it will not appear in the form window at all. A **DefaultLayout** procedure is provided that places each created item on a separate line.

A form window consists of horizontal lines with zero or more items on each line. Each line may be a different height. Any desired vertical spacing may be accomplished by using appropriate heights for lines. Any desired horizontal spacing may be accomplished by using appropriate margins between items. Items may be lined up horizontally by using **TabStops**. Lines are created by calling **AppendLine** or **InsertLine**. Items are placed on a line by calling **AppendItem** or **InsertItem**. (See §25.2.6 for more detail.)

25.2 Interface Items

25.2.1 Creating a FormWindow, etc.

```
Create: PROCEDURE[
   window: Window.Handle,
   makeItemsProc: MakeItemsProc,
   layoutProc: LayoutProc ← NIL,
   windowChangeProc: GlobalChangeProc ← NIL,
   minDimsChangeProc: MinDimsChangeProc ← NIL,
   zone: UNCOUNTED ZONE ← NIL,
   clientData: LONG POINTER ← NIL ];
```

Create takes an ordinary window and makes it a form window.

window is a window created by the client. Windows are usually created by calling **StarWindowShell.CreateBody**.

makeItems is a client-supplied procedure that is called to make the form items in the window. **makeItems** should call various **FormWindow.MakeXXXItem** procedures (see §25.2.2). Fine Point: **makeItems** is not called after **Create** returns, so **makeItems** can be a nested procedure.

layoutProc is a client-supplied procedure that is called to specify the desired position of the items in the window. **layoutProc** is called after **makeItems** has been called. **layoutProc** should call various layout procedures (see §25.2.6), such as **AppendLine** and **AppendItem**. If the default is taken, the **DefaultLayout** of one item per line will be used.

windowChangeProc is the global change proc for the entire window. Any time any item in the window changes, this procedure is called.

zone is the zone from which storage for the items will be allocated. **FormWindow** uses a private zone if none is supplied.

clientData is passed to **makeItems**, **layoutProc**, and **windowChangeProc** when called.

May raise **Error[alreadyAFormWindow]**.

```
DefaultLayout: LayoutProc;
```

The default for the **Create layoutProc** parameter. Specifies a layout of one item per line.

```
Destroy: PROCEDURE [window: Window.Handle];
```

Destroy destroys all **FormWindow** data associated with **window**, turning it back into an ordinary window. All form items are destroyed, but the window itself is not destroyed. May raise **Error[notAFormWindow]**.

```
GetClientData: PROCEDURE [window: Window.Handle]
   RETURNS [clientData: LONG POINTER];
```

GetClientData returns the **clientData** that was passed to **Create**. May raise **Error[notAFormWindow]**.

```
GlobalChangeProc: TYPE = PROCEDURE [
   window: Window.Handle,
item: ItemKey,
calledBecauseOf: ChangeReason,
clientData: LONG POINTER];
```

The client may supply a **GlobalChangeProc** to **Create**. Any time the value of any item in the window is changed, the **GlobalChangeProc** is called with the key of the item that was changed. If more than one item was changed at one time (such as by a client call to **FormWindow.Restore**), **nullItemKey** will be passed in and the client must examine the "changed" boolean of all items to see what was changed (see §25.2.4). **calledBecauseOf** indicates what kind of action caused the **GlobalChangeProc** to be called. **clientData** is the LONG POINTER that was passed to **Create**.

```
GetGlobalChangeProc: PROCEDURE [window: Window.Handle]
  RETURNS [proc: GlobalChangeProc];
```

GetGlobalChangeProc returns the **GlobalChangeProc** that was passed to **Create**. May raise **Error[notAFormWindow]**.

```
SetGlobalChangeProc: PROCEDURE [window: Window.Handle,
proc: GlobalChangeProc] RETURNS [old: GlobalChangeProc];
```

SetGlobalChangeProc changes the **GlobalChangeProc** that was passed to **Create**. May raise **Error[notAFormWindow]**.

```
MinDimsChangeProc: TYPE = PROCEDURE [window: Window.Handle,
  old, new: Window.Dims];
```

Whenever the minimum dimensions of the **FormWindow** change, the client supplied **MinDimsChangeProc** is called. This is useful for form windows that are nested as window items inside another outer form window. Whenever the dimensions of the nested form window change (due to items being made visible or invisible or a text item growing or shrinking or new items being added or...), the client that created the window item and the nested form window can be called so that it can make the window item bigger or smaller for the nested form window to be completely visible. See also **NeededDims**.

```
GetZone: PROCEDURE [window: Window.Handle]
  RETURNS [zone: UNCOUNTED ZONE];
```

GetZone returns the zone associated with the **FormWindow**. May raise **Error[notAFormWindow]**.

```
IsIt: PROCEDURE [window: Window.Handle] RETURNS [yes: BOOLEAN];
```

IsIt is used to determine if a window is a form window. If **window** was made into a form window by calling **FormWindow.Create**, then **IsIt** returns TRUE, else FALSE.

```
LayoutProc:TYPE = PROCEDURE [window: Window.Handle, clientData: LONG POINTER];
```

The client supplies a **LayoutProc** to **Create** to specify the location of items created by the **MakeItemsProc**. See §25.2.6 for details of layout.

```
MakeItemsProc: TYPE = PROCEDURE [
   window: Window.Handle,
   clientData: LONG POINTER];
```

The client supplies a **MakeItemsProc** to **Create** to make the form items in the window. **Create** will call the client's **MakeItemsProc**, and it should call various **MakeXXXItem** procedures (see §25.2.2) to make the items. **window** should be passed to the various **MakeXXXItem**. **clientData** is the same as that passed to **Create**. Fine point for clients of **PropertySheet**: **clientData** can be passed to **PropertySheet.Create** and will be passed on to **FormWindow.Create** and the **MakeItemsProc**.

```
NeededDims: PROCEDURE [window: Window.Handle]
   RETURNS [Window.Dims];
```

NeededDims returns the minimum dimensions required for a window to hold all the currently visible items in the form.

```
NumberOfItems: PROCEDURE [window: Window.Handle] RETURNS [CARDINAL];
```

NumberOfItems returns the current number of form items in **window**. This count will include visible and invisible items. This is useful for clients that create additional items dynamically after the form has been created. May raise **Error[notAFormWindow]**.

```
Repaint: PROCEDURE [window: Window.Handle];
```

Repaint causes the entire form to be repainted. This is used in conjunction with the **SetXXXItemValue**, **SetVisibility**, **AppendItem**, and **InsertItem** procedures. All these procedures take a **repaint: BOOLEAN** parameter. To minimize screen flashing while changing several items at the same time, the client may call these procedures with **repaint = FALSE**, then call **FormWindow.Repaint**. The form window will not be repainted until **Repaint** is called. **Warning:** After calling any procedure with **repaint = FALSE**, **FormWindow.Repaint** must be called. Otherwise, the screen will be inconsistent with the internal values. May raise **Error[notAFormWindow]**.

25.2.2 Making Form Items, etc.

Create procedures are provided for each type of item. These **MakeXXXItem** routines are used to originally create items in a form window as well as to add items to an existing window.

A number of parameters to each **MakeXXXItem** procedure are identical and are described here, rather than with each procedure. If all of the defaults are taken for an item, it will be boxed, with no tags and not read-only. All of these may raise **Error[notAFormWindow]**;

window is the form window the item is contained in. It should be the same as the window passed to the client's **MakeItemsProc**.

myKey is a client-defined key (**ItemKey**) for the item. The item key uniquely identifies the item and should be used to make calls on other **FormWindow** procedures, such as **GetXXXItemValue**. **Caution:** The key must be *unique* within this form window.

tag is the text to be displayed before (to the left of) the item on the same line. (To put a tag on a separate line, use **MakeTagOnlyItem**.)

suffix is the text to be displayed after (to the right of) the item on the same line.

visibility indicates whether the item should be displayed on the screen.

boxed indicates whether the item should have a box drawn around it or not.

readOnly = TRUE indicates that the item can not be edited by the user. The item can still be changed by calling a **SetXXXItemValue** procedure.

```
ItemKey: TYPE = CARDINAL;
```

ItemKey uniquely identifies an item. An **ItemKey** is supplied by the client whenever an item is made (**MakeXXXItem**) and should be used thereafter to identify the item to **FormWindow**, such as then calling **GetXXXItemValue** or **SetVisibility**.

```
ItemType: TYPE = MACHINE DEPENDENT {choice(0), multiplechoice, decimal, integer,
boolean, text, command, tagonly, window, last(15)};
```

There are several types of items, each of which serves a different purpose and behaves differently for the user. All items except tagonly and command have a current value that can be obtained (**GetXXXItemValue**) and set (**SetXXXItemValue**).

A **choice** item has an enumerated list of choices, only one of which can be selected at any point in time. A choice item's value is of type FormWindow.ChoiceIndex.

A **multiplechoice** item is a choice item that can have an initial value of more than one choice selected, but any succeeding values can have only one choice selected. A multiple choice item's value is of type LONG DESCRIPTOR FOR ARRAY OF CARDINAL.

A **text** item is a user-editable text string, and contains only nonattributed text. A text item's value is of type XString.ReaderBody.

A **decimal** item is a text item that has a value of type XLReal.Number.

An **integer** item is a text item that has a value of type LONG INTEGER.

A **boolean** item is an item with two states (on and off, or TRUE and FALSE). A boolean item's value is of type BOOLEAN.

A **command** item allows a user to invoke a command. When the user clicks over a command item, a client procedure is called.

A **tagonly** item is an uneditable, nonselectable text string.

A **window** item is a window that is a child of the **FormWindow** and can contain whatever the client desires. A window item's value is a Window.Handle. A client must provide its own TIP.NotifyProc and window display procedure for the window item.

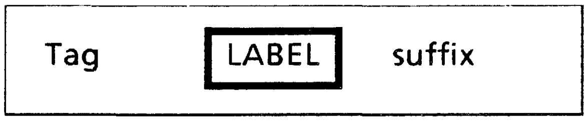
```
nullItemKey: ItemKey;
```

nullItemKey is used to indicate no item.

25.2.2.1 Boolean Items

```
MakeBooleanItem: PROCEDURE [
  window: Window.Handle,
  myKey: ItemKey,
  tag: XString.Reader ← NIL,
suffix: XString.Reader ← NIL,
visibility: Visibility ← visible,
boxed: BOOLEAN ← TRUE,
readOnly: BOOLEAN ← FALSE,
changeProc: BooleanChangeProc ← NIL,
label: BooleanItemLabel,
initBoolean: BOOLEAN ← TRUE];
```

MakeBooleanItem creates a boolean item. A boolean item value is of type BOOLEAN. When the value is TRUE, the item is highlighted. When FALSE, it is not highlighted. When the user clicks over the label part of a boolean item, the value toggles.



Unhighlighted boolean item, value = FALSE

changeProc is a client-supplied procedure that will be called whenever the value of the item changes.

label is the string or bitmap that the user points at to toggle the item's value. If **label** is a string, the string is copied. If **label** is a bitmap, the bits are *not* copied, so the client must ensure that the bitmap pointer is valid for the lifetime of the form window.

initBoolean is the initial value of the item.

May raise **Error[notAFormWindow, duplicateItemKey]**.

```
BooleanItemLabel: TYPE = RECORD [
  var: SELECT type: BooleanItemLabelType FROM
    string = > [ string: XString.ReaderBody],
    bitmap = > [ bitmap: Bitmap]
    ENDCASE];

BooleanItemLabelType: TYPE = {string, bitmap};
```

A **BooleanItemLabel** is passed to **MakeBooleanItem**. It is the part of the item that the user points at and is or is not highlighted, depending on the value of the item. A **label** may be either a string or a bitmap. (See §25.2.8 on Miscellaneous **TYPE**s for the definition of **Bitmap**). If **label** is a string, the string is copied. If **label** is a bitmap, the bits are *not* copied, so the client must ensure that the bitmap pointer is valid for the lifetime of the form window.

```
BooleanChangeProc: TYPE = PROCEDURE [
  window: Window.Handle,
  item: ItemKey,
  calledBecauseOf: ChangeReason,
  newValue: BOOLEAN];
```

The client may provide a **BooleanChangeProc** to **MakeBooleanItem**. Whenever the item's value changes (TRUE to FALSE or FALSE to TRUE), this procedure is called. **window** is the form window that the item is in. **item** is the key of the boolean item to which this

BooleanChangeProc is attached. **calledBecauseOf** indicates what kind of action caused the change proc to be called. **newValue** is the vew value of the item. The item will already have the new value when this procedure is called.

Caution: If a **BooleanChangeProc** does a **SetXXXItemValue**, the client should take extreme care to prevent infinite recursion. (See §25.3.1.)

25.2.2.2 Choice Items

```
MakeChoiceItem: PROCEDURE [
  window: Window.Handle,
  myKey: ItemKey,
  tag: XString.Reader ← NIL,
  suffix: XString.Reader ←NIL,
  visibility: Visibility ← visible,
  boxed: BOOLEAN ← TRUE,
  readOnly: BOOLEAN ← FALSE,
  values: ChoiceItems,
  initChoice: ChoiceIndex,
  fullyDisplayed: BOOLEAN ← TRUE,
  verticallyDisplayed: BOOLEAN ← FALSE,
  hintsProc: ChoiceHintsProc ← NIL,
  changeProc: ChoiceChangeProc ← NIL,
  outlineOrHighlight: OutlineOrHighlight ← highlight];
```

MakeChoiceItem creates a choice item. A choice item is an enumerated list of choices, only one of which can be selected at any time . The choices can be displayed to the user as either strings or bitmaps, or some of each. The current choice is highlighted. When the user clicks on a choice, it becomes the current choice and is highlighted. Each choice has a client-defined **ChoiceIndex** associated with it that uniquely identifies that choice. The value of a choice item is of type **ChoiceIndex**.

values is the list of all the possible choices. An indication of where to wrap the display around to the next line can be made by specifying a **wrapIndicator** variant in the appropriate place in the **values** array. If a choice is a string, the string is copied. If a choice is a bitmap, the bits are *not* copied, so the client must ensure that the bitmap pointer is valid for the lifetime of the form window.

initChoice is the value of the initial choice.

fullyDisplayed indicates whether all the choices should be displayed or not. If **fullyDisplayed** = TRUE, all the choices are displayed. If **fullyDisplayed** = FALSE, only the current choice is displayed, with the rest of the choices being accessed via a popup menu.

verticallyDisplayed indicates whether the choices should be displayed vertically or horizontally. If **fullyDisplayed** = FALSE, the value of **verticallyDisplayed** is ignored. Any **wrapIndicators** are skipped over when choices are displayed vertically.

If **hintsProc** is supplied, it is called to make a popup hint menu. If the default is taken, the form window will make a hint menu with all choices. **Note:** Since menus can only contain strings (not bitmaps), a bitmap choice will appear in the hints menu as a number indicating the choice's position. **Note:** This is *not* the same as the **ChoiceIndex** for that choice.

If **changeProc** is supplied, it is called whenever the choice changes.

May raise **Error[notAFormWindow,duplicateItemKey, invalidChoiceNumber]**.

```
OutlineOrHighlight: TYPE = {outline, highlight};
```

Normally the selected choice for a choice item is indicated by highlighting the choice. The **outlineOrHighlight** parameter allows the selected choice to be indicated by outlining the choice with a black box. This is intended to support the Shading choice item on, for example, the triangle and ellipse property sheets in the ViewPoint editor.

```
ChoiceItems: TYPE = LONG DESCRIPTOR FOR ARRAY ChoiceIndex OF ChoiceItem;
```

ChoiceItems is the list of possible choice for a choice item. A **ChoiceItems** ARRAY is passed to **MakeChoiceItem**. The choices are displayed in the order they appear in the **ChoiceItems** ARRAY.

```
ChoiceItem: TYPE = RECORD [
  var: SELECT type: ChoiceItemType FROM
  string = > [
    choiceNumber: ChoiceIndex,
    string: XString.ReaderBody],
  bitmap = >[
    choiceNumber: ChoiceIndex,
    bitmap: Bitmap],
  wrapIndicator = > NULL];

ChoiceItemType: TYPE = {string, bitmap, wrapIndicator};

ChoiceIndex: TYPE = CARDINAL [ 0..37777B ];
```

A choice item consists of an array of choices (**ChoiceItems**). Each choice (**ChoiceItem**) consists of a unique number that identifies the choice (**ChoiceIndex**) and either a string or a bitmap to display to the user. In addition, the **ChoiceItems** array can contain a **wrapIndicator** wherever the client desires the choices be wrapped around to begin another line of choices. A **wrapIndicator ChoiceItem** is not a real choice and serves only as additional layout information for the **FormWindow**. If **ChoiceItem** is a string, the string is copied. If **ChoiceItem** is a bitmap, the bits are *not* copied, so the client must ensure that the bitmap pointer is valid for the lifetime of the **FormWindow**.

The client must construct a **ChoiceItems** array before calling **MakeChoiceItem**. This can be simplified if all the choices are strings by using the **FormWindowMessageParse** interface. This allows all the choices for a choice item to be stored as a single **XMessage** with embedded syntax indicating individual choice strings and choice numbers. (See **FormWindowMessageParse** for more detail.)

```
ChoiceChangeProc: TYPE = PROCEDURE [
  window: Window.Handle,
  item: ItemKey,
  calledBecauseOf: ChangeReason,
  oldValue, newValue: ChoiceIndex];
```

The client may provide a **ChoiceChangeProc** to **MakeChoiceItem**. Whenever the choice changes, this procedure is called. **window** is the form window that the item is in. **item** is the key of the choice item to which this **ChoiceChangeProc** is attached. **calledBecauseOf** indicates what kind of action caused the change proc to be called. **oldValue** and **newValue** correspond to the choice numbers assigned to the choices in **MakeChoiceItem**. The item will have the new value when this procedure is called.

Caution: If a **ChoiceChangeProc** does a **SetXXXItemValue**, the client should take extreme care to prevent infinite recursion. See §25.3.1, Calling **ChangeProcs**.

```
ChoiceHintsProc: TYPE = PROCEDURE [
   window: Window.Handle,
   item: ItemKey]
   RETURNS [
   hints: LONG DESCRIPTOR FOR ARRAY OF ChoiceIndex,
   freeHints: FreeChoiceHintsProc];

FreeChoiceHintsProc: TYPE = PROCEDURE [
   window: Window.Handle,
   item: ItemKey,
   hints: LONG DESCRIPTOR FOR ARRAY OF ChoiceIndex];
```

The client may provide a **ChoiceHintsProc** to **MakeChoiceItem**. Whenever the user points at the mouse menu for a choice item, this procedure is called and the hints returned are used to construct a popup menu that is displayed. If the user selects one of the choices from the popup menu, that choice becomes the current choice.

window is the form window that the item is in.

item is the key of the choice item to which this **ChoiceHintsProc** is attached.

hints is an array of choice numbers for the choices that the client wants to appear in the menu. This allows a client to show a subset of all the choices to the user for situations in which not all the choices make sense.

freeHints is a procedure that will be called after the hint menu has been taken down to allow the client to free any storage that was allocated when creating the hints array.

```
MakeMultipleChoiceItem: PROCEDURE [
   window: Window.Handle,
   myKey: ItemKey,
   tag: XString.Reader ← NIL,
   suffix: XString.Reader ← NIL,
   visibility: Visibility ← visible,
   boxed: BOOLEAN ← TRUE,
   readOnly: BOOLEAN ← FALSE,
   values: ChoiceItems,
   initChoice: LONG DESCRIPTOR FOR ARRAY OF ChoiceIndex,
   verticallyDisplayed: BOOLEAN ← FALSE,
   hintsProc: ChoiceHintsProc ← NIL,
   changeProc: MultipleChoiceChangeProc ← NIL];
```

May raise **Error[notAFormWindow, duplicateItemKey]**.

```
MultipleChoiceChangeProc: TYPE = PROCEDURE [
   window: Window.Handle,
   item: ItemKey,
   calledBecauseOf: ChangeReason,
   oldValue: LONG DESCRIPTOR FOR ARRAY OF ChoiceIndex,
   newValue: LONG DESCRIPTOR FOR ARRAY OF ChoiceIndex];
```

A multiple choice item is identical to a choice item, except that it may have more than one initial value. See **MakeChoiceItem** above for details of choice items. A multiple choice item is useful for showing the properties of a heterogenous selection, such as the font property of a text selection that has more than one font.

25.2.2.3 Command Items

```
MakeCommandItem: PROCEDURE [
   window: Window.Handle,
   myKey: ItemKey,
   tag: XString.Reader ← NIL,
   suffix: XString.Reader ← NIL,
   visibility: Visibility ← visible,
   boxed: BOOLEAN ← TRUE,
   readOnly: BOOLEAN ← FALSE,
   commandProc: CommandProc,
   commandName: XString.Reader,
   clientData: LONG POINTER ← NIL];
```

Creates a command item. A command item allows a user to invoke a command. When the user clicks over the **commandName**, **commandProc** is called. If **boxed** is TRUE, the **commandName** appears with a rounded corner box drawn around it (rather than a square-cornered box, to distinguish a command item from a boolean item). May raise **Error[notAFormWindow, duplicateItemKey]**.

```
CommandProc: TYPE = PROCEDURE [
   window: Window.Handle,
   item:ItemKey, clientData: LONG POINTER];
```

A **CommandProc** is supplied by the client to **MakeCommandItem**. It is called whenever the user selects the command item. **window** is the **FormWindow** that the item is in. **item** is the key of the command item to which this **CommandProc** is attached.

25.2.2.4 Tagonly items

```
MakeTagOnlyItem: PROCEDURE [
   window: Window.Handle,
   myKey: ItemKey,
   tag: XString.Reader,
   visibility: Visibility ← visible];
```

Creates a **tagonly** item. **Tagonly** items are displayed as uneditable, nonselectable text.May raise **Error[notAFormWindow, duplicateItemKey]**.

25.2.2.5 Text and Number Items

```
MakeTextItem: PROCEDURE [
   window: Window.Handle,
   myKey: ItemKey,
   tag: XString.Reader ← NIL,
   suffix: XString.Reader ← NIL,
   visibility: Visibility ← visible,
   boxed: BOOLEAN ← TRUE,
   readOnly: BOOLEAN ← FALSE,
   width: CARDINAL, -- in screen dots
   initString: XString.Reader ← NIL,
   wrapUnderTag: BOOLEAN ← FALSE,
   passwordFeedback: BOOLEAN ← FALSE,
   hintsProc: TextHintsProc ← NIL,
   nextOutOfProc: NextOutOfProc ← NIL,
   SPECIALKeyboard: BlackKeys.Keyboard ← NIL];
```

Creates a text item. Text items are user-editable text strings. The value of a text item is of type **XString.ReaderBody**. The user may select text, extend the selection, insert text, delete text, move and copy text, etc. Text items are fixed width but may grow and shrink vertically as the user enters and deletes text. A text item will contain nonattributed text only. **FormWindow** handles all storage allocation for the backing string.

width is the number of screen dots wide that the item should be. The item may grow arbitrarily long as the user enters text, but it will always retain the same width.

initString is the initial string to place in the text item. The bytes are copied by **FormWindow**.

wrapUnderTag specifies whether any text wider than the width of the text item should appear underneath the tag (**wrapUnderTag = TRUE**) or start at the left edge of the text item (**wrapUnderTag = FALSE**). **Note:** This feature is not yet implemented.

passwordFeedback indicates that the text should be displayed in an unreadable form rather than as normal characters. The correct value of the string is maintained internally, so that a call to **GetTextItemValue** will return the proper value.

If **hintsProc** is supplied, it is called to make a list of strings to be displayed to the user as a popup hint menu. (See **TextHintsProc** below.)

If **nextOutOfProc** is supplied, it is called when the user presses the NEXT key while the input focus is in this text item. This gives the client an opportunity to create more text items. After calling the **nextOutOfProc** or if no **nextOutOfProc** is supplied, the NEXT key causes the selection and input focus to move to the next text or window item in the form. See **NEXT key** in this chapter for further explanation.

If **SPECIALKeyboard** is supplied, it allows clients to make a special keyboard available to the user when typing into a text or number field.

May raise **Error[notAFormWindow, duplicateItemKey]**.

```
MakeDecimalItem: PROCEDURE [
   window: Window.Handle,
   myKey: ItemKey,
   tag: XString.Reader ← NIL,
   suffix: XString.Reader ← NIL,
   visibility: Visibility ← visible,
   boxed: BOOLEAN ← TRUE,
   readOnly: BOOLEAN ← FALSE,
   signed: BOOLEAN ← FALSE,
   width: CARDINAL, -- in screen dots --
   initDecimal: XLReal.Number ← XLReal.zero,
   wrapUnderTag: BOOLEAN ← FALSE,
   hintsProc: TextHintsProc ← NIL,
   nextOutOfProc: NextOutOfProc ← NIL,
   displayTemplate: XString.Reader ← NIL,
   SPECIALKeyboard: BlackKeys.Keyboard ← NIL];
```

Creates a decimal item. A decimal item is a text item that has a value of type **XLReal.Number**. (See **MakeTextItem** above for details of text items.) The user can type any text into the decimal item, but when the client calls **GetDecimalItemValue** to retrieve the value, **FormWindow** converts the string to **XLReal.Number**. **initDecimal** is the initial decimal value to place in the item. **displayTemplate** parameter is defined as in the **XLReal.PictureReal**. **XLReal.PictureReal** is used to display the value of the decimal item. The client may provide a keyboard interpretation with the **SPECIALKeyboard** parameter (see Chapter 8, §2.1). May raise **Error[notAFormWindow, duplicateItemKey]**.

```
MakeIntegerItem: PROCEDURE [
   window: Window.Handle,
   myKey: ItemKey,
   tag: XString.Reader ← NIL,
   suffix: XString.Reader ← NIL,
   visibility: Visibility ← visible,
   boxed: BOOLEAN ← TRUE,
   readOnly: BOOLEAN ← FALSE,
   signed: BOOLEAN ← FALSE,
   width: CARDINAL, -- in screen dots --
   initInteger: LONG INTEGER ← 0,
   wrapUnderTag: BOOLEAN ← FALSE,
   hintsProc: TextHintsProc ← NIL,
   nextOutOfProc: NextOutOfProc ← NIL,
   SPECIALKeyboard: BlackKeys.Keyboard ← NIL ];
```

Creates an integer item. An integer item is a text item that has a value of type **LONG INTEGER**. (See **MakeTextItem** above for details of text items.) The user can type any text into the integer item, but when the client calls **GetIntegerItemValue** to retrieve the value, FormWindow converts the string to a **LONG INTEGER**. **initInteger** is the initial number to place in the item. The client may provide a keyboard interpretation with the **SPECIALKeyboard** parameter (see Chapter 8, §2.1). May raise **Error[notAFormWindow, duplicateItemKey]**.

```
TextHintAction: TYPE = {replace, append, nil};

TextHintsProc: TYPE = PROCEDURE [
   window: Window.Handle,
   item: ItemKey]
   RETURNS [
   hints: LONG DESCRIPTOR FOR ARRAY OF XString.ReaderBody,
   freeHints: FreeTextHintsProc,
   hintAction: TextHintAction ← replace];

FreeTextHintsProc: TYPE = PROCEDURE [
   window: Window.Handle,
   item: ItemKey,
   hints: LONG DESCRIPTOR FOR ARRAY OF XString.ReaderBody];
```

The client may provide a **TextHintsProc** to **MakeTextItem**, **MakeDecimalItem**, and **MakeIntegerItem**. Whenever the user points at the mouse menu for a text item, this procedure is called and the hints returned are used to construct a popup menu that is displayed.

When the user selects one of the strings from the popup menu, one of three things will happen, depending on the **hintAction** returned by the **TextHintsProc**. If **hintAction = replace**, the selected string will replace the current value of the text item. If **hintAction = append**, the selected string will be appended to the current value of the text item. If **hintAction = nil**, the current value of the text item will not change. **hintAction = nil** is useful for displaying "help-like" information to the user for text items that do not have a finite number of possible values, such as a file name.

freeHints is a procedure that will be called after the hint menu has been taken down to allow the client to free any storage that was allocated when creating the hints array.

25.2.2.6 Window Items

```
MakeWindowItem: PROCEDURE [
   window: Window.Handle,
   myKey: ItemKey,
   tag: XString.Reader ← NIL,
   visibility: Visibility ← visible,
   boxed: BOOLEAN ← TRUE,
   size: Window.Dims,
   nextIntoProc: NextIntoProc ← NIL]
   RETURNS [clientWindow: Window.Handle];
```

Creates a window item. A window item is a window (**Window.Handle**) that is a child of the **FormWindow** and can contain anything the client desires. A window with dimensions **size** is created and returned as **clientWindow**. It is expected that the client will associate a display proc (see **Window.SetDisplayProc**) and a **TIP.NotifyProc** with the window. The window may be treated just like any other window, *except* **FormWindow.SetWindowItemSize** *must* be used to change the size of the window rather than calling **Window.SlideAndSize** directly. This allows **FormWindow** to move any other items, if necessary, to accomodate the different-sized window item.

If **nextIntoProc** is supplied, it is called when the user presses the NEXT key in an item just before this window item. This gives the window item an opportunity to gain control of the NEXT key by setting the input focus to be the window item's window. The window item may then retain control of the NEXT key within the window item. When the window item no longer wants to process the NEXT key (for instance, when the NEXT key should move the selection outside the window item), the window item client must call

FormWindow.TakeNEXTKey, which returns the NEXT key processing to the form window. (See §25.2.10 for an explanation of the NEXT key.)

May raise Error[notAFormWindow, duplicateItemKey].

```
SetWindowItemSize: PROCEDURE [
   window: Window.Handle,
   windowItemKey: ItemKey,
   newSize: Window.Dims];
```

SetWindowItemSize should be used to change the size of a window item's window. The client should *never* call Window.SlideAndSize directly. Any items below the window item are moved down or up to accommodate the new dimensions. window is the form window that the window item is in. windowItemKey must be the key of a window item. newSize indicates the new dimensions. May raise Error[notAFormWindow, invalidItemKey, wrongItemType].

25.2.2.7 Destroying Items

```
DestroyItem: PROCEDURE [
   window:Window.Handle,
   item: ItemKey,
   repaint: BOOLEAN ← TRUE];
```

DestroyItem destroys item. Most clients will not need to use this procedure, since FormWindow.Destroy destroys all the items in the FormWindow. May raise Error[notAFormWindow, invalidItemKey].

```
DestroyItems: PROCEDURE [
   window:Window.Handle,
   item: LONG DESCRIPTOR FOR ARRAY OF ItemKey,
   repaint: BOOLEAN ← TRUE];
```

DestroyItems destroys several items at once. Most clients will not need to use this procedure, since FormWindow.Destroy destroys all the items in the FormWindow. May raise Error[notAFormWindow, invalidItemKey].

25.2.3 Getting and Setting Values

The client may examine or change the value of an item. All GetXXXItem procedures return the current value of an item. All SetXXXItem procedures take a given new value and change the value internally, as well as updating the screen if necessary.

In all these procedures, window is the FormWindow the item is in. item uniquely identifies the item to get/set the value of.

Note: There are two ways to get the value of a text item. GetTextItemValue copies the bytes of the string so that the storage for the returned value is owned by the client. LookAtTextItemValue simply returns a pointer to the FormWindow-owned backing string. This value is therefore read-only and must be released when the client is done examining it by calling DoneLookingAtTextItemValue.

All of these may raise Error[notAFormWindow, invalidItemKey, wrongItemType].

25.2.3.1 Getting Values

```
GetBooleanItemValue: PROCEDURE [
   window: Window.Handle,
   item: ItemKey]
   RETURNS [value: BOOLEAN];

GetChoiceItemValue: PROCEDURE [
   window:Window.Handle,
   item: ItemKey]
   RETURNS [value: ChoiceIndex];

GetDecimalItemValue: PROCEDURE [
   window: Window.Handle,
   item: ItemKey]
   RETURNS [value:XLReal.Number];
```

May raise XLReal.Error [notANumber].

```
GetIntegerItemValue: PROCEDURE [
   window: Window.Handle,
   item: ItemKey]
   RETURNS [value: LONG INTEGER];
```

May raise XString.InvalidNumber or XString.Overflow.

```
GetMultipleChoiceItemValue: PROCEDURE [
   window:Window.Handle,
   item: ItemKey, zone: UNCOUNTED ZONE]
   RETURNS [values: LONG DESCRIPTOR FOR ARRAY OF ChoiceIndex];
```

The zone parameter is added. The storage for the DESCRIPTOR will be allocated out of zone and the storage must be freed by the client.

```
GetTextItemValue: PROCEDURE [
   window: Window.Handle,
   item: ItemKey,
   zone: UNCOUNTED ZONE]
   RETURNS [value: XString.ReaderBody];
```

GetTextItemValue copies the string. Storage for the bytes is allocated out of zone. The client should free the storage using XString.FreeReaderBytes and zone.

```
GetWindowItemValue: PROCEDURE [
   window: Window.Handle,
   item: ItemKey]
   RETURNS [value: Window.Handle];

LookAtTextItemValue: PROCEDURE [
   window: Window.Handle,
   item: ItemKey]
   RETURNS [value: XString.ReaderBody];

DoneLookingAtTextItemValue: PROCEDURE [
   window: Window.Handle,
   item: ItemKey];
```

LookAtTextItemValue does not copy the string but returns a pointer to it. **value** should *not* be changed by the client. Clients using **LookAtTextItemValue** must call **DoneLookingAtTextItemValue** when done examining it. During the time between these calls, if another client calls **LookAtTextItemValue** or **SetTextItemValue** for the same text item, the second client's process will WAIT.

```
GetNextAvailableKey: PROCEDURE [window: Window.Handle]
   RETURNS [key: ItemKey];
```

Returns the next available item key: MAX[usedKeys] + 1.

25.2.3.2 Setting Values

All the **SetXXXItem** procedures take a **repaint: BOOLEAN**. If **repaint** = TRUE and the item is currently visible, it will be repainted with the new value. If **repaint** = FALSE, the item will not be repainted until **FormWindow.Repaint** is called. This allows the client to change the values of several items at once without the screen flashing for each item. **Warning:** After calling any procedure with **repaint** = FALSE, **FormWindow.Repaint** must be called. Otherwise, the screen will be inconsistent with the internal values.

Caution: If a change proc does a **SetXXXItemValue**, the client should take extreme care to prevent infinite recursion. (See §25.3.1.)

```
SetBooleanItemValue: PROCEDURE [
   window: Window.Handle,
   item: ItemKey,
   newValue: BOOLEAN,
   repaint: BOOLEAN ← TRUE];

SetChoiceItemValue: PROCEDURE [
   window: Window.Handle,
   item: ItemKey,
   newValue: ChoiceIndex,
   repaint: BOOLEAN ← TRUE];
```

May raise **FormWindow.Error[invalidChoiceNumber]**.

```
SetDecimalItemValue: PROCEDURE [
   window: Window.Handle,
   item: ItemKey,
   newValue: XLReal.Number,
   repaint: BOOLEAN ← TRUE];

SetIntegerItemValue: PROCEDURE [
   window: Window.Handle,
   item: ItemKey,
   newValue: LONG INTEGER,
   repaint: BOOLEAN ←TRUE];

SetMultipleChoiceItemValue: PROCEDURE [
   window:Window.Handle,
   item: ItemKey,
   newValue: LONG DESCRIPTOR FOR ARRAY OF ChoiceIndex,
   repaint: BOOLEAN ←TRUE];
```

May raise FormWindow.Error[invalidChoiceNumber].

```
SetTextItemValue: PROCEDURE [
   window: Window.Handle,
   item: ItemKey,
   newValue: XString.Reader,
   repaint: BOOLEAN ←TRUE];
```

25.2.4 "Changed" BOOLEAN

Every item that has a value that the user can change (all except tagonly and command items) has a "changed" boolean associated with it. All items are created with this boolean set to FALSE. **FormWindow** automatically sets this boolean to TRUE whenever the user changes the item. This allows the client to determine which items have changed when, for example, the user selects "Done" or "Apply" on a property sheet. The client is responsible for resetting the changed boolean to false by calling **ResetChanged** or **ResetAllChanged** after examining the changed boolean with **HasBeenChanged** or **HasAnyBeenChanged**.

```
HasAnyBeenChanged: PROCEDURE [
   window: Window.Handle]
   RETURNS [yes: BOOLEAN];
```

HasAnyBeenChanged returns true if any item's changed boolean is TRUE. May raise Error[notAFormWindow].

```
HasBeenChanged: PROCEDURE [
   window: Window.Handle,
   item: ItemKey]
   RETURNS [yes: BOOLEAN];
```

HasBeenChanged returns TRUE if the user has changed item. The client may reset the changed boolean to FALSE by using **ResetChanged** or **ResetAllChanged**. May raise Error[notAFormWindow, invalidItemKey].

```
ResetChanged: PROCEDURE [window: Window.Handle, item: ItemKey];
```

ResetChanged sets the changed boolean of item to FALSE. May raise Error[notAFormWindow, invalidItemKey].

```
ResetAllChanged: PROCEDURE [window: Window.Handle];
```

ResetAllChanged sets the changed boolean of all items to **FALSE**. May raise **Error[notAFormWindow]**.

```
SetChanged: PROCEDURE [
  window: Window.Handle,
  item: ItemKey];
```

SetChanged sets the changed boolean of **item** to **TRUE**. May raise **Error[notAFormWindow, invalidItemKey]**.

```
SetAllChanged: PROCEDURE [
  window: Window.Handle];
```

SetAllChanged sets the changed boolean of all items to **TRUE**. May raise **Error[notAFormWindow]**.

25.2.5 Visibility

```
Visibility: TYPE = {visible, invisible, invisibleGhost};
```

An item either is or is not displayed in the form window. If an item is displayed in the form window, it is **visible**. If an item is not currently displayed, it is either **invisible** or **invisibleGhost**. If it is **invisible**, it does not take up any space on the screen; any items below it move up to take its screen space. If an item is **invisibleGhost**, the space that it would occupy were it visible is white on the screen. An item's visibility can be changed anytime by calling **SetVisibility**.

```
GetVisibility: PROCEDURE [
  window: Window.Handle,
  item: ItemKey]
  RETURNS [visibility: Visibility];
```

GetVisibility returns the current visibility of **item**. May raise **Error[notAFormWindow, invalidItemKey]**.

```
SetVisibility: PROCEDURE [
  window: Window.Handle,
  item: ItemKey,
  visibility: Visibility,
  repaint: BOOLEAN ←TRUE];
```

SetVisibility sets the visibility of **item**. If **repaint** = **TRUE** and the item's visibility is changing, the form window will be repainted. If **repaint** = **FALSE**, the form window will not be repainted until **FormWindow.Repaint** is called. This allows the client to change the visibility of several items at once without the screen flashing for each item. **Warning:** After calling **SetVisibility** with **repaint** = **FALSE**, **FormWindow.Repaint** must be called. Otherwise, the screen will be inconsistent with internal values. May raise **Error[notAFormWindow, invalidItemKey]**.

25.2.6 Layout

The exact layout of items in a form window is done by calling various procedures specified below, after creating the items to be laid out. If an item is not explicitly laid out, it will not appear in the form window at all. Note that **FormWindow.DefaultLayout** may be used when the client is not concerned with the exact placement of items, but wants a functional form window.

There are two different types of layout. The most common is flexible layout, which allows text, decimal, integer, and window items to grow and shrink (and all other items are moved around accordingly) as the user or client changes their values. Flexible layout is done by calling such procedures as **AppendLine** and **AppendItem**. The other is fixed layout, which allows the client to specify exactly where items will go by calling **SetItemBox**, but does not allow text, decimal, integer, and window items to grow or shrink. All items stay where they are laid out unless the client calls **SetItemBox** again.

25.2.6.1 Flexible Layout

A form window with flexible layout consists of horizontal lines with zero or more items on each line. Lines now are always just tall enough to hold the items on that line. The **spaceAboveLine** parameter specifies the amount of white spae to leave above each line. Any desired horizontal spacing may be accomplished by using appropriate margins between items. Items may be lined up horizontally by using **TabStops** (see §25.2.6.2 below).

Lines are created by calling **AppendLine** or **InsertLine**. Items are placed on a line by calling **AppendItem** or **InsertItem**. The Append routines are used to add items after the previously created line or item. The Insert routines are used to add items between previously created items or lines.

```
AppendLine: PROCEDURE [
  window: Window.Handle,
  spaceAboveLine: CARDINAL ← 0]
  RETURNS [line: Line];
```

AppendLine creates a new line and appends it to the bottom of the form window. All items must be placed on a line, so **AppendLine** must be called before any calls to **AppendItem**. The line returned by **AppendLine** should be passed to **AppendItem** or **InsertItem**. **window** is the **FormWindow** the line is being appended to. May raise **Error[notAFormWindow]**.

```
Line: TYPE;
```

Line uniquely identifies a line and is returned by **AppendLine** and **InsertLine**. A **Line** must be passed to **AppendItem** and **InsertItem**.

```
AppendItem: PROCEDURE [
  window: Window.Handle,
  item: ItemKey,
  line: Line,
  preMargin: CARDINAL ← 0,
  tabStop: CARDINAL ← nextTabStop,
  repaint: BOOLEAN ←TRUE];
```

AppendItem appends **item** to **line**.

preMargin is the number of pixels of white space to place before the left edge of this item. If tabs have been set, **preMargin** is added after placing the item at its tab stop.

tabStop is the ordinal number of the tab stop at which to place this item. If the default is taken, the next tab stop on the line after the previous item is used. If no tabs have been defined (i.e., **SetTabStops** has never been called), **tabStop** is ignored. See §25.2.6.2 for more detail on tabs.

repaint specifies whether the screen should be repainted after the **AppendItem** is done. When called from the client's **LayoutProc**, **repaint** is ignored and the items are not painted until the **LayoutProc** returns. When not called from the client's **LayoutProc**, and **repaint** = TRUE, the form window will be repainted immediately after appending the item. When not called from the client's **LayoutProc**, and **repaint** = FALSE, the form window will not be repainted until FormWindow.**Repaint** is called. This allows the client to add several items at once without the screen flashing for each new item. **Warning:** After calling **AppendItem** with **repaint** = FALSE, FormWindow.**Repaint** must be called. Otherwise, the screen will be inconsistent with internal values.

May raise **Error[notAFormWindow, invalidItemKey, noSuchLine]**.

```
InsertLine: PROCEDURE [
  window: Window.Handle,
  before: Line,
  spaceAboveLine: CARDINAL ← 0]
  RETURNS [line: Line];
```

InsertLine inserts a new line before (above) an existing line. The **spaceAboveLine** parameter indicates how much space (in screen dots) to leave between the previous line and this line. This allows clients to leave white space at the top of the form before the first line and also provides an easy way to put white space in a form. (See **AppendLine** for details of creating a line.)May raise **Error[notAFormWindow, noSuchLine]**.

```
InsertItem: PROCEDURE [
  window: Window.Handle,
  item: ItemKey,
  line: Line,
  beforeItem: ItemKey,
  preMargin: CARDINAL ← 0,
  tabStop: CARDINAL ← nextTabStop,
  repaint: BOOLEAN ←TRUE];
```

InsertItem inserts item to the left of **beforeItem** on **line**. See **AppendItem** for details of placing an item on a line. May raise **Error [notAFormWindow, invalidItemKey, noSuchLine, itemNotOnLine]**.

```
RemoveItemFromLine: PROCEDURE [
  window: Window.Handle,
  item: ItemKey,
   line: Line,
   repaint: BOOLEAN ←TRUE];
```

RemoveItemFromLine will "unlayout" an item that has been previously laid out. This allows clients to move an item from one place on the form to another without destroying and recreating the item, by calling **RemoveItemFromLine** followed by a call to **AppendItem** or **InsertItem**. **RemoveItemFromLine** will not destroy the item. The item will be "in limbo" until it is laid out again using **AppendItem** or **InsertItem**.

```
LayoutInfoFromItem: PROCEDURE [
   window: Window.Handle, item: ItemKey]
   RETURNS [ line: Line, margin: CARDINAL,
   tabStop: CARDINAL, box: Window.Box];
```

LayoutInfoFromItem returns various layout characteristics of **item**. May raise **Error[notAFormWindow, invalidItemKey]**.

```
LineUpBoxes: PROCEDURE [window: Window.Handle,
   items: LONG DESCRIPTOR FOR ARRAY OF ItemKey ←NIL];
```

Calling this procedure will force the boxes of the specified items to line up vertically, as in most ViewPoint property sheets. If no items are specified, and a fixed-pitch font is used, the first item on every line will line up as shown in Figure 25.1.

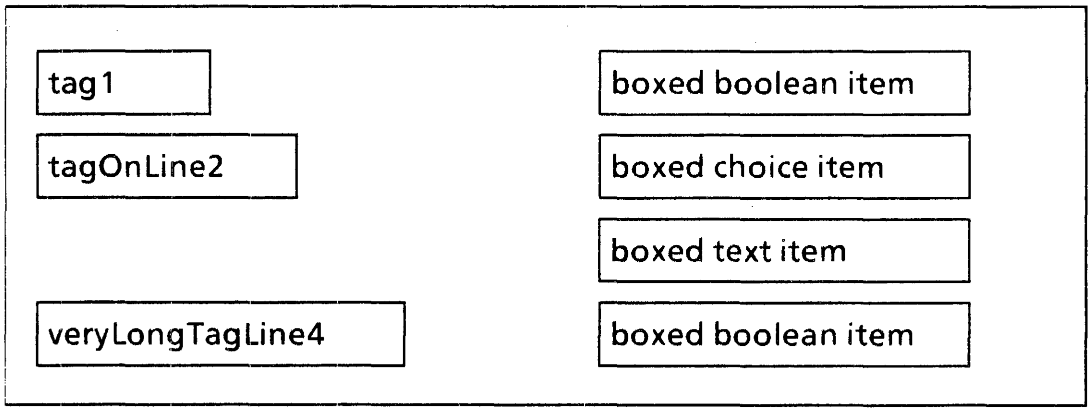


Figure 25.1 **LineUpBoxes**

The specified items must be the first item on their line. The longest tag is measured; then the boxed part of each item appears at the next available tab stop after the longest tag. This also works for non-boxed items.

25.2.6.2 Tabs

```
TabType: TYPE = {fixed, vary};

TabStops: TYPE = RECORD [
   variant: SELECT type: TabType FROM
   fixed = > [interval: CARDINAL],
vary => [list: LONG DESCRIPTOR FOR ARRAY OF CARDINAL]
ENDCASE];
```

The client may specify tab stops to facilitate lining up items one directly below the other. Tabs may be specified two ways: fixed and varying. Fixed tab stops are specified by a single CARDINAL (**interval**) that indicates a tab stop at each interval pixel, such as if **interval** = 100, there will be tab stops at 10, 20, 30, etc. Varying tab stops are specified by an ARRAY OF CARDINAL, each element of the ARRAY indicating the number of pixels from the left edge of the window. Typically, a client will call **SetTabStops** at the beginning of the **LayoutProc**, then call **AppendLine** and **AppendItem** repeatedly, taking the **nextTabStop** default for each item.

```
noTabStop: CARDINAL = CARDINAL.LAST-1;
```

Can be used with **AppendItem** and **InsertItem** to indicate that this item should ignore tab stops completely.

```
defaultTabStops: TabStops = [fixed[interval: 100]];
```

```
SetTabStops: PROCEDURE [window: Window.Handle, tabStops: TabStops];
```

SetTabStops sets the tab stops for **window**. Any items laid out before to this call will now be moved to conform to these tab stops. May raise **Error[notAFormWindow]**.

```
nextTabStop: CARDINAL = ...;
```

Used for item layout, it is the default for the **tabStop** parameter for **AppendItem** and **InsertItem**. Indicates that the next item should be placed at the next tab stop.

```
GetTabStops: PROCEDURE [window: Window.Handle]
  RETURNS [tabStops: TabStops];
```

GetTabStops returns the current tab stops for **window**. If no tab stops have been set for **window**, **tabStops** will be fixed with an interval of 0. May raise **Error[notAFormWindow]**.

25.2.6.3 Fixed Layout

```
SetItemBox: PROCEDURE [
  window: Window.Handle,
  item: ItemKey,
  box: Window.Box];
```

SetItemBox is used to set the exact position of an item for fixed layout. With fixed layout, all items stay right where they are laid out unless the client calls **SetItemBox** again. With fixed layout, text, decimal, integer, and window items will not grow or shrink. **SetItemBox** is incompatible with flexible layout (such as. **AppendLine**, **AppendItem**, **SetTabStops**, etc). **Note:** Either all layout must be flexible, or all layout must be fixed. Attempting to mix them will raise **Error[notAFormWindow, invalidItemKey]**.

25.2.7 Save and Restore

```
Restore: PROCEDURE [window: Window.Handle];
```

```
Save: PROCEDURE [window: Window.Handle];
```

Restore and **Save** deal with restoration of a form window to a previous state. **Save** causes the current item values to be saved. **Restore** causes the previously saved values to be copied back into the form. A **Restore** done before a **Save** is a no-op. **Save** done after **Save** (but before a **Restore**) overwrites the first **Save**. These procedures support the Defaults and Reset functions of property sheets. May raise **Error[notAFormWindow]**.

25.2.8 Miscellaneous TYPEs

```
Bitmap: TYPE = RECORD[
   height, width: CARDINAL,
   bitsPerLine: CARDINAL,
   bits: Environment.BitAddress];
```

A **Bitmap** is the data structure that is passed to **MakeBooleanItem** and **MakeChoiceItem** for items that are to be displayed as bitmaps. **height** is the height in pixels, of the bitmap. **width** is the width in pixels, of the bitmap. **bits** is a pointer to the actual bits in the bitmap. **bitsPerLine** is the number of bits in each line of bits. **bitsPerLine** is usually greater than or equal to **width**, and is often a multiple of 16.

```
ChangeReason: TYPE = {user, client, restore};
```

A **ChangeReason** is passed to a **GlobalChangeProc**, **BooleanChangeProc**, and **ChoiceChangeProc**. It indicates whether the change was caused by the user, or by the client calling **SetXXXItemValue**, or by the client calling **Restore**.

25.2.9 Miscellaneous Item Operations

```
GetReadOnly: PROCEDURE [window: Window.Handle, item: ItemKey]
   RETURNS [readOnly: BOOLEAN];
```

GetReadOnly returns the current value of the **readOnly** BOOLEAN for item. May raise **Error[notAFormWindow, invalidItemKey]**.

```
GetTag: PROCEDURE [
   window: Window.Handle,
item: ItemKey]
RETURNS [tag: XString.Reader];
```

GetTag returns the tag associated with **item**. May raise **Error[notAFormWindow, invalidItemKey]**.

```
SetSelection: PROCEDURE [
   window: Window.Handle,
   item: ItemKey,
   firstChar: CARDINAL ← 0,
   lastChar: CARDINAL ← CARDINAL.LAST];
```

SetSelection sets the current selection to be **item**. This is useful for helping the user correct an incorrect user entry. **item** must be a text, decimal, or integer item. **firstChar** is the first character of the portion of the string to be selected and highlighted. **lastChar** is the last character of the portion of the string to be selected and highlighted. The defaults for **firstChar** and **lastChar** causes the entire string to be selected. May raise **Error[notAFormWindow, invalidItemKey, wrongItemType]**.

```
SetInputFocus: PROCEDURE [
   window: Window.Handle,
   item: ItemKey,
   beforeChar: CARDINAL ← CARDINAL.LAST];
```

SetInputFocus sets the current input focus to be in **item**. This is useful for highlighting an incorrect user entry. item must be a text, decimal, or integer item. **beforeChar** is the character before which the input focus should go. The default causes the input focus to be at the end of the string. May raise **Error[notAFormWindow, invalidItemKey, wrongItemType]**.

```
SetReadOnly: PROCEDURE [
   window: Window.Handle,
   item: ItemKey,
   readOnly: BOOLEAN]
   RETURNS [old: BOOLEAN];
```

SetReadOnly sets the current "readOnly-ness" of item and returns the old value. May raise **Error[notAFormWindow, invalidItemKey]**.

```
SetItemWidth: PROCEDURE [window: Window.Handle, item: ItemKey,
   width: CARDINAL];
```

This procedure sets the width of an item. Normally, items are as wide as they need to be to display the text of the item (except text, decimal, and integer items whose width is specified when the items are created). **SetItemWidth** overrides the normal width of the item and thus could result in the text of the item being truncated. **SetItemWidth** should therefore be used with great caution. In particular, programmers should keep in mind that applications are intended to be multinational and strings in other languages are often longer than their English equivalents. This layout procedure can only be used with a flexible layout.

25.2.10 NEXT Key

When the user presses the NEXT key while the input focus is in a form window (more exactly: in a text, decimal, or integer item in a form window), the form window does the following:

1. If the item with the input focus has a **NextOutOfProc**,it is called. This gives the client an opportunity to, for example, add another blank text item after this one.

2. Find the next text, decimal, integer, or window item. Note: If the client added another text item after the one that had the input focus, that new item will be the one found by form window.

3a. If the next item is a text, decimal, or integer item, the input focus and selection are moved to that item.

3b. If the next item is a window item and the window item has a **NextIntoProc**, it is called, giving the window item an opportunity to take the input focus. For example, if the window item contains a table of values, the NEXT key could be used to step from entry to entry through the table, but the window item's **TIP.NotifyProc** would have to do this. **Note:** If a **NextIntoProc** is supplied for a window item, it MUST call **TIP.SetInputFocus** so that all further NEXT key notifications will go to the window item. When the window item no longer wants the NEXT key (such as the user has NEXTed out of the last entry of the table), it must call **FormWindow.TakeNEXTKey**. **TakeNEXTKey** proceeds as in steps 2 and 3.

3c. If the next item is a window item, but the window item does not have a **NextIntoProc**, the form window repeats steps 2 and 3.

```
NextIntoProc: TYPE = PROCEDURE [
  window: Window.Handle,
  item: ItemKey];
```

A **NextIntoProc** can be provided by the client with window items. If provided, the **NextIntoProc** will be called when the user NEXTs into the item using the NEXTkey. (See the discussion above.)

```
NextOutOfProc: TYPE = PROCEDURE [
  window: Window.Handle,
  item: ItemKey];
```

A **NextOutOfProc** can be provided by the client with text, decimal, and integer items. If provided, the **NextOutOfProc** is called when the user hits the NEXT key while the input focus is in an item just before this one. See the discussion above.

```
SetNextOutOfProc: PROCEDURE [
  window: Window.Handle,
  item: ItemKey,
  nextOutOfProc: NextOutOfProc]
  RETURNS [old: NextOutOfProc];
```

SetNextOutOfProc sets the **NextOutOfProc** for a text, decimal, or integer item. This is useful when the **NextOutOfProc** for a text item creates another text item after itself. After creating the new item, the client will probably want to set the **NextOutOfProc** for the old item to NIL, so that next time the user NEXTs out of the old item, the selection and input focus will simply move to the new item rather than creating yet another new item.

```
GetNextOutOfProc: PROCEDURE [
   window: Window.Handle,
   item: ItemKey]
   RETURNS [NextOutOfProc];
```

GetNextOutOfProc returns the **NextOutOfProc** for **item**.

```
TakeNEXTKey: PROCEDURE [
   window: Window.Handle,
   item: ItemKey];
```

TakeNEXTKey informs form window that the window item which was handling the NEXT item is done with it and the input focus should be passed on to the next item that can take it. **item** identifies the window item that is involved. May raise **Error[notAFormWindow, wrongItemType]**.

25.2.11 SIGNALs and ERRORs

```
Error: ERROR [code: ErrorCode];

ErrorCode: TYPE = MACHINE DEPENDENT {notAFormWindow(0), wrongItemType,
   invalidChoiceNumber, noSuchLine, alreadyAFormWindow,
   invalidItemKey, itemNotOnLine, duplicateItemKey,
   incompatibleLayout, alreadyLaidOut, last(15)};
```

notAFormWindow	The term **notAFormWindow** means the window passed in to the procedure is not a form window. Any **FormWindow** procedure, except **Create** and **IsIt**, may raise this error.
wrongItemType	The term **wrongItemType** means the item passed in to the FormWindow procedure is the wrong type. For example, **GetChoiceItemValue** must be passed a choice item.
invalidChoiceNumber	The term **invalidChoiceNumber** means the choice number supplied does not match any of the choice numbers in the **ChoiceItems**.
noSuchLine	The term **noSuchLine** means the line supplied to **AppendItem** or **InsertItem** was not previously created.
alreadyAFormWindow	The term **alreadyAFormWindow** means the window passed in is already a form window. Raised if a **FormWindow** is passed into **Create**.
invalidItemKey	The term **invalidItemKey** means an **ItemKey** was used for which there was no item created.
itemNotOnLine	The term **itemNotOnLine** means an attempt was made to insert an item on a line before an item that is not on that line. See **InsertItem**.
duplicateItemKey	The term **duplicateItemKey** means an item was created with the key of another item. **ItemKeys** must be unique.

incompatibleLayout	The term **incompatibleLayout** means the client is attempting to intermix fixed and flexible layout styles.
alreadyLaidOut	The term **alreadyLaidOut** means an attempt was made to specify the layout for an item more than once.

```
LayoutError: SIGNAL [code: LayoutErrorCode];

LayoutErrorCode: TYPE = {onTopOfAnotherItem, notEnufTabsDefined};
```

25.2.12 Multinational items

```
Flushness: TYPE = SimpleTextDisplay.Flushness;

StreakSuccession: TYPE = SimpleTextDisplay.StreakSuccession;

GetFlushness: PROCEDURE [
  window: Window.Handle,
  item: ItemKey]
  RETURNS [old: Flushness];

SetFlushness: PROCEDURE [
  window: Window.Handle,
  item: ItemKey,
  new:Flushness]
  RETURNS [old:Flushness];

GetStreakSuccession: PROCEDURE [
  window: Window.Handle,
  item: ItemKey]
  RETURNS [old: StreakSuccession];

SetStreakSuccession: PROCEDURE [
  window: Window.Handle,
  item: ItemKey,
  new:StreakSuccession]
  RETURNS [old:StreakSuccession];
```

25.3 Usage/Examples

25.3.1 Calling ChangeProcs

There are three ways for a client to determine if an item has been changed. (1) The client may supply a **GlobalChangeProc** that governs the entire window, (2) it may supply a **XXXChangeProc** for certain items (such as choice and boolean), and (3) it may examine the "changed" boolean associated with each item.

An item can change because the user changes the item, or because a client calls **SetXXXItemValue**, or because a client calls **RestoreAllItems**.

The two kinds of change procs are called whenever the "changed" boolean goes from false to true (whether that is caused by user actions or client actions). The following describes the exact order of events for each source of change:

- User action

  1. Change value of item and set "changed" boolean.
  2. Call local change proc, if any.
  3. Call global change proc, if any.

- Client call to **SetXXXItemValue**

  1. Change value of item and set "changed" boolean.
  2. Call local change proc, if any.
  3. Call global change proc, if any.

- Client call to **RestoreAllItems**

  1. Change value of item and set "changed" boolean.
  2. Call global change proc, if any, with **nullItemKey**.

Note: If a change proc does a **SetXXXItemValue**, the client should take extreme care to prevent infinite recursion.

25.3.2 Creating a Simple FormWindow

```
MyItems: TYPE = {boolean, choice, text};



.
.
shell: StarWindowShell.Create [...];
formWindow: StarWindowShell.CreateBody [shell];
FormWindow.Create [window: formWindow, makeItems: MakeItems,
layoutProc: DoLayout];
.
.
.

MakeItems: FormWindow.MakeItemsProc = {
  <<[window: Window.Handle, clientData: LONG POINTER]>>
  tag: XString.ReaderBody;

  -- Make a boolean item
  BEGIN
  booleanLabel: FormWindow.BooleanItemLabel ← [string[
    XString.FromSTRING ["This is a boolean item"]]];
  tag ← XString.FromSTRING ["Tag"];
  FormWindow.MakeBooleanItem [
  window: window, myKey: MyItems.boolean.ORD,
  tag: @tag, label: booleanLabel,
initBoolean: FALSE];
END;

-- Make a choice item
BEGIN
choice1: XString.ReaderBody ← XString.FromSTRING["Choice One"];
choice2: XString.ReaderBody ← XString.FromSTRING["Choice 2"];
choices: ARRAY [0..2) OF FormWindow.ChoiceItem ← [
   [ string[0, choice1] ],
   [ string[1, choice2] ] ];
tag ← XString.FromSTRING ["Choice item"];
FormWindow.MakeChoiceItem [
   window: window, myKey: MyItems.choice.ORD,
   tag: @tag, values: DESCRIPTOR[choices],
   initChoice: 0];
END;

-- Make a text item
tag ← XString.FromSTRING ["Text item"];
FormWindow.MakeTextItem[
window: window, myKey: MyItems.text.ORD,
tag: @tag, width: 30];
};

DoLayout: FormWindow.LayoutProc = {
   <<[window: Window.Handle, clientData: LONG POINTER]>>

   FormWindow.SetTabStops [window: window, tabStops: [ fixed [100] ] ];

   line: FormWindow.Line ← FormWindow.AppendLine [window];

   -- Put boolean and choice item on line 1
   FormWindow.AppendItem[window, MyItems.boolean.ORD, line];
   FormWindow.AppendItem[window, MyItems.choice.ORD, line];

   -- Put text item on line 2
   line ← FormWindow.AppendLine [window];
   FormWindow.AppendItem[window, MyItems.text.ORD, line];
   };
```

25.3.3 Specifying Bitmaps in Choice Items

This example creates a choice item with three possible values. Two of them are bitmaps, one is a string. The initial value to be highlighted is #2, the string.

```
--The bits. (These are in a global frame or a file. They MUST be around for the duration of
the FormWindow since the bits are NOT copied.)
bm1: FormWindow.Bitmap ← [height: 48, width: 64, bitsPerLine: 64, bits: [mybits1, 0, 0]];
bm2:FormWindow.Bitmap ← [height: 48, width: 64, bitsPerLine: 64, bits: [mybits2, 0, 0]];
mybits1: LONG POINTER TO UNSPECIFIED ← @bitmap1[0];
bitmap1: ARRAY [0..192) OF WORD ← [--some bits--];
mybits2: LONG POINTER TO UNSPECIFIED ← @bitmap2[0];
```

```
bitmap2: ARRAY [0..192) OF WORD ← [--some bits--];
choiceOther: XString.ReaderBody ← XString.FromSTRING["OTHER"];
choices: ARRAY [0..3) OF FormWindow.ChoiceItem ← [
   [bitmap[0, bm1] ],
   [bitmap[1, bm2] ],
   [string[2, choiceOther] ]
   ];

FormWindow.MakeChoiceItem[
   window: window,
   tag: @tag,
   myKey: MyItems.choice.ORD,
   values: DESCRIPTOR[choices],
   changeProc: ChoiceChangeProc,
   initChoice: 2];
```

25.3.4 The NEXT Key and Text Items

This example creates a text item that inserts a new item after itself every time the user presses the NEXT key.

```
--Make the text item
MakeItems: FormWindow.MakeItemsProc =
   BEGIN
   . . .

   FormWindow.MakeTextItem[
      window: window,
      myKey: MyItems.text.ORD,
      width: 50,
      tag: @tag,
      initString: @initStringLong,
      nextOutOfProc: TextNextOut];
   . . .

   END;

TextNextOut: FormWindow.NextOutOfProc =
   BEGIN
   tag: XString.ReaderBody ← XString.FromSTRING["Inserted Item:"];
   initString: XString.ReaderBody ← XString.FromSTRING["I DARE you! Edit ME!"];

   --create a new line on which to display the new item
   nextLine: FormWindow.Line ← FormWindow.LayoutInfoFromItem
      [window, MyItems.testChoice2.ORD].line;
   line: FormWindow.Line ← FormWindow.InsertLine[window, nextLine, 60];

   --create the new item.
   FormWindow.MakeTextItem[
      window: window,
      myKey: cntr,
        --cntr is a counter to keep track of the next available
        --   key number since all ItemKeys are unique
      width: 50,
      tag: @tag,
      initString: @initString ,
      nextOutOfProc: TextNextOut];

   --put the new item on the line
   FormWindow.AppendItem[
      window: window,
      item: cntr,
      line: line];
   cntr ← cntr + 1;

   --set the last item's NextOutOfProc to NIL
   [] ← FormWindow.SetNextOutOfProc[window, item, NIL];
   END;
```

25.3.5 Window Items (Including Interaction with the NEXT Key)

This example creates a window item that wishes to be given control when a user NEXTs into it.

```
--create the item
MakeItems: FormWindow.MakeItemsProc =
   BEGIN
   dims: Window.Dims ← [200,200];
   ...
   myWindow ← FormWindow.MakeWindowItem[
      window: window,
      myKey: MyItems.window.ORD,
      tag: @tag,
      size: dims,
      destroyProc: NIL,
      nextIntoProc: MyNextInto];

   --set the display and notify procs
   [] ← Window.SetDisplayProc[myWindow, WindowItemDisplayProc];
   [] ← TIP.SetTableAndNotifyProc [window: myWindow,
      table: TIPStar.NormalTable[], notify: MyNotify];
   . . .
   END;

--MyNextInto is called when a user presses the NEXT key "into" the window item
MyNextInto: FormWindow.NextIntoProc =
   BEGIN
   --set the input focus so the window item gets all of the notifications
   TIP.SetInputFocus [w: myWindow, takesInput: TRUE];
   END;
```

--FormWindow is notified so the window item no longer requires the NEXT key so FormWindow can pass it along to the appropriate item

```
MyNotify: TIP.NotifyProc =
  BEGIN
  FOR input: TIP.Results ← results, input.next UNTIL input = NIL DO
    WITH z: input SELECT FROM
      atom => SELECT z.a FROM
         nextDown =>
            FormWindow.TakeNEXTKey
               [window: myWindow.GetParent, item: MyItems.window.ORD];
            . . .
         ENDCASE;
      ENDCASE;
    ENDLOOP;
  END;
```

25.3.6 Hints

This example creates a text item that has a popup menu associated with it:

```
MakeItems: FormWindow.MakeItemsProc =
  BEGIN
  . . .
  FormWindow.MakeTextItem[
    window: window,
    myKey: MyItems.text.ORD,
    width: 50,
    tag: @tag,
    initString: @initString,
    hintsProc: TextHints];
  . . .
  END;
```

--Every time TextHints is called, specify the strings to put into the popup menu. The hintAction specifies that when a string is selected from the hints menu, it should replace the string in the text item

```
TextHints: FormWindow.TextHintsProc =
  BEGIN
  hintsArray ← --some computation--;
  RETURN [hints: DESCRIPTOR[hintsArray], freeHints: FreeHints, hintAction: replace];
  END;

FreeHints: FormWindow.FreeTextHintsProc =
  BEGIN
  --free the strings and whatever other storage here
  END;
```

25.3.7 Saving and Restoring Items

The following example saves the original values of the items in a form window and restores them when the user presses RESET.

```
--When creating the FormWindow also call
FormWindow.Save[window];

--user changes some values
--user decides he wants the original values back; presses Reset
FormWindow.Restore[window];
```

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26 FormWindowMessageParse

26.1 Overview

The **FormWindowMessageParse** interface provides procedures that parse strings to produce various **FormWindow** TYPES. These strings are usually acquired from a message file. Currently, only FormWindow.**ChoiceItems** are supported.

26.2 Interface Items

```
ParseChoiceItemMessage: PROCEDURE [
   choiceItemMessage: XString.Reader,
   zone: UNCOUNTED ZONE]
RETURNS [choiceItems:FormWindow.ChoiceItems];
```

Parses a **choiceItemMessage** (presumably retrieved using XMessage.**Get**) with the following syntax: "choiceString:choiceNumber@choiceString:choiceNumber@|", where choiceString is the string to be displayed for that choice, choiceNumber is the fixed number associated with that choice, @ is the separator between choices, and | indicates the point at which to wrap the choices. The choices will be displayed in the order they appear in the message. **choiceItems** is a descriptor for an array that must be freed using **FreeChoiceItems**.

```
FreeChoiceItems: PROCEDURE [
   choiceItems:FormWindow.ChoiceItems,
   zone: UNCOUNTED ZONE];
```

Frees the array and everything it points to (strings).

26.3 Usage/Examples

The following example is taken from the folder implementation. The message acquired by XMessage.**Get** looks like "Sorted:0@Unsorted:1".

```
choices: FormWindow.ChoiceItems ← FormWindowMessageParse.ParseChoiceItemMessage [
   XMessage.Get[mh, FolderOps.kpsSorted], z];
```

```
FormWindow.MakeChoiceItem [
 window: window,
 myKey: MyItemType.sorted.ORD,
 values: choices,
 initChoice: sorted.ORD,
 changeProc: SortedChanged ];

FormWindowMessageParse.FreeChoiceItems[choices, z];
```

26.4 Index of Interface Items

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IdleControl

27.1 Overview

The **IdleControl** interface provides access to ViewPoint's basic controlling module.

ViewPoint's control loop is organized as a series of two out-calls to a greeter procedure and a desktop procedure. Each procedure is implemented as a procedure variable, initialized to an appropriate no-op.

Interface procedures allow the client to plug in its own greeter and desktop procedures. A plugged-in procedure will then be called the next time that the control routine goes around the loop.

27.2 Interface Items

IdleControl keeps track of one **GreeterProc** and a list of **DesktopProcs**. A client may plug in a number of **DesktopProcs** and specify the one to be called by the value of the **Atom.ATOM** returned by the **GreeterProc**.

27.2.1 DesktopPlug-in

DesktopProc: TYPE = PROCEDURE;

SetDesktopProc: PROCEDURE [atom: Atom.ATOM, desktop: DesktopProc] RETURNS [old: DesktopProc];

SetDesktopProc allows the client to specify the desktop procedure to be called in the control loop. **desktop** is the procedure to be called. **atom** is the **Atom.ATOM** associated with **desktop**. **old** is the previously plugged-in desktop procedure.

GetDesktopProc: PROCEDURE [atom: Atom.ATOM] RETURNS [DesktopProc];

27.2.2 Greeter Plug-in

GreeterProc: TYPE = PROCEDURE RETURNS [Atom.ATOM];

SetGreeterProc: PROCEDURE [new: GreeterProc] RETURNS [old: GreeterProc];

SetGreeterProc allows the client to specify the greeter procedure to be called in the control loop. new is the procedure to be called. old is the previously plugged-in greeter procedure.

GetGreeterProc: PROCEDURE RETURNS [GreeterProc];

DoTheGreeterProc: GreeterProc;

DoTheGreeterProc calls the currently plugged-in GreeterProc.

27.2.3 Idle Loop

The control loop is the logical equivalent of :

```
DO
  atom: Atom.ATOM ← pluggedInGreeterProc [];
  pluggedInDesktopProc ← GetDesktopProcWithAtom[atom];
  pluggedinDesktopProc[];
  ENDLOOP;
```

Idle: PROCEDURE

Idle is called or FORKed to enter the idle state.
Only clients who start the world should call Idle.

27.3 Usage/Examples

In the following example, the GreeterProc (IdleProc) displays a bouncing square on the screen. The GreeterProc is set in the mainline code of the module The DesktopProc and GreeterProc can be initialized in different modules as long as they agree on the Atom.ATOM (in this case StarDesktop).

```
starDesktopAtom: Atom.ATOM ← Atom.MakeAtom["StarDesktop"L];

IdleProc: IdleControl.GreeterProc = BEGIN--display a bouncing square until the user
presses any key
  RETURN [starDesktopAtom];
  END;

StarDesktop: PROCEDURE = BEGIN
--do Star logon
--initialize and display Star desktop
--wait until Logoff
END;

Init: PROCEDURE =
  BEGIN
  [] ←IdleControl.SetGreeterProc[IdleProc];
  [] ←IdleControl.SetDesktopProc [starDesktopAtom, StarDesktop];
  END; -- of Init
```

27.4 Index of Interface Items

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KeyboardKey

28.1 Overview

KeyboardKey is a keyboard registration facility. It provides clients with a means of registering "system-wide" keyboards (available all the time, like English, French, European), a special keyboard (like Equations), and/or client-specific keyboards (such as these available only when the client has the input focus). The labels from these registered keyboards are displayed in the softkeys when the user holds down the KEYBOARD key.

The client adds system keyboards by calling **AddToSystemKeyboards**. The client registers a special keyboard by calling **RegisterClientKeyboards** with the **SPECIALKeyboard** parameter. The client registers client-specific keyboards by calling **RegisterClientKeyboards** with the **keyboards** parameter.

28.2 Interface Items

28.2.1 System Keyboards

A system keyboard is defined as one that is available to all clients who wish to recognize some general set of keyboards. (The default case is for a client to recognize system keyboards.) Examples of system keyboards are the various language keyboards--English, French, European, etc., and the general-purpose keyboards - Math, Office, Logic, and Dvorak.

AddToSystemKeyboards: PROCEDURE **[keyboard:** BlackKeys.**Keyboard];**

The **AddToSystemKeyboards** procedure registers a client's keyboard interpretation with the keyboard key manager. The client is expected to provide a pointer to a keyboard record. This keyboard will be made available whenever system keyboards are available.

May raise **Error[alreadyInSystemKeyboards]**.

RemoveFromSystemKeyboards: PROCEDURE **[keyboard:** BlackKeys.**Keyboard];**

Removes a **Keyboard** from the list of system keyboards.

May raise **Error[notInSystemKeyboards]**.

28.2.2 Client Keyboards

A client keyboard is defined as one that is specific to the application and would have no meaning in a different context. Examples are the special keyboards (such as equations and fields) and Spreadsheet and 3270 keyboards.

A client registers its keyboards with the keyboard manager when it gets control (gets the inputFocus). **RegisterClientKeyboards** tells the keyboard manager what keyboards should be made available to the user when the KEYBOARD key is held down. When the client loses control (releases the input Focus) it should call **RemoveClientKeyboards** to release its keyboards. Only 0-1 set of client keyboards is registered at any given time. If no client is registered, then all system keyboards are available to the user.

```
RegisterClientKeyboards: PROCEDURE [
   wantSystemKeyboards: BOOLEAN ← TRUE,
   SPECIALKeyboard: BlackKeys.Keyboard ← NIL,
   keyboards: LONG DESCRIPTOR FOR ARRAY OF BlackKeys.KeyboardObject ← NIL];
```

RegisterClientKeyboards establishes a list of client keyboards with the keyboard manager. This should occur at the same time the client takes the input focus. **wantSystemKeyboards** specifies whether the client wishes to recognize system keyboards. **SPECIALKeyboard** denotes the keyboard to be invoked by pressing the key combination of KEYBOARD key and the softkey labeled "Special". The **keyboards** array contains any other client keyboards. A typical case is for a client to provide only a Special keyboard and **wantSystemKeyboards** = TRUE. If **wantSystemKeyboards** = FALSE the client should set one of his keyboards using **SetKeyboard** (see section 2.3)

```
RemoveClientKeyboards: PROCEDURE ;
```

RemoveClientKeyboards removes the clients keyboards from the keyboard managers list. This list of available keyboards will revert to system keyboards only. The "Set" keyboard will be the last system keyboard that was "Set" (either by the user or a call to **SetKeyboard**). It is the client's responsibility to make sure his keyboards are removed when relinquishing control. It would be appropriate for this to be done as part of a TIP.**LosingFocusProc**.

28.2.3 Setting and Enumerating Keyboards

Note: Most clients will probably not have reason to use the information in this section.

```
SetKeyboard: PROCEDURE [keyboard: BlackKeys.Keyboard];
```

SetKeyboard sets the current keyboard to **keyboard**. This keyboard will remain the current keyboard until the user presses a KEYBOARD key/SoftKeyOption/Set combination, which chooses a new keyboard, or until another **SetKeyboard** command is encountered.

SetKeyboard is provided for those clients who have reason to set a keyboard programmatically. The usual case is for the user to cause a keyboard to be set by pressing the key combination KEYBOARD key/SomeSoftKeyDesignatingAKeyboard. However, for a client calling **RegisterClientKeyboards** with **wantSystemKeyboards** = FALSE it is appropriate to call **SetKeyboard[@oneOfClientKeyboards]**. (Otherwise there would be no typing possible until the user made a keyboard choice through the KEYBOARD key/SoftKey routine.) The other primary reason for calling **SetKeyboard** would be to set an initial keyboard at boot time.

```
EnumerateKeyboards: PROCEDURE [class: KeyboardClass, enumProc: EnumerateProc];
```

```
EnumerateProc: TYPE = PROCEDURE[keyboard: BlackKeys.Keyboard, class: KeyboardClass]
  RETURNS[stop: BOOLEAN ←FALSE];
```

EnumerateKeyboards calls the specified **EnumerateProc** until the **Stop** boolean becomes TRUE or until there are no more **keyboards** to enumerate. When calling **EnumerateKeyboards,** the client may specify which keyboards he wants enumerated: **system**, **client**, **special**, or **all** of the registered keyboards. When the keyboard manager calls the client's **EnumerateProc,** the keyboard returned will be qualified by **class**: **client**, **system**, or the **special** keyboard..

```
KeyboardClass: TYPE = {system, client, special, all, none};
```

system = A system keyboard is defined as one that is available to all clients who wish to recognize some general set of keyboards. Examples of system keyboards are the various language keyboards - English, French, European, etc.,and the general-purpose keyboards--Math, Office, Logic, and Dvorak.

client = A client keyboard is defined as one that is specific to the application. These are the keyboards registered in the **keyboards** array by the client calling **RegisterClientKeyboards**.

special = A client-specific keyboard is invoked by pressing the combination of KEYBOARD key and the softkey labeled "Special". Specifically, this is the keyboard registered by the client as **SPECIALKeyboard** when calling **RegisterClientKeyboards**.

all = All keyboards: system, client, and special.

28.2.4 Keyboard Window Plug-in

This section pertains only to those clients interested in implementing a Keyboard Window facility.

```
ShowKeyboardProc: TYPE = PROCEDURE,
```

```
SetShowKeyboardProc: PROCEDURE [ShowKeyboardProc];
```

```
GetShowKeyboardProc: PROCEDURE RETURNS [ShowKeyboardProc];
```

SetShowKeyboardProc and **GetShowKeyboardProc** provide an interface between a keyboard window application and KeyboardKey's "Show" key. The clients

ShowKeyboardProc will be called whenever the user presses the key combination KEYBOARD key/Show. This gives the client the opportunity to display a keyboard window.

28.2.5 Errors

```
Error: ERROR[code: ErrorCode];

ErrorCode: TYPE = {alreadyInSystemKeyboards, notInSystemKeyboards,
   insufficientSpace};
```

28.3 Usage/Examples

28.3.1 AddToSystemKeyboards Example

In this application a keyboard has been defined that will be useful across all applications. Registering it as a system keyboard will make it available globally.

```
usefulKeyboard: BlackKeys.KeyboardObject ←
   [charTranslator: [proc: MyCharTrans, data: NIL],
    pictureProc: MapPicture,
   label ← XString.FromString["Useful Keyboard "L]];

KeyboardKey.AddToSystemKeyboards[@myUsefulKeyboard];
```

The keyboard manager will add the keyboard **usefulKeyboard** to the list of registered system keyboards and a key labeled *Useful Keyboard* to its labels for the KeyboardKey soft keys. When the user pushes the soft key labeled *Useful Keyboard*, **MyCharTrans** will be registered as the TIP.**CharTranslator**, and if the keyboard window is open, **MapPicture** will be called so that the picture and geometry table can be mapped.

28.3.2 Special Keyboard Example

This example contains a keyboard that is specific to a particular application and will be available to the user through the "Special" key. The user should also be able to use the system keyboards in this application. Notice that it is appropriate to default the **label** when specifying a Special keyboard, because this keyboard will be presented to the user as the current Special keyboard and labeled as such.

```
AddMyClientKeyboards: PROCEDURE =
BEGIN
 specialKeyboard: BlackKeys.KeyboardObject;
 fileName: XString.ReaderBody ← XString.FromSTRING["JSpecial.TIP"L];
 table: TIP.Table ← TIP.CreateTable[@fileName];
 [] ← TIP.SetNotifyProcForTable[table, NotifyProc];
 specialKeyboard ← [table: table];
 KeyboardKey.RegisterClientKeyboards[
   wantSystemKeyboards:TRUE,
   SPECIALKeyboard: @specialKeyboard];
END; -- AddMyClientKeyboards
```

```
LosingFocusProc: TIP.LosingFocusProc =
<<[w: Window.Handle, data: LONG POINTER]>>
BEGIN
 KeyboardKey.RemoveClientKeyboards[];
 --release any data structures I don't want to keep around
END; -- LosingFocusProc
```

28.3.3 Registering Multiple Client Keyboards Example

This example deals with a client who has a special keyboard and several client-specific keyboards and does not plan to allow the user to use any system keyboards while in this application.

```
keyboardRecords: ARRAY [0..3) OF BlackKeys.KeyboardObject;      -- records filled in
specialKeyboard: BlackKeys.Keyboard;                            -- elsewhere

AddClientKeyboards: PROCEDURE =
BEGIN
 KeyboardKey.RegisterClientKeyboards[
   wantSystemKeyboards: FALSE,
   SPECIALKeyboard: specialKeyboard,
   keyboards: DESCRIPTOR[keyboardRecords]];
 KeyboardKey.SetKeyboard[@keyboardRecords[0]]
END; -- AddClientKeyboards

LosingFocusProc: TIP.LosingFocusProc =
 <<[w: Window.Handle, data: LONG POINTER]>>
 BEGIN
  KeyboardKey.RemoveClientKeyboards[];
  --release any data structures I don't want to keep around
 END; -- LosingFocusPro --
```

28.4 Index of Interface Items

29

KeyboardWindow

29.1 Overview

The **BlackKeys** and **KeyboardKey** interfaces provide the framework for including a keyboard window in ViewPoint. The window implementation is a plug-in (see KeyboardKey.SetShowKeyboardProc). This **KeyboardWindow** interface and its implementation provide one such keyboard window.

29.2 Interface Items

29.2.1 Default Values

defaultPicture: BlackKeys.Picture;

defaultGeometry: BlackKeys.GeometryTable;

The default values provided by this keyboard window implementation correspond to the standard English keyboard.

DefaultPictureProc: BlackKeys.PictureProc;

DefaultPictureProc returns **defaultPicture** and **defaultGeometry** to the caller when **action = acquire**. Clients may specify **pictureProc: KeyboardWindow.DefaultPictureProc** in their BlackKeys.**KeyboardObject** if they wish to display the default picture in the keyboard window while their keyboard is in effect.

picture = BlackKeys.nullPicture or BlackKeys.PictureProc = NIL will result in the keyboard window displaying only gray in the viewing region.

29.2.2 Geometry Table Structure

```
GeometryTableEntry: TYPE = RECORD[
 box: Box, key: KeyStations, shift: ShiftState];
```

```
Box: TYPE = RECORD[place: Window.Place, width: INTEGER, height: INTEGER];
```

Area within the bitmap that will generate a particular keystroke when selected with the mouse.

```
KeyStations: TYPE = MACHINE DEPENDENT {
 k1, k2, k3, k4, k5, k6, k7, k8, k9, k10, k11, k12, k13, k14, k15, k16, k17,
 k18, k19, k20, k21, k22, k23, k24, k25, k26, k27, k28, k29, k30, k31, k32,
 k33, k34, k35, k36, k37, k38, k39, k40, k41, k42, k43, k44, k45, k46, k47,
 k48, a1, a2, a3, a4, a5, a6, a7, a8, a9, a10, a11, a12, last(96) };
```

The following is a translation to LevelIVKeys.KeyName:

```
k1 => One;
k2 => Q;
k3 => A;
k4 => Two;
k5 => Z;
k6 => W;
k7 => S;
k8 => Three;
k9 => X;
k10 => E;
k11 => D;
k12 => Four;
k13 => C;
k14 => R;
k15 => F;
k16 => Five;
k17 => V;
k18 => T;
k19 => G;
k20 => Six;
k21 => B;
k22 => Y;
k23 => H;
k24 => Seven;
k25 => N;
k26 => U;
k27 => J;
k28 => Eight;
k29 => M;
k30 => I;
k31 => K;
k32 => Nine;
k33 => Comma;
k34 => O;
k35 => L;
```

```
k36 => Zero;
k37 => Period;
k38 => P;
k39 => SemiColon;
k40 => Minus;
k41 => Slash;
k42 => LeftBracket;
k43 => CloseQuote;
k44 => Equal;
k45 => RightBracket;
k46 => OpenQuote;
k47 => Key47;
k48 => Tab;
a1 => ParaTab;
a2 => BS;
a3 => Lock;
a4 => NewPara;
a5 => LeftShift;
a6 => RightShift;
a7 => Space;
a8 => A8;
a9 => A9;
a10 => A10;
a11 => A11;
a12 => A12;
```

```
ShiftState: TYPE = {None, One, Two, Both};
```

Simulates the position of the shift keys associated with the keystroke.

29.2.3 Bitmap Structure

BlackKeys.Picture.bitmap is a LONG POINTER. It is further defined within this keyboard window implementation as follows: **bitmap** points to the bits of the keyboard bitmap where dims = [505, 145] and **bitmapBitWidth** = 32*16.

29.2.4 Getting to the Keyboard Window Handle

```
GetDisplayWindow: PROCEDURE RETURNS [Window.Handle];
```

Returns handle to the body window of the keyboard window.

29.3 Usage/Examples

29.3.1 Using DefaultPictureProc

```
DefineKeyboard: PROCEDURE =
BEGIN
 nameString: XString.ReaderBody ← XString.FromSTRING["Zulu"L]
 zuluKeyboardRecord: BlackKeys.KeyboardObject ← [
  table: NIL,
  charTranslator: [MakeChar, NIL],
  pictureProc: KeyboardWindow.DefaultPictureProc,
  label: XString.CopyToNewReaderBody[@nameString, Heap.systemZone]];
 --save the pointer to the record somewhere for future use --
END; --DefineKeyboard --
```

29.3.2 Using defaultGeometry

```
DefineKeyboard: PROCEDURE =
BEGIN
 nameString: XString.ReaderBody ← XString.FromSTRING["Swahili"L]

 swahiliKeyboardRecord: BlackKeys.KeyboardObject ← [
  table: NIL,
  charTranslator: [MakeChar, NIL],
  pictureProc: MapBitmapFile,
  label: XString.CopyToNewReaderBody[@nameString, Heap.systemZone]];
 --save the pointer to the record somewhere for future use --
END; --DefineKeyboard --

MapBitmapFile: BlackKeys.PictureProc =
BEGIN
 pixPtr: BlackKeys.Picture.bitmap ← BlackKeys.nullPicture;
 SELECT action FROM
  acquire => 
 {--Do the right thing to map the bitmap. Uses the default Geometry table --.
   RETURN[pixPtr, KeyboardWindow.defaultGeometry] };
  release => {--Do the right thing to unmap the bitmap
   RETURN[BlackKeys.nullPicture, NIL] }
END; -- MapBitmapFile
```

29.3.3 Sample Geometry Table Entries

```
box: [place: [x: XXX, y: XXX], w idth: XXX, height: XXX], key: XXX, shift: XXX
[[19, 11], 27, 27], k48, None           -- 'tab' key, dims: whole key picture
[[51, 11], 27, 14], k1, One             -- shifted '1' key, dims: upper half key
[[51, 24], 27, 14], k1, None            -- '1' key, dims: lower half key
[[83, 11], 27, 14], k4, One             -- shifted '2' key, dims: upper half key
[[83, 24], 27, 14], k4, None            -- '2' key, dims: lower half key
```

29.4 Index of Interface Items

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LevelIVKeys

30.1 Overview

LevelIVKeys is documented in the *Pilot Programmer's Manual*: 610E00160; however, the names of several keys were changed for ViewPoint. The key names now more closely match the names on the physical keys.

30.2 Interface Items

```
OPEN ks: KeyboardWindow.KeyStations;

DownUp: TYPE = ks.DownUp;

Bit: TYPE = ks.Bit;

KeyBits: TYPE = PACKED ARRAY KeyName OF DownUp;

KeyName: TYPE = MACHINE DEPENDENT {
  notAKey(0),
  Keyset1(ks.KS1), Keyset2(ks.KS2), Keyset3(ks.KS3), Keyset4(ks.KS4),
  Keyset5(ks.KS5),
  MouseLeft(ks.M1), MouseRight(ks.M3), MouseMiddle(ks.M2),
  Five(ks.k16), Four(ks.k12), Six(ks.k20), E(ks.k10), Seven(ks.k24),
  D(ks.k11), U(ks.k26), V(ks.k17), Zero(ks.k36), K(ks.k31), Minus(ks.k40),
  P(ks.k38), Slash(ks.k41), Font(ks.R8), Same(ks.L8), BS(ks.A2),
  Three(ks.k8), Two(ks.k4), W(ks.k6), Q(ks.k2), S(ks.k7), A(ks.k3),
  Nine(ks.k32), I(ks.k30), X(ks.k9), O(ks.k34), L(ks.k35), Comma(ks.k33),
  CloseQuote(ks.k43), RightBracket(ks.k45), Open(ks.L11), Keyboard(ks.R11),
  One(ks.k1), Tab(ks.k48), ParaTab(ks.A1), F(ks.k15), Props(ks.L12),
  C(ks.k13), J(ks.k27), B(ks.k21), Z(ks.k5), LeftShift(ks.A5),
  Period(ks.k37), SemiColon(ks.k39), NewPara(ks.A4),
  OpenQuote(ks.k46), Delete(ks.L3), Next(ks.R1), R(ks.k14), T(ks.k18),
  G(ks.k19), Y(ks.k22), H(ks.k23), Eight(ks.k28), N(ks.k25), M(ks.k29),
  Lock(ks.A3), Space(ks.A7), LeftBracket(ks.k42), Equal(ks.k44),
RightShift(ks.A6), Stop(ks.R12), Move(ks.L9), Undo(ks.R6), Margins(ks.R5),
R9(ks.R9), L10(ks.L10), L7(ks.L7), L4(ks.L4), L1(ks.L1), A9(ks.A9),
R10(ks.R10), A8(ks.A8), Copy(ks.L6), Find(ks.L5), Again(ks.L2),
Help(ks.R2), Expand(ks.R7), R4(ks.R4), D2(ks.D2), D1(ks.D1),
Center(ks.T2), T1(ks.T1), Bold(ks.T3), Italics(ks.T4), Underline(ks.T5),
Superscript(ks.T6), Subscript(ks.T7), Smaller(ks.T8), T10(ks.T10),
R3(ks.R3), Key47(ks.k47), A10(ks.A10), Defaults(ks.T9), A11(ks.A11),
A12(ks.A12)};
```

30.3 Index of Interface Items

31

MenuData

31.1 Overview

The **MenuData** interface defines the data abstraction that is a titled list of named commands. It defines the object formats for a menu item and a menu as well as how to create and manipulate these objects. It is not concerned with how a menu might be displayed to a user.

31.2 Interface Items

31.2.1 Menu and Item Creation

Items and menus are the two primary data objects in the **MenuData** interface. Items are a name-procedure pair that constitute a command. Menus are an abstraction representing a collection of items to be presented to the user. These objects can be built and deallocated through this interface.

```
CreateItem: PROCEDURE [
    zone: UNCOUNTED ZONE,
    name:XString.Reader,
    proc: MenuProc,
    itemData: LONG UNSPECIFIED ← 0]
    RETURNS [ItemHandle];
```

```
ItemHandle: TYPE = LONG POINTER TO Item;
```

```
Item: TYPE = PrivateItem;
```

```
MenuProc: TYPE = PROCEDURE [
    window: Window.Handle, menu: MenuHandle, itemData: LONG UNSPECIFIED];
```

CreateItem builds an item record in the indicated **zone** to be added to a menu. The **name** parameter is copied so it can be in the client's local frame. The **proc** parameter is the command procedure that will be associated with a command name in an item. Client data that must be available when the **MenuProc** is called can be passed via the **itemData** parameter.

An **Item** is the representation for a {command-name, command-procedure} pair. The "nameWidth" field, if non-zero, is the display width of the name. It may be set by a module that computes the width using **SetItemNameWidth**(see §31.2.3). Except for that, an item is read-only.

```
DestroyItem: PROCEDURE [zone: UNCOUNTED ZONE, item: ItemHandle];
```

This procedure destroys the item, recovering the space. **zone** must be the zone in which the item was created, and **item** is the **ItemHandle** returned by **CreateItem**. The item should not be in use when this procedure is called.

```
CreateMenu: PROCEDURE [
    zone: UNCOUNTED ZONE,
    title: ItemHandle,
    array: ArrayHandle,
    copyItemsIntoMenusZone: BOOLEAN ← FALSE ]
    RETURNS [MenuHandle];

ArrayHandle: TYPE = LONG DESCRIPTOR FOR ARRAY OF ItemHandle;

MenuHandle: TYPE = LONG POINTER TO MenuObject;

MenuObject: TYPE = PrivateMenu;
```

CreateMenu builds a menu record in **zone**. **title** is an item containing the menu's title and **array** contains the collection of items that make up the menu. The items pointed to by the **array** and the **title** parameters will only be copied if **copyItemsIntoMenusZone** is TRUE. Since item records are "read-only," an item can be in several menus without copying. The procedure associated with the **title** item is currently unused and should be NIL for future compatibility.

```
DestroyMenu: PROCEDURE [zone: UNCOUNTED ZONE, menu: MenuHandle ]
```

DestroyMenu destroys the menu, recovering the space. **zone** must be the zone in which the menu was created; **menu** is the **MenuHandle** returned by **CreateMenu**. It should only be called when the menu is not in use. There is no explicit way to test if a menu is in use.

Items are not typically destroyed, but their space may be recovered by calling **zone.FREE [itemHandle]**. The zone below is exported for clients that do not wish to manage their own.

```
PublicZone: PROCEDURE RETURNS [UNCOUNTED ZONE];
```

31.2.2 Menu Manipulation

```
AddItem: PROCEDURE [menu: MenuHandle, new: ItemHandle ] =
    INLINE {menu.swapItemProc [menu: menu, old: NIL, new: new]};
```

```
SubtractItem: PROCEDURE [
menu: MenuHandle, old: ItemHandle ] =
    INLINE {menu.swapItemProc [menu: menu, old: old, new: NIL]};

SwapItem: PROCEDURE [
    menu: MenuHandle, new, old: ItemHandle ] =
    INLINE {menu.swapItemProc [menu: menu, old: old, new: new]};
```

These procedures alter a menu in the obvious ways. They call through the **swapItemProc** field in the menu object. This allows a module that posts a menu to "plant" a procedure in the **swapItemProc** field and thus get control on add/subtract/swap requests. With control, data can be monitored appropriately.

```
SetSwapItemProc: PROCEDURE [menu: MenuHandle, new: SwapItemProc]
    RETURNS [old: SwapItemProc];

SwapItemProc: TYPE = PROCEDURE [
    menu: MenuHandle, old, new: ItemHandle];
```

The **SwapItemProc** is the work horse for manipulating menus, as evidenced by the **INLINE** calls above. It can be changed by calling **SetSwapItemProc**.

```
UnpostedSwapItemProc: SwapItemProc;
```

This procedure is the standard procedure that is placed in a menu's **swapItemProc** when the menu is created. It is in the **MenuData** implementation, and it can handle altering a menu when it is not posted. As discussed above, if a routine that posts a menu wants to get control on attempted menu alterations, it should alter the **swapItemProc** in the menu. When it has finished posting the menu, it should store **MenuData.UnpostedSwapItemProc** as the **swapItemProc**. Alternatively, it can call **MenuData.UnpostedSwapItemProc** from within its own **swapItemProc** to perform the actual alteration of the menu object.

31.2.3 Accessing Data

The following provide procedural access to the internal data structures for an item or menu.

```
ItemData: PROCEDURE [item: ItemHandle] RETURNS [LONG UNSPECIFIED];

ItemName: PROCEDURE [item: ItemHandle]
    RETURNS [name: XString.ReaderBody];

SetItemNameWidth: PROCEDURE [item: ItemHandle, width: CARDINAL] =
    INLINE {item.nameWidth ← width};

ItemNameWidth: PROCEDURE [item: ItemHandle] RETURNS [CARDINAL] =
    INLINE {RETURN [item.nameWidth]};

ItemProc: PROCEDURE [item: ItemHandle] RETURNS [proc: MenuProc] =
    INLINE {RETURN [item.proc]};
```

```
MenuArray: PROCEDURE [menu: MenuHandle] RETURNS [array: ArrayHandle] =
    INLINE {RETURN [menu.array]};

MenuTitle: PROCEDURE [menu: MenuHandle] RETURNS [title: ItemHandle] =
    INLINE {RETURN [menu.title]};
```

Note: MenuObjects and Items are private records that are of use to menu posters, but not of interest to general clients. The private records shown below are purely informative in nature.

```
PrivateItem: TYPE = PRIVATE RECORD [
    proc: MenuProc,
    nameWidth: NATURAL,
    nameBytes: NATURAL,
    body: SELECT hasItemData: BOOLEAN FROM
      FALSE => [name XString.ByteSequence],
      TRUE => [itemData: LONG UNSPECIFIED, name: XString.ByteSequence]
      ENDCASE];

PrivateMenu: TYPE = PRIVATE RECORD [
    zone: UNCOUNTED ZONE,
    swapItemProc: SwapItemProc,
    title: ItemHandle ←NIL,
    array: ArrayHandle ←NIL,
    arrayAllocatedItemHandles: NATURAL ←0,
    itemsInMenusZone: BOOLEAN ←FALSE];
```

31.3 Usage/Examples

A menu is displayed to the user by a mechanism outside the scope of this interface. A given menu instance cannot ordinarily be displayed more than once at the same time.

When the user asks that a command be executed, the command item's procedure is called. The argument is a pointer that is dependent on the display mechanism; it might be the StarWindowShell.Handle that the menu is posted in.

31.3.1 Example 1.

```
sysZ: UNCOUNTED ZONE = Heap.systemZone;

Init: PROC = {
   sampleTool: XString.ReaderBody ←XString.FromSTRING["Sample Tool"L];
   Attention.AddMenuItem [
      MenuData.CreateItem [
         zone: sysZ,
         name: @sampleTool,
         proc: MenuProc] ] };

MenuProc: MenuData.MenuProc = {
   another: XString.ReaderBody ←XString.FromSTRING["Another"L];
   repaint: XString.ReaderBody ←XString.FromSTRING["Repaint"L];
   post: XString.ReaderBody ←XString.FromSTRING["Post A Message"L];
```

```
    sampleTool: XString.ReaderBody ← XString.FromSTRING["Sample Tool"L];

    -- Create the StarWindowShell. --
    shell: StarWindowShell.Handle = StarWindowShell.Create [name: @sampleTool];

    .
    .
    .

    -- Create some menu items. --
    z: UNCOUNTED ZONE ← StarWindowShell.GetZone [shell];
    items: ARRAY [0..3) OF MenuData.ItemHandle ← [
       MenuData.CreateItem [zone: z, name: @another, proc: MenuProc],
       MenuData.CreateItem [zone: z, name: @repaint, proc: RepaintMenuProc],
       MenuData.CreateItem [zone: z, name: @post, proc: Post] ];
    myMenu: MenuData.MenuHandle = MenuData.CreateMenu [
       zone: z,
       title: NIL,
       array: DESCRIPTOR [items] ];

    StarWindowShell.SetRegularCommands [sws: shell, commands: myMenu];
    .
    .
    .
    };

Post: MenuData.MenuProc = {
    msg: XString.ReaderBody ← XString.FromSTRING ["This is a sample attention window
    message."L];
    Attention.Post [@msg] };

RepaintMenuProc: MenuData.MenuProc = {
    body: Window.Handle = StarWindowShell.GetBody[[window]];
    Window.InvalidateBox[body, [[0, 0], [30000, 30000] ]];
    Window.Validate[body] };

-- Mainline code --

Init[];
```

31.3.2 Example 2

```
-- Declare and create an item title and command array to be placed in a menu --
mouseMenuTitle: MenuData.ItemHandle ← InitMouseMenuTitle [];
mouseMenuCmnds: ARRAY [0..10) OF MenuData.ItemHandle;

-- Create the menu --
mouseMenu: MenuData.MenuHandle ← MenuData.CreateMenu [
   zone: MenuData.PublicZone [],-- could be a client-supplied zone --
   title: mouseMenuTitle,
   array: DESCRIPTOR [@mouseMenuCmnds[0], 1] ];
```

```
CommandProc: MenuData.MenuProc = {
   --does something reasonable for the corresponding item -- };

.
.
.

InitMouseMenuTitle: PROCEDURE RETURNS [MenuData.ItemHandle] = {
   zone: UNCOUNTED ZONE ← MenuData.PublicZone [];
   mouseBitMap: ARRAY [0..15) OF WORD ← [ -- ... octal code -- ];
   mouseSymbolChar: XString.Character ←
      SimpleTextFont.AddClientDefinedCharacter [ -- ... parameters -- ];
   mouseString: XString.ReaderBody ← XString.FromChar [@mouseSymbolChar];
   cmndTitle: XString.ReaderBody ← XString.FromSTRING ["Command"];
   mouseMenuCmnds[0] ← MenuData.CreateItem [zone, @cmndTitle, CommandProc];
   RETURN [MenuData.CreateItem [zone, @mouseString, NIL] ] };
```

The above example is just one technique for initializing a menu. The routine **InitMouseMenuTitle** is used to place variables in the local frame that don't need to be global. Close attention should be paid to placement of variables to prevent dangling references.

31.4 Index of Interface Items

32

MessageWindow

32.1 Overview

MessageWindow provides a facility for posting messages to the user in a window. This is similar to posting messages using the **Attention** interface, but there can be many message windows on the screen at once, while there is only one attention window. A message window is usually a short window with less than 10 lines of text in it. As more messages are posted, previous messages scroll off.

MessageWindow.Create takes a "plain" window, typically obtained by calling **StarWindowShell.CreateBody** or **FormWindow.MakeWindowItem**, and turns it into a message window. Messages may then be posted by calling **Post**. The window can be cleared by calling **Clear**. Various TYPEs may be formatted into messages to be posted in the window by using the **XFormat.Object** returned by **XFormatObject**.

32.2 Interface Items

32.2.1 Create, Destroy, etc.

Create: PROCEDURE [window: Window.Handle,
   zone: UNCOUNTED ZONE ← NIL, lines: CARDINAL ← 10];

Create turns **window** into a message window. **zone** will be used for storage of any strings posted. If **zone** is NIL, a private zone is used. **lines** is the number of lines of text to display. After more than **lines** of text are posted, the oldest lines are scrolled out of the window. Fine Point: The current ViewPoint implementation does not support user scrolling.

Destroy: PROCEDURE [Window.Handle];

Destroy turns the window back into an ordinary window, destroying any **MessageWindow** specific context associated with the window. It does *not* destroy the window.

IsIt: PROCEDURE [Window.Handle] RETURNS [yes: BOOLEAN];

IsIt returns TRUE if the window was made into a message window by a call to **Create**.

32.2.2 Posting messages

```
Post: PROCEDURE [window: Window.Handle,
  r: XString.Reader, clear: BOOLEAN ← TRUE];
```

Post displays r in window. If clear is TRUE, r starts on a new line. If clear is FALSE, r is appended to the last line posted.

```
PostSTRING: PROCEDURE [window: Window.Handle,
  s: LONG STRING, clear: BOOLEAN ← TRUE] = INLINE
    BEGIN
    r: XString.ReaderBody ← XString.FromSTRING [s];
    MessageWindow.Post [window, @r, clear];
    END;
```

PostSTRING posts s in window. If clear is TRUE, r starts on a new line. If clear is FALSE, r is appended to the last line posted.

```
Clear: PROCEDURE [window: Window.Handle];
```

Clear clears the entire window.

```
XFormatObject: PROCEDURE [window: Window.Handle] RETURNS [o: XFormat.Object];
```

XFormatObject returns an XFormat.Object that can be used to post messages in window. The format procedure logically calls Post with clear = FALSE. See examples.

32.3 Usage/Examples

The following example has a client displaying the name and size of a file. It uses the NSFile interface to access the file and get the name and size attributes. See the *Services Programmer's Guide* - 610E00180 - *Filing Programmer's Manual* for documentation on the NSFile interface. The example intermixes use of the format handle and use of the Post procedure.

```
  . . .
  msgW: Window.Handle ← FormWindow.MakeWindowItem [. . .];
  MessageWindow.Create [window: msgW, lines: 5];
  . . .
  PostNameAndSize [file, msgW];
  . . .

PostNameAndSize: PROCEDURE [file: NSFile.Handle, msgW: Window.Handle ] = {
  nameSelections: NSFile.Selections = [interpreted: [name: TRUE]];
  attributes: NSFile.AttributesRecord;
  msgWFormat: XFormat.Object ← MessageWindow.XFormatObject[msgW];
  rb: XString.ReaderBody ← Message[theFile];
  MessageWindow.Post[window: msgW, s: @rb, clear: TRUE]; -- start a new message
  XFormat.NSString[@msgWFormat, attributes.name];
  XFormat.ReaderBody[h: @msgWFormat, rb: Message[contains]];
  XFormat.Decimal[h: @msgWFormat, n: NSFile.GetSizeInBytes[file]];
rb ← Message[bytes];
MessageWindow.Post[window: msgW, s: @rb]}; -- clear defaults to TRUE

Message: PROCEDURE [key: {theFile, contains, bytes}] RETURNS [XString.ReaderBody] = {
  ...};
```

An example of the resulting message displayed in the message window is

```
The file Foo contains 53324 bytes
```

32.4 Index of Interface Items

33

OptionFile

33.1 Overview

OptionFile reads values from profile files (text files) with the following format:

```
[Section]
Entry1: TRUE -- a boolean entry
Entry2: A string value
Entry3: 123 -- an integer entry
```

These files are primarily used for keeping user options across logon and boot sessions (thus the name profile file). Applications will typically read various options out of the current user profile file at logon. These options often specify default values for properties and/or behavior of the application.

33.2 Interface Items

33.2.1 Getting Values from a File

Each **GetXXXValue** procedure takes a **section** name and an **entry** name that identifies the entry. It is expected that the section and entry strings will be obtained from **XMessage**. Each also takes a **file**. If **file** is defaulted, the current user profile is used (see the Current Profiles section below). All these procedures may raise **Error [invalidParameters, inconsistentValue, notFound, syntaxError]**.

```
GetBooleanValue: PROCEDURE [section, entry: XString.Reader,
    file: NSFile.Reference ← NSFile.nullReference]
    RETURNS [value: BOOLEAN];
```

GetBooleanValue returns the value of a boolean entry. The entry must contain either "TRUE" or "FALSE" or the translated string for TRUE or FALSE as defined in the message files.

```
GetIntegerValue: PROCEDURE [section, entry: XString.Reader,
    index: CARDINAL ← 0, file: NSFile.Reference ← NSFile.nullReference]
    RETURNS [value: LONG INTEGER];
```

GetIntegerValue returns the value of an integer entry. The entry must contain a number that can be parsed by **XString.ReaderToNumber**. **index** causes the **index**th entry to be read, for repeating entries.

```
GetStringValue: PROCEDURE [section, entry: XString.Reader,
    callBack: PROCEDURE [value: XString.Reader], index: CARDINAL ← 0,
    file: NSFile.Reference ← NSFile.nullReference];
```

GetStringValue calls **callBack** with the value of a string entry. **index** causes the **index**th entry to be read, for repeating entries.

33.2.2 Current Profiles

ViewPoint supports a current User profile file and a Workstation profile file. The current User profile is automatically changed whenever a user logs on or off. The Workstation profile contains entries specific to the workstation rather than specific to each user. There is one Workstation profile on each workstation.

```
GetUserProfile: PROCEDURE RETURNS [file: NSFile.Reference];
```

GetUserProfile returns the current User profile file. **Note:** Each of the **Get** and **Enumerate** procedures will use this file as the **file** parameter is defaulted.

```
GetWorkstationProfile: PROCEDURE RETURNS [file: NSFile.Reference];
```

GetWorkstationProfile returns the current Workstation profile file.

33.2.3 Enumerating a File

EnumerateXXX are useful for applications that look for the same entry in all sections.

```
EnumerateSections: PROCEDURE [callBack: SectionEnumProc,
    file: NSFile.Reference ← NSFile.nullReference];
```

```
SectionEnumProc: TYPE = PROCEDURE [section: XString.Reader]
    RETURNS [stop: BOOLEAN ← FALSE];
```

EnumerateSections will call **callBack** for each **section** in **file**, until **stop** = TRUE. If **file** is defaulted, the current user profile is used.

```
EnumerateEntries: PROCEDURE [section: XString.Reader, callBack: EntryEnumProc,
    file: NSFile.Reference ← NSFile.nullReference];
```

```
EntryEnumProc: TYPE = PROCEDURE [entry: XString.Reader]
    RETURNS [stop: BOOLEAN ← FALSE];
```

EnumerateEntries will call **callBack** for each **entry** in **section** in **file**, until **stop** = TRUE. If **file** is defaulted, the current user profile is used.

33.2.4 Errors

```
Error: ERROR [code: ErrorCode];

ErrorCode: TYPE = {invalidParameters, inconsistentValue, notFound, syntaxError};
```

invalidParameters	such as passing in a NIL string.
inconsistentValue	calling **GetBooleanValue** for an entry that does not have TRUE or FALSE as its value, or calling **GetIntegerValue** for an entry that will not parse as number.
notFound	asking for an entry that is not in the file.
invalidFile	reading from a file that is not a profile file.
syntaxError	garbage in the file.

```
NotAProfileFile: SIGNAL;
```

The passed file is not a profile file; that is it has the wrong file type. RESUMEing will read the file anyway.

33.3 Usage/Examples

```
-- In global frame
displayMessage: BOOLEAN ← TRUE;
whereToDisplay: SampleBWSApplicationOps.WhereToDisplay ← window;
messageToDisplay: XString.Reader ← NIL;

-- Called from initialization code
GetOptionsAtLogon: PROCEDURE = {
    logon: Atom.ATOM ← Atom.MakeAtom["Logon"L];
    desktopRef: NSFile.Reference;
    [] ← Event.AddDependency [agent: LogonEvent, myData: NIL, event: logon];
    IF (desktopRef ← StarDesktop.GetCurrentDesktopFile []) # NSFile.nullReference THEN {
        -- If the desktop is NOT null, then a user's already logged on,
        --i.e., we got loaded after logon.
        -- So we go read the options immediately by calling our
        --Event.AgentProcedure directly. --
        desktop: NSFile.Handle ← NSFile.OpenByReference [desktopRef];
        [] ← LogonEvent [event: logon, eventData: LOOPHOLE [desktop], myData: NIL];
        NSFile.Close [desktop];
        };
    };

LogonEvent: Event.AgentProcedure = {
    <<[event: Event.EventType, eventData: LONG POINTER,
    myData: LONG POINTER]
    RETURNS [remove: BOOLEAN ← FALSE, veto: BOOLEAN ← FALSE]>>
    OPEN Ops: SampleBWSApplicationOps;
    mh: XMessage.Handle = Ops.GetMessageHandle[];
CopyMessageToDisplay: PROCEDURE [value: XString.Reader] = {
    messageToDisplay ← XString.CopyReader [value, sysZ]};

GetWhereToDisplay: PROCEDURE [value: XString.Reader] = {
    window: XString.ReaderBody ← XMessage.Get [mh, Ops.kwindow];
    attention: XString.ReaderBody ← XMessage.Get [mh, Ops.kattention];
    both: XString.ReaderBody ← XMessage.Get [mh, Ops.kboth];
    whereToDisplay ← SELECT TRUE FROM
        XString.Equivalent [value, @window] = > window,
        XString.Equivalent [value, @attention] = > attention,
        XString.Equivalent [value, @both] = > both,
        ENDCASE = > window;
    };

section: XString.ReaderBody ← XMessage.Get [mh, Ops.kApplicationName];

entry: XString.ReaderBody ← XMessage.Get [mh, Ops.kDisplayMessage];
displayMessage ← OptionFile.GetBooleanValue [@section, @entry !
    OptionFile.Error = > CONTINUE];

entry ← XMessage.Get [mh, Ops.kMessageToDisplay];
OptionFile.GetStringValue [@section, @entry, CopyMessageToDisplay !
    OptionFile.Error = > CONTINUE];

entry ← XMessage.Get [mh, Ops.kWhereToDisplay];
OptionFile.GetStringValue [@section, @entry, GetWhereToDisplay !
    OptionFile.Error = > CONTINUE];
};
```

33.4 Index of Interface Items

34

PopupMenu

34.1 Overview

The **PopupMenu** interface provides a single procedure that posts a popup menu.

34.2 Interface Items

```
Popup: PROCEDURE [
  menu: MenuData.MenuHandle,
  clients:Window.Handle,
  showTitle: BOOLEAN ← TRUE,
  place: Window.Place ← [-1,-1] ];
```

This procedure causes the display of the client's **menu** at or near the indicated **place** in the **rootWindow**; if the **place** [-1,-1] is given, the current cursor position is used. If the point button goes up while the cursor is over one of the menu items, then that item's **MenuData.MenuProc** is called. **clients** will be passed to the **MenuData.MenuProc** as the **window** parameter. The **showTitle** field indicates whether the menu's title should be displayed above its command-strings.

The implementation assumes that the "point" button is down; consequently, the menu is displayed until the "point" button goes up **Popup** does *not* return until the menu is taken down, regardless of whether a menu item is selected or not.

34.3 Usage/Examples

Much of the complication in using the **PopupMenu** interface stems from its reliance on **MenuData**. A thorough understanding of how to create a menu is needed before using this interface (see the **MenuData** chapter for details).

34.3.1 Example

```
-- Create the menu:
myMenu: MenuData.MenuHandle ← MenuData.CreateMenu [
   -- ...-- pass in miscellaneous parameters; see the MenuData interface for details --
];

PopupMenu.Popup[
   menu: myMenu,
   clients: currentWindow];
   -- showTitle and place are defaulted in this call.
```

34.4 Index of Interface Items

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ProductFactoring

35.1 Overview

ProductFactoring allows an application to determine whether the customer has purchased the application for the workstation the application is running on. **ProductFactoring** maintains a record of the applications that have been purchased (enabled) on the workstation's disk. Tools are provided to customers for enabling various applications (options). The enabling of an application is outside the scope of this interface.

ProductFactoring also allows an application to register a name for its product option, thus allowing the product factoring tools to display meaningful names to the user of the tools.

35.2 Interface Items

35.2.1 Products and ProductOptions

Product: TYPE = CARDINAL [0..16);

A **Product** refers to a large set of software, (also see the **ProductFactoringProducts** interface.)

ProductOption: TYPE = CARDINAL [0..28);

A **ProductOption** refers to a particular piece of software that a customer can buy within a **Product**, such as Spreadsheets, Advanced Star Graphics, or Print Service. To obtain a ProductOption for a particular application, see your Xerox Sales Represenative.

Option: TYPE = RECORD [product: Product, productOption: ProductOption];

nullOption: Option = . . . ;

An **Option** uniquely identifies a **ProductOption** within a **Product**.

35.2.2 Checking for an Enable Option

Enabled: PROCEDURE [option: Option] RETURNS [enabled: BOOLEAN];

Enabled returns TRUE if **option** is enabled on this workstation, otherwise FALSE. Typically, an application will call **Enabled** every time it is called to perform some user operation such as opening an icon. **Enabled** is fast; it does not read the file every time it is called. It may raise **Error[notStarted]** if there is no product factoring file on the workstation.

35.2.3 Describing an Product and an Option

```
DescribeProduct: PROCEDURE [product: Product, desc: XString.Reader];
```

Provides a name for **product**. **desc** will be copied to an internal zone. May raise **Error[illegalProduct]** if the value of product is out of range.

```
DescribeOption: PROCEDURE [option: Option, desc: XString.Reader,
  prerequisite: Prerequisite ← nullPrerequisite];

Prerequisite: TYPE = RECORD [
    prerequisiteSpec: BOOLEAN ←FALSE,
    option: Option];

nullPrerequisite: Prerequisite = [FALSE, nullOption];
```

Describes **option**. **desc** is a name for the option. **prerequisite** specifies any other options that this option depends on. All data will be copied to an internal zone. Use of this procedure overrides any earlier definition with the same **option** value. May raise **Error[illegalProduct]** if the value of **option.product** is out of range. May raise **Error[illegalOption]** if the value of **option.productOption** is out of range. May raise **Error[missingProduct]** if **option.product** has not yet been defined.

35.2.4 Errors

```
Error: ERROR [type: ErrorType];

ErrorType: TYPE = {
    dataNotFound, notStarted, illegalProduct, illegalOption,
    missingProduct, missingOption};
```

dataNotFound	The term **dataNotFound** means the product data file is missing.
notStarted	The term **notStarted** means **Start proc** has not been called yet.
illegalProduct	The term **illegalProduct** means not a legal **Product** value.
illegalOption	The term **illegalOption** means not a legal **ProductOption** value.
missingProduct	The term **missingProduct** means the **Product** specified has not yet been defined.
missingOption	The term **missingOption** means the **ProductOption** specified has not yet been defined.

35.3 Usage/Examples

```
-- In global frame --
sampleApplicationPFOption: ProductFactoring.ProductOption = 27;
    -- 27 was chosen arbitrarily for this sample. --
    -- A real application should obtain a real ProductOption! --

-- Called during initialization --
InitProductFactoring: PROCEDURE = {
    mh: XMessage.Handle = SampleBWSApplicationOps.GetMessageHandle[];
    rb: XString.ReaderBody ← XMessage.Get [mh,
        SampleBWSApplicationOps.kApplicationName];
    ProductFactoring.DescribeOption [
        option: [ product: ProductFactoringProducts.Star,
            productOption: sampleApplicationPFOption],
        desc: @rb];
    };

-- GenericProc --
GenericProc: Containee.GenericProc = {
    IF ~ProductFactoring.Enabled [option: [
            product: ProductFactoringProducts.Star,
            productOption: sampleApplicationPFOption]] THEN {
        mh: XMessage.Handle ← SampleBWSApplicationOps.GetMessageHandle[];
        rb: XString.ReaderBody ← XMessage.Get [mh, SampleBWSApplicationOps.kNotEnabled];
        ERROR Containee.Error [@rb];
        };
    SELECT atom FROM
    . . .
    };
```

35.4 Index of Interface Items

36

ProductFactoringProducts

36.1 Overview

ProductFactoringProdcuts defines the **ProductFactoring.Products** for various Xerox products, (see the **ProductFactoring** interface.)

36.2 Interface Items

Product: TYPE = ProductFactoring.Product;

Star: Product = 0;

Star defines the Xerox Star workstation product.

Services: Product = 1;

Services defines the Xerox network services product.

Fonts: Product = 2;

Fonts defines the product for Xerox printer fonts. Fine Point: In ViewPoint, this is in **ProductFactoringProdcutsExtras.**

Spinnaker: Product = 3;

Spinnaker defines the Xerox Spinnaker product. Fine Point: In ViewPoint, this is in **ProductFactoringProdcutsExtras.**

36.3 Index of Interface Items

Item	Page
Product: TYPE	1
Fonts: Product	1
Services: Product	1
Spinnaker: Product	1
Star: Product	1

37 PropertySheet

37.1 Overview

The **PropertySheet** interface allows clients to create property sheets. A property sheet shows the user the properties of an object and allows the user to change these properties. Several different types of properties are supported. The most common ones are boolean, choice (enumerated), and text. (See Figure 37.1.)

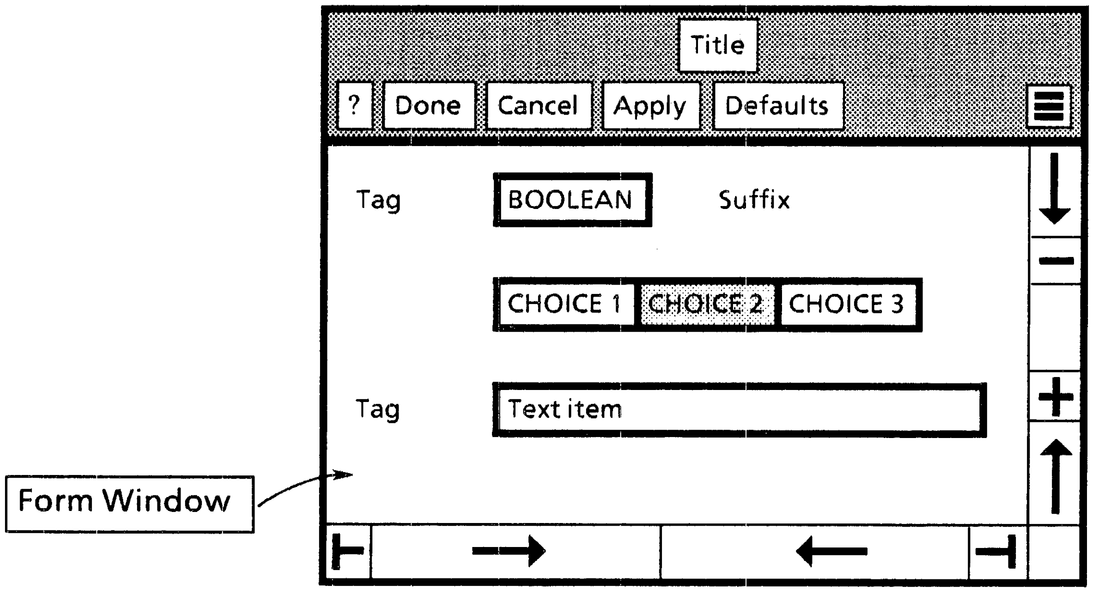

Figure 37.1. A Property Sheet

From a client's point of view, a property sheet is a Star window shell with a form window as a body window. See the **StarWindowShell** and **FormWindow** interfaces. The **FormWindow** interface especially must be understood in order to create a property sheet.

A property sheet is created by calling **PropertySheet.Create**, providing a procedure that will make the form items in the form window (a **FormWindow.MakeItemsProc**), a list of commands to put in the header of the property sheet, such as *Done*, *Cancel*, and *Apply* (**PropertySheet.MenuItems**), and a procedure to call when the user selects one of these commands (a **PropertySheet.MenuItemProc**). **PropertySheet.Create** returns the

StarWindowShell.Handle for the property sheet. When the user selects one of the commands in the header of the property sheet, the client's **PropertySheet.MenuItemProc** is called. If the user selected *Done* , for example, the client can then verify and apply any changes the user made to the object's properties.

PropertySheet also provides the capability to create linked property sheets. Several property sheets may be logically linked together in the same property sheet shell. This is accomplished by changing form windows within a property sheet's Star window shell, and having an additional choice item that specifies which form window is currently displyed. Linked property sheets are further described in the section on Linked Property Sheets below.

37.2 Interface Items

37.2.1 Create a PropertySheet (Not a Linked One)

```
Create: PROCEDURE [
   formWindowItems: FormWindow.MakeItemsProc,
   menuItemProc: MenuItemProc,
   size: Window.Dims,
   menuItems: MenuItems ← propertySheetDefaultMenu,
   title: XString.Reader ← NIL,
   placeToDisplay: Window.Place ← nullPlace,
   formWindowItemsLayout:FormWindow.LayoutProc ← NIL,
   windowAttachedTo: StarWindowShell.Handle ← [NIL],
   globalChangeProc: FormWindow.GlobalChangeProc ← NIL,
   display: BOOLEAN ← TRUE,
   clientData: LONG POINTER ← NIL,
   afterTakenDown: MenuItemProc ← NIL,
   zone: UNCOUNTED ZONE ← NIL]
   RETURNS [shell: StarWindowShell.Handle];
```

Create creates a property sheet.

formWindowItems is a client-supplied procedure that is passed a body window of the property sheet. It should fill the window with the form items that make up the main body of the property sheet. (See the **FormWindow** interface for a full description of how to create form items in a window.)

menuItemProc is a client-supplied procedure that is called whenever the user selects one of the menu items in the header of the property sheet window. (See §37.2.2 below.)

size is the preferred size of the property sheet star window shell.

menuItems specifies the menu items that are displayed in the header of the property sheet. The default is *? (help)*, *Done*, and *Cancel.*

title is the title to be displayed in the header of the property sheet.

placeToDisplay is the preferred location on the screen of the property sheet. If the default is taken, **Create** will calculate the place to display.

formWindowItemsLayout specifies the desired position of the form items in the **FormWindow**. (See **FormWindow.LayoutProc** for a full description.). If

formWindowItemsLayout is NIL, then FormWindow.DefaultLayout of one item per line is used

windowAttachedTo is the **StarWindowShell** that this property sheet is showing properties for. If **windowAttachedTo** is not NIL, then the user will not be able to close **windowAttachedTo** until this property sheet is closed. (See also StarWindowShell.Create.host.)

globalChangeProc is called if any item in the property sheet is changed. (See FormWindow.GlobalChangeProc for a full description).

display indicates whether the property sheet should actually be displayed on the screen (inserted into the visible window tree) or just created but not actually painted on the screen (not inserted into the visible window tree). If this is a property sheet for a file (i.e., if it is being created as the result of a call to a Containee.GenericProc [atom: Props]), then **display** should be FALSE and the StarWindowShell.Handle should be returned from the **GenericProc** so that, for example, the desktop implementation can put the property sheet on the display by calling StarWindowShell.Push.

clientData will be passed to **formWindowItems**, **formWindowItemsLayout**, and **menuItemProc**. Fine Point: **formWindowItems** will not be called after **Create** returns and therefore may be nested.

The **afterTakenDown** is called after the property sheet has been removed from the screen. The return parameter of the **MenuItemProc** is ignored in this case. **Note:** Clients must still provide a regular **MenuItemProc**.

Clients may pass in a **zone** to be used instead of the default zone created by the **StarWindowShell** implementation.

shell is the property sheet.

```
nullPlace: Window.Place;
```

nullPlace defines the default for placement of a property sheet. If the default is used, the property sheet is placed at an appropriate place on the screen.

37.2.2 Menu Items and the MenuItemProc

```
MenuItemType: TYPE = {done, apply, cancel, defaults, start, reset};

MenuItems: TYPE = PACKED ARRAY MenuItemType OF BooleanFalseDefault;

BooleanFalseDefault: TYPE = BOOLEAN ← FALSE;

propertySheetDefaultMenu: MenuItems = [done: TRUE, apply: TRUE, cancel: TRUE];

optionSheetDefaultMenu: MenuItems = [start: TRUE, cancel: TRUE];
```

The client specifies a set of commands to be placed in the header of the property sheet. **MenuItemType** specifies all of the possible commands. **MenuItems** specifies a set of these commands and is passed to PropertySheet.Create. **propertySheetDefaultMenu** and **optionSheetDefaultMenu** specify two common sets of commands.

```
MenuItemProc: TYPE = PROCEDURE [
  shell: StarWindowShell.Handle,
    formWindow: Window.Handle,
    menuItem: MenuItemType]
    RETURNS [ok: BOOLEAN ← FALSE];
```

The client supplies a **MenuItemProc** when a property sheet is created. It is called whenever the user selects one of the menu items in the header of the property sheet. **formWindow** is the main form window of the property sheet. **menuItem** is the type of menu item that the user selected. The client typically (when the user selects *Done* or *Apply*) retrieves the values of the items that the user edited (using **FormWindow.HasChanged** and **FormWindow.GetXXXItemValue** procedures), verifies that the values are meaningful (for example, numbers that are within proper range), and applies the new values to the properties of the object this property sheet represents.

The return parameter **ok** has slightly different meanings in the following two cases:

1. For an ordinary property sheet (not a linked property sheet), the **MenuItemProc** is called when the user selects a command and the return parameter indicates whether the property sheet should be destroyed.
2. For a linked property sheet, the **MenuItemProc** is called both when the user selects a command in the header (in which the case above applies) and when the client calls **SwapExistingFormWindows** or **SwapFormWindows** with **apply = TRUE**. In this case the **MenuItemProc** is called to allow the client to apply any changes made to the form window sheet being linked from. The **menuItem** parameter will be "done"; the return parameter indicates whether to allow the swap to actually occur. **ok = FALSE** indicates that there is something invalid in the form window and the client does not want the swap to occur (the client typically posts a message before returning). If **ok = TRUE**, the swap occurs.

Note: The client need not worry about these cases when writing the **MenuItemProc**, but can simply write the "done" code as usual. If the user selects *Done* and the **MenuItemProc** returns **ok = TRUE**, the property sheet is destroyed. If the user links to another sheet on a linked property sheet and the **MenuItemProc** returns **ok = TRUE**, the sheets are swapped, rather than the whole property sheet being destroyed.

37.2.3 Linked PropertySheets

Several property sheets may be logically linked together in the same property sheet. This is accomplished by changing form windows within a property sheet's Star window shell, and having an additional choice item that specifies which form window is currently displayed. See Figure 37.2 below.

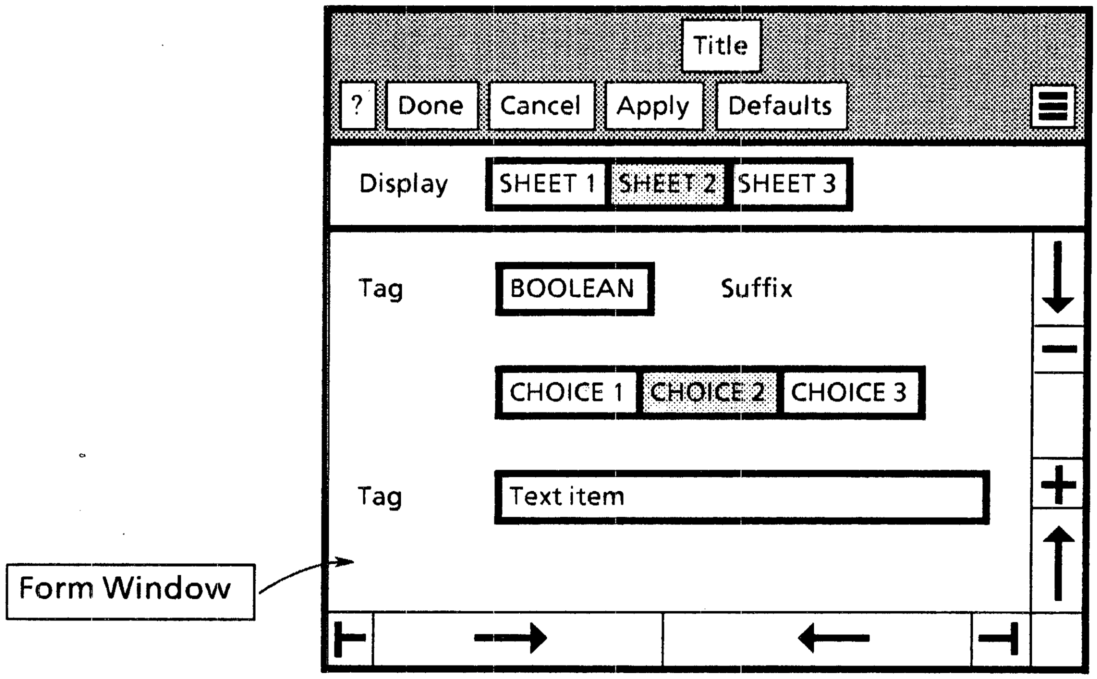

Figure 37.2 A Linked Property Sheet

This additional choice item actually resides in an additional form window, called a *link window*. This link window is another body window of the Star window shll. The link window remains visible all the time, while the main form window may be swapped. The client does this by supplying a **FormWindow.ChoiceChangeProc** for the single choice item in the link window. Then when the user selects a new choice for that item, the client (in the **ChoiceChangeProc**) calls **SwapFormWindows** or **SwapExistingFormWindows** to change the main form window. **Note:** *Only one* main form window is installed in the Star window shell at a time. A linked property sheet is created by calling **CreateLinked**:

```
CreateLinked: PROCEDURE [
  formWindowItems: FormWindow.MakeItemsProc,
  menuItemProc: MenuItemProc,
  size: Window.Dims,
  menuItems: MenuItems ← propertySheetDefaultMenu,
  title: XString.Reader ← NIL,
  placeToDisplay: Window.Place ← nullPlace,
  formWindowItemsLayout:FormWindow.LayoutProc ← NIL,
  windowAttachedTo: StarWindowShell.Handle ← [NIL],
  globalChangeProc: FormWindow.GlobalChangeProc ← NIL,
  display: BOOLEAN ← TRUE,
  linkWindowItems: FormWindow.MakeItemsProc,
  linkWindowItemsLayout:FormWindow.LayoutProc ← NIL,
  clientData: LONG POINTER ← NIL,
  afterTakenDownProc: MenuItemProc ← NIL,
  zone: UNCOUNTED ZONE ← NIL]
  RETURNS [shell: StarWindowShell.Handle];
```

CreateLinked creates a linked property sheet. Creating a linked property sheet is almost identical to creating an ordinary property sheet, (see **Create** above for a full description of all the parameters), except **CreateLinked** has the additional parameters **linkWindowItems** and **linkWindowItemsLayout**. **linkWindowItems** is called to make the choice item in the link window. It should create a single choice item with a **FormWindow.ChoiceChangeProc**. **linkWindowItemsLayout** is called to specify the position of the choice item in the link window. The default places the item appropriately in the link window, so most clients will want to take the default for **linkWindowItemsLayout**. **Note: formWindowItems** and **formWindowItemsLayout** specify the main form window that is *initially* visible in the property sheet.

```
SwapFormWindows: PROCEDURE [
   shell: StarWindowShell.Handle,
   newFormWindowItems: FormWindow.MakeItemsProc,
   newFormWindowItemsLayout:FormWindow.LayoutProc ← NIL,
   apply: BOOLEAN ← TRUE,
   destroyOld: BOOLEAN ← TRUE,
   newMenuItemProc: MenuItemProc ← NIL,
   newMenuItems: MenuItems ← ALL[FALSE],
   newTitle: XString.Reader ← NIL,
   newGlobalChangeProc: FormWindow.GlobalChangeProc ← NIL,
   newAfterTakenDownProc: MenuItemProc ← NIL]
   RETURNS [old: Window.Handle];
```

SwapFormWindows swaps the main form window of a property sheet with a new one. This will usually be called from the **FormWindow.ChoiceChangeProc** of the choice item in the link window. May raise **Error [notAPropSheet]**.

shell is the property sheet.

newFormWindowItems supplies the items for the new window.

newFormWindowItemsLayout specifies the layout for the items in the new form window.

apply specifies whether any changes to the current form window should be applied before the swap. If **apply = TRUE**, the current **MenuItemProc** for shell is called with **menuItem = apply**. If **apply = FALSE**, the **MenuItemProc** is not called.

The **destroyOld** parameter indicates whether the old form window should be destroyed or not. If **destroyOld = FALSE**, then the return parameter is the old form window, else the return parameter is **NIL**. This allows clients to perform the following typical sequence of events:

1. Create a linked property sheet using **CreateLinked**.
2. The first time the user links to another sheet, call **SwapFormWindows** with **destroyOld = FALSE** and save the old form window.
3. When the user goes back to the first sheet, call **SwapExistingFormWindows**, supplying the previously saved old form window, and thus avoiding having to create the first form window again.

newMenuItemProc allows the client to install a different **MenuItemProc** than the one that was supplied with **CreateLinked**.

newAfterTakenDownProc allows the client to install a different takedown **MenuItemProc** than the one that was supplied with **CreateLinked**.

newMenuItems, **newTitle**, and **newGlobalChangeProc** allow the client to change these as well.

If the default **newMenuItemProc**, **newMenuItems**, **newTitle**, or **newGlobalChangeProc** is taken, the current values are retained.

```
SwapExistingFormWindows: PROCEDURE [
   shell: StarWindowShell.Handle,
   new: Window.Handle,
   apply: BOOLEAN ← TRUE,
   newMenuItemProc: MenuItemProc ← NIL,
   newMenuItems: MenuItems ← ALL[FALSE],
   newTitle: XString.Reader ← NIL,
   newAfterTakenDownProc: MenuItemProc ← NIL]
   RETURNS [old: Window.Handle];
```

SwapExistingFormWindows swaps the main form window of a property sheet with a new one. The new form window must already exist. If it does not, use **SwapFormWindow**. **new** is the new form window. **apply**, **newMenuItemProc**, **newMenuItems**, and **newTitle** are the same as in **SwapFormWindow**. **old** is the previous main form window. May raise **Error [notAPropSheet]**.

37.2.4 Miscellaneous

```
GetFormWindows: PROCEDURE [shell: StarWindowShell.Handle]
   RETURNS [form, link: Window.Handle];
```

GetFormWindows returns the current form windows of **shell**. If **shell** is not a linked property sheet, **link** is NIL. May raise **Error [notAPropSheet]**.

```
InstallFormWindow: PROCEDURE [
   shell: StarWindowShell.Handle,
   menuItemProc: MenuItemProc,
   menuItems: MenuItems ← propertySheetDefaultMenu,
   title: XString.Reader ← NIL,
   formWindow: Window.Handle,
   afterTakenDownProc: MenuItemProc ← NIL];
```

InstallFormWindow installs **formWindow** in **shell**. May raise **Error [notAPropSheet]**.

37.2.5 Signals and Errors

```
Error: ERROR [code: ErrorCode];
```

```
ErrorCode: TYPE = {notAPropSheet};
```

Error [notAPropSheet] is raised if a **StarWindowShell.Handle** that is not a property sheet is passed to a **PropertySheet** procedure .

37.3 Usage/Examples

37.3.1 Flow Description of Creating a Property Sheet

The following describes the sequence of calls involved in creating and taking down a property sheet, including ViewPoint interfaces and clients.

1. Client calls PropertySheet.Create, supplying a FormWindow.MakeItemsProc, a FormWindow.LayoutProc (optional), and a PropertySheet.MenuItemProc.

2. PropertySheet.Create creates a Star window shell and a body window inside the StarWindowShell. It then calls FormWindow.Create, passing in the body window.

3. FormWindow.Create calls the client's FormWindow.MakeItemsProc.

4. The client's FormWindow.MakeItemsProc creates the items in the property sheet by calling various FormWindow.MakeXXXItem procedures.

5. FormWindow.Create calls the client's FormWindow.LayoutProc. If the client did not provide one, a default LayoutProc provided by FormWindow is called.

6. The FormWindow.LayoutProc makes calls to FormWindow.AppendLine and FormWindow.AppendItem to specify the layout of the items created by the FormWindow.MakeItemsProc.

7. FormWindow.Create returns to PropertySheet.Create. PropertySheet.Create returns to the client. The client returns to the notifier process.

8. The property sheet is now on the screen and the notifier process is waiting for the user.

9. The user changes some values in the property sheet. This is all managed by FormWindow; the client gets called only if there is a FormWindow.BooleanChangeProc or FormWindow.ChoiceChangeProc or FormWindow.GlobalChangeProc.

10. The user selects *Done* in the header of the property sheet.

11. A procedure inside of PropertySheet is called. PropertySheet calls the client's PropertySheet.MenuItemProc.

12. The client's PropertySheet.MenuItemProc checks for any changed values (FormWindow.HasBeenChanged and FormWindow.HasAnyBeenChanged) and calls the appropriate FormWindow.GetXXXItemValue to obtain the new values. The client validates and applies these new values, then returns an indication of whether the property sheet should be taken down.

13. PropertySheet takes down the property sheet and returns to the notifier.

14. END.

37.3.2 An Ordinary Property Sheet

This example creates a property sheet from some arbitrary properties and then applies the user's changes to those properties. It uses a rather contrived set of properties described by **Properties** and **PropertiesObject**. In general, a real property sheet would get its properties from some real object. This example will produce the property sheet shown in Figure 37.1.

```
-- PropertySheetExample.mesa

DIRECTORY
  FormWindow USING [
    ChoiceItem, GetBooleanItemValue, GetChoiceItemValue, GetTextItemValue,
    HasAnyBeenChanged, HasBeenChanged, ItemKey, MakeBooleanItem,
    MakeChoiceItem, MakeItemsProc, MakeTextItem, SetBooleanItemValue,
    SetChoiceItemValue, SetTextItemValue],
  PropertySheet USING [Create, MenuItemProc],
  StarWindowShell USING [Handle],
  XString USING [FreeReaderBytes, FromSTRING, ReaderBody],
  Window USING [Handle];

PropertySheetExample: PROGRAM IMPORTS FormWindow, PropertySheet, XString = {

Properties: TYPE = LONG POINTER TO PropertiesObject;

PropertiesObject: TYPE = RECORD [
  boolean: BOOLEAN,
  choice: Choices,
  text: XString.ReaderBody];

Items: TYPE = {boolean, choice, text};

Choices: TYPE = {choice1, choice2, choice3};

zone: UNCOUNTED ZONE ← . . . ;

MakePropertySheet: PROCEDURE [props: Properties]
  RETURNS [shell: StarWindowShell.Handle] = {
  title: XString.ReaderBody ← XString.FromSTRING ["Title"L];

  shell ← PropertySheet.Create [
    formWindowItems: MakeItems,
    menuItemProc: MenuItemProc,
    menuItems: [help: TRUE, done: TRUE, cancel: TRUE,
      apply: TRUE, defaults: TRUE],
    size: [w: 300, h: 200],
    title: @title,
    clientData: props];
  };
```

```
MakeItems: FormWindow.MakeItemsProc = {
  props: Properties ← clientData;
  tag: XString.ReaderBody ← XString.FromSTRING["Tag"L];

  BEGIN
  label: XString.ReaderBody ← XString.FromSTRING["BOOLEAN"L];
  suffix: XString.ReaderBody ← XString.FromSTRING["suffix"L];
  FormWindow.MakeBooleanItem [
    window: window,
    myKey: Items.boolean.ORD,
    tag: @tag,
    suffix: @suffix,
    label: [string [label] ],
    initBoolean: props.boolean ];
  END;

  BEGIN
  c1: XString.ReaderBody ← XString.FromSTRING["CHOICE 1"L];
  c2: XString.ReaderBody ← XString.FromSTRING["CHOICE 2"L];
  c3: XString.ReaderBody ← XString.FromSTRING["CHOICE 3"L];
  choices: ARRAY [0..3) OF FormWindow.ChoiceItem ← [
    [string[Choices.choice1.ORD, c1] ],
    [string[Choices.choice2.ORD, c2] ],
    [string[Choices.choice3.ORD, c3] ] ];
  FormWindow.MakeChoiceItem [
    window: window,
    myKey: Items.choice.ORD,
    values: DESCRIPTOR[choices],
    initChoice: props.choice.ORD ];
  END;

  FormWindow.MakeTextItem [
    window: window,
    myKey: Items.text.ORD,
    tag: @tag,
    width: 40,
    initString: @props.text ];

};

MenuItemProc: PropertySheet.MenuItemProc = {
  props: Properties ← clientData;
  SELECT menuItem FROM
    help = > . . . ;
    done = > RETURN[destroy: ApplyAnyChanges[formWindow, props].ok];
    cancel = > RETURN[destroy: TRUE];
    apply = > [] ← ApplyAnyChanges[formWindow, props];
    defaults = > SetDefaults[formWindow, props];
    ENDCASE = > ERROR;
  RETURN[destroy: FALSE];
  };
```

```
ApplyAnyChanges: PROC [window: Window.Handle, props: Properties]
  RETURNS [ok: BOOLEAN] = BEGIN
  IF ~FormWindow.HasAnyBeenChanged [window] THEN RETURN [ok: TRUE];
  FOR eachItem: Items IN Items DO
    itemKey: FormWindow.ItemKey = eachItem.ORD;
    IF ~FormWindow.HasBeenChanged [window, itemKey] THEN LOOP;
    SELECT eachItem FROM
      boolean = > props.boolean ← FormWindow.GetBooleanItemValue[window, itemKey];
      choice = > props.choice ← VAL[ FormWindow.GetChoiceItemValue[window, itemKey] ];
      text = > {
         XString.FreeReaderBytes [r: @props.text, z: zone];
         props.text ← FormWindow.GetTextItemValue [window, itemKey, zone]};
      ENDCASE;
    ENDLOOP;
  RETURN [ok: TRUE];
  END;-- ApplyAnyChanges

SetDefaults: PROC [window: Window.Handle, props: Properties] =
  BEGIN
  defaultText: XString.ReaderBody ← XString.FromSTRING["Text item"L];
  FormWindow.SetBooleanItemValue [
    window: window,
    item: Items.boolean.ORD,
    newValue: FALSE ];
  FormWindow.SetChoiceItemValue [
    window: window,
    item: Items.choice.ORD,
    newValue: Choices.choice2.ORD ];
  FormWindow.SetTextItemValue [
    window: window,
    item: Items.text.ORD,
    newValue: @defaultText];
  END;

}...
```

37.4 Index of Interface Items

38

Prototype

38.1 Overview

Prototype manipulates prototype files. A prototype file is a blank copy of an application's file that the user can copy. Prototype files are in the Directory icon under "Blank Documents, Folders, etc."

A prototype file resides in the prototype catalog (see the **Catalog** interface) and is uniquely identified by it is file type, subtype, and version. Subtype is used to distinguish between objects of the same file type, such as the blank document and the basic graphics transfer document. Subtype is stored in an extended attribute on the prototype file. A nonexistent subtype is equivalent to subtype 0.

Version is stored in the BWS-standard version extended attribute (see **BWSAttributeTypes**). The intent is that clients need only examine the version to determine if the prototype is current. A nonexistent version attribute is equivalent to version 0.

Prototype provides **Find** and **Create** procedures. A client will typically call **Find** and if it returns **NSFile.nullReference**, then call **Create**.

38.2 Interface Items

```
Version: TYPE = CARDINAL;
```

```
Subtype: TYPE = CARDINAL;
```

```
Find: PROCEDURE [type: NSFile.Type, version: Version,
    subtype: Subtype ← 0, session: NSFile.Session ← NSFile.nullSession]
    RETURNS [reference: NSFile.Reference];
```

Find returns a reference for the file with the specified **type**, **version**, and **subtype**. If the file does not exist, **NSFile.nullReference** is returned.

```
Create: PROCEDURE [
    name: XString.Reader,
    type: NSFile.Type,
    version: Version,
    subtype: Subtype ← 0,
    size: LONG CARDINAL ← 0,
    isDirectory: BOOLEAN ← FALSE,
    session: NSFile.Session ← NSFile.nullSession]
    RETURNS [prototype: NSFile.Handle];
```

Creates a file in the prototype catalog with the specified **name**, **type**, **version**, **subtype**, **size** in bytes, and **isDirectory** attribute.

```
Add: PROCEDURE [file: NSFile.Handle, version: Version,
    subtype: Subtype ← 0, session: NSFile.Session ← NSFile.nullSession];
```

Moves an already existing **file** into the prototype catalog, assigning it the given **version** and **subtype**. Fine Point: This is in **PrototypeExtra** in ViewPoint.

```
PurgeOldVersions: PROCEDURE [type: NSFile.Type, current: Version, subtype: Subtype ← 0];
```

Deletes any versions of the given prototype that are older (smaller number) than **current**. **PurgeOldVersions** assumes that higher version numbers are more recent than lower version numbers. If this is not true for your version numbers, do not call this operation .

38.3 Usage/Examples

This is an example of a procedure that an application would probably call at initialization time.

```
sampleIconFileType: NSFile.Type = ... ;

version: CARDINAL = ... ;

FindOrCreateIconFile: PROCEDURE = {
    name: XString.ReaderBody ← XString.FromSTRING["Sample Icon"L];
    -- This name should really come from XMessage.
    IF (Prototype.Find [
        type: sampleIconFileType, version: version] = NSFile.nullReference) THEN
        NSFile.Close [Prototype.Create [
            name: @name, type: sampleIconFileType, version: version] ];
    };
```

38.4 Index of Interface Items

39 Selection

39.1 Overview

The **Selection** interface defines the abstraction that is the user's current selection. It provides a procedural interface to the abstraction that allows it to be set, saved, cleared, and so forth. It also provides procedures that enable someone other than the originator of the selection to request information relating to the selection and to negotiate for a copy of the selection in a particular format.

39.1.1 Requestors and Managers

The **Selection** interface is used by two different classes of clients. Most clients wish merely to obtain the *value* of the current selection in some particular format; such clients are called *requestors*. These programs call **Convert** (or **ConvertNumber**, which in turn calls **Convert**), **Query**, or **Enumerate**. These clients need not be concerned with many of the details of the **Selection** interface.

The other class of clients consists of those who wish to own or set the current selection; these clients are called *managers*. A manager calls **Selection.Set** and provides procedures that may be called to convert the selection or to perform various actions on it. The manager remains in control of the current selection until some other program calls **Selection.Set**. These clients *do* need to understand most of the details of the **Selection** interface.

The goal of the **Selection** interface is that the requestor need never know, and should never care, what module is managing the selection. All that matters is whether the selection can be rendered in a suitable form. For example, suppose the user presses COPY and selects a printer icon as the destination. The printer implementation needn't know what is printable and what isn't. It simply queries the selection to determine whether it can be rendered as an Interpress master, and if so it obtains it and sends it. Otherwise, it queries whether the selection can be enumerated as a sequence of Interpress masters (as would be true of a folder, for instance). If this also fails, the object is rejected.

The selection is the expression of the user indicating the datum to be operated on. As such, it is conceptually owned by the user. The selection manager is a slave following the user's instructions.

To maintain this user interface model, the selection must only be changed at the explicit direction of the user. Software must allow the user to change the selection at will. To implement this user model, the selection is only changed from within the *user process* or *notifier*. The notifier is the system process that passes the user's actions, encoded as **TIP** results, to application software.

Software that wishes to read the selection must deal with the fact that the selection may be changed at any time that the notifier process is running. The way to synchronize with this potentially asynchronous activity is to only read the selection in the notifier process. This guarantees that the selection will not be altered while it is being read. Application software running in the notifier process can be assured that the selection will not change until after the application returns to the system. Thus the first rule for dealing with the selection is:

The selection may only be read or changed in the notifier process.

Once an application returns to the notifier, any knowledge it retains about the selection may be invalidated at any instant when the user subsequently changes the selection. Similarly, if an application running in the notifier passes some information about the selection to another process, that information may similarly be invalidated at any time. In these circumstances, the application must copy the selection's value, using **Copy**, **Move**, or **CopyMove**, to assure that its data remains valid. Thus the second rule for dealing with the selection is:

Copy the selection's value before returning to the system or before passing it to another process.

Fine point: If an application is not running in the notifier process and needs to obtain or manipulate the selection, a **TIP.PeriodicNotify** may be used. **TIP.CreatePeriodicNotify** allows the application to be called back from inside the notifier process.

39.1.2 Essentials for a Requestor

Clients that need the *value* of the current selection.

39.1.2.1 Convert, Target, Value, Enumerate, CanYouConvert

The fundamental operation performed by a selection requestor is to obtain the value of the current selection by calling **Selection.Convert**. **Convert** takes a **Selection.Target** and returns a **Selection.Value**. The **Target** specifies what **TYPE** of data the selection should be converted to. The **Value** contains a pointer to the converted selection. For example, **Selection.Convert [target: string]** will return a pointer to a string, i.e., an **XString.Reader**.

Not all selections can be converted to all **Targets**; in fact most selections can be converted to only a small number of **Targets**. For example, if the selection is a text string, it can be converted to **Target string** and perhaps to **integer**, but probably not to **file** or **fileType**. **Note:** Converting to some **Targets** is not so much requesting the value of the selection as requesting some general information about the selection or its environment. For example, **Selection.Convert [target: window]** is a request for the window that the selection is in, **Selection.Convert [target: help]** is a request for user help information about the selection, etc. Note that **Target** is an open-ended enumeration and that clients can create new

Targets by using **Selection.UniqueTarget**. The TYPE associated with each **Target** is determined by system-wide convention. Several of these TYPE/**Target** conventions are defined below under the description of **Target**. Other TYPE/**Target** conventions are documented in §39.2.1.1, Convert.

A requestor can also enumerate the selection if it is more than a single item or if it can be split into smaller pieces. This is done by calling **Selection.Enumerate**.

Finally, a requestor can determine what **Targets** the selection can be converted to without actually doing the conversion by calling **Selection.CanYouConvert**, **Selection.Query**, or **Selection.HowHard**.

39.1.2.2 Resource Allocation/Deallocation Considerations

It is a strict rule that the **Values** produced by **Selection.Convert** and **Selection.Enumerate** describe objects *owned by the selection manager*. The requestor may examine the data referenced by the **value** field, but must not alter it. Furthermore, the requestor must free the **Value** (using **Selection.Free**) once he no longer needs it.

If the requestor wishes to (1) keep the value after it returns to the system, or (2) pass the value to another process, it must call **Selection.Copy**, **Selection.Move**, or **Selection.CopyMove**. These in turn invoke a procedure supplied by the selection manager that modifies the **Value** such that the requestor may then make changes to **value**↑ without affecting the selection manager. Fine Point: The procedure supplied by the manager is returned by the manager as part of the **Value** record. If a **Move** is performed, the item is also deleted from the manager's domain. After the **Move** or **Copy**, any storage associated with the **Value** is now owned by the requestor. This storage may be freed by calling **Selection.Free**.

For example, if the current selection is a document icon, then **Convert[file]** yields a **Value** containing a LONG POINTER TO **NSFile.Reference** for the file containing the document. If the requestor were to create a new document and associate it with the same file, it would probably have undesirable effects. Instead, the requestor should call **Copy**, passing in **data**:LONG POINTER TO **NSFile.Reference** for the destination directory of the new file. When **Copy** returns, the **Value** contains a reference to a copy of the original file, and the requestor can use this freely.

As a second example, suppose the selection manager uses a Mesa STRING as the internal selection representation. Then **Convert[string]** simply builds the string pointer into an **XString.Reader** using **XString.FromSTRING**. If the requestor wants to save the string for very long, he should call **Copy**, and the manager will allocate a copy of the original string using the **zone** passed to **Convert**. An alternative, somewhat simpler, is for the requestor to call **XString.CopyReader** or **XString.CopyToNewReaderBody** or **XString.CopyToNewWriterBody** to copy the bytes, and then call **Selection.Free** to dispose of the original **Reader**.

39.1.3 Essentials for a Manager

Clients that own and manage the current selection.

39.1.3.1 Set, ConvertProc, ActOnProc, ManagerData

The implementor of a selection manager needs to know everything that the implementor of a selection requestor knows, plus more (see the previous section **Essentials for a Requestor**).

The fundamental operation performed by a selection manager is to become the current manager by calling **Selection.Set**. **Set** takes a **ConvertProc**, an **ActOnProc**, and a **LONG POINTER** (**ManagerData**).

The **ConvertProc** is called to obtain the value of the selection, whenever a requestor calls **Selection.Convert** or **Selection.Enumerate**. The **ConvertProc** is also called to determine what **Targets** the selection can be converted to, whenever a requestor calls **Selection.CanYouConvert**, **Selection.Query**, or **Selection.HowHard**. **ConversionInfo** is a variant record passed to the **ConvertProc** that indicates which operation to perform: **convert**, **enumeration**, or **query**.

The **ActOnProc** is called to perform various **Actions** on the selection, such as **mark**, **unmark**, and **clear**.

The **ManagerData** passed to **Set** is passed back to the **ConvertProc** and the **ActOnProc**. Typically, the **ManagerData** identifies exactly what portion of the manager's domain is currently selected. For example, if the current selection is some text in a document, the actual manager is the document application, which has some **ManagerData** that indicates exactly which characters are currently selected.

When a manager calls **Selection.Set**, the previous manager is told to **ActOn [clear]**, and **Selection** forgets about the previous manager. Hence, there is only one selection at a time. However, **Selection** also supports the notion of a "saved" selection. A client can become the current manager by calling **Selection.SaveAndSet**, which does a **Set** but also saves the previous selection. Later, the manager that did the **SaveAndSet** can do a **Selection.Restore**, which restores the previous selection.

39.1.3.2 More on Selection.Value, ValueFreeProc, and ValueCopyMoveProc

The **Value** produced by a manager's **ConvertProc** contains more than simply a pointer to the converted selection. It also contains a pointer to two procedures, a **ValueFreeProc** and a **ValueCopyMoveProc**. The **ValueFreeProc** is called when the requestor calls **Selection.Free** so that the manager can release any resources that were allocated when the selection was converted. The manager's **ValueCopyMoveProc** is called when the requestor calls **Copy**, **Move**, or **CopyMove**. The **ValueCopyMoveProc** should copy or move the converted selection value so that the manager no longer owns the resources associated with the value. A third field in the **Value** record is a **LONG UNSPECIFIED** that may be used to store data for the **ValueFreeProc** and the **ValueCopyMoveProc**.

If the converted selection value can be copied or moved, the manager must return a **ValueCopyMoveProc** with the **Value**. For example, **Targets string** and **file** can be moved or copied, while it does not make sense to move or copy **Targets window** and **fileType**. The **ValueCopyMoveProc** modifies the **Value** such that the requestor may then make changes to **value↑** without affecting the selection manager. If a **Move** is performed, the item is also deleted from the manager's domain. (Some managers may implement **Copy** but raise

Error[invalidOperation] if asked to do a **Move**.) The interpretation of the **data** given to a **ValueCopyMoveProc** depends on the manager; the typical use is to specify a destination for the object.

39.1.3.3 Storage Considerations for ConvertProc

As stated above, it is a strict rule that the **Values** produced by the **ConvertProc** describe objects *owned by the manager*. If the manager allocated any resources to produce the converted selection value, then a **ValueFreeProc** must be returned with the **Value** so that the resources can be released. If a **ValueCopyMoveProc** was returned with the **Value**, after the converted selection value has been copied or moved, the manager must ensure that the correct things will happen when the **Value**'s **ValueFreeProc** is called (i.e., when the requestor calls **Selection.Free**). This may involve replacing the original **ValueFreeProc**.

The manager's **ConvertProc** takes a **zone** that **Selection** guarantees is valid (except for the **query** operation). The manager should allocate any storage for the converted selection value from that **zone**. The **ConvertProc** can store the **zone** in the **context** (LONG UNSPECIFIED) field of the **Value** record (or in a record pointed to by the **context** field). The **ValueFreeProc** and **ValueCopyMoveProc** can then retrieve this **zone** to free the storage.

Numerous defaults are provided by **Selection** to ease the manager's task of proper storage management. In practice, the **ConvertProc** can simply default the **context** field and **Selection** will place the **zone** there. Also, procedures such as **FreeStd** and **FreeContext** are provided that perform the LOOPHOLEs, FREE the storage, and store null and/or no-op values such as **NopFree** in the **Value** record.

39.1.3.4 Storage Considerations for ManagerData

The **ManagerData** that identifies exactly what part of the manager's domain is currently selected should be allocated whenever a **Selection.Set** is done and deallocated whenever **ActOn [clear]** is requested. In particular, a manager should not assume that there will be only one selection at a time in his domain. The existence of **SaveAndSet** and **Restore** implies that the same manager *code* could have several pushed selections at once and therefore would have several **ManagerData** records allocated at once.

39.2 Interface Items

39.2.1 Requestor items

39.2.1.1 Convert

```
Convert: PROCEDURE [target: Target, zone: UNCOUNTED ZONE ← NIL]
  RETURNS [value: Value];

Value: TYPE = RECORD [value: LONG POINTER,...];

nullValue: Value = [value: NIL,...];
```

Convert is a request to the current selection manager to produce the selection as a **TYPE** specified by **target**, if possible. **value.value** will be a **LONG POINTER TO** the converted selection. The **TYPE** of object pointed to by **value.value** depends on **target** and is described below under **Target**. If the conversion requires that storage be allocated, it will be allocated out of **zone**. If **zone** is defaulted, the system heap is used.

The value returned is read-only; it belongs to the manager. If the requestor wishes to (1) keep the value after it returns to the system, or (2) pass the value to another process, it must call **Copy**, **Move**, or **CopyMove** to make a copy of the value, which is then owned by the requestor. If **Copy, Move**, or **CopyMove** is called, the requestor must still call **Free**.

If **Copy**, **Move**, or **CopyMove** is not called, the requestor must call **Free** after calling **Convert**. This allows the manager to free any resources that were allocated to perform the conversion. If **Copy**, **Move**, or **CopyMove** is called, the requestor then owns any resources and may retain them indefinitely and/or may free them by calling **Free**.

There are other fields in the **Value** record, but the requestor need not be concerned with them. They are described in the section on **Manager Items**

nullValue is returned if the selection manager does not implement the desired conversion, or if the particular selection is incompatible with the target (e.g., **Convert[integer]** when non-numeric characters are selected).

```
Target: TYPE = MACHINE DEPENDENT{
   window(0), shell, subwindow, string, length, position,
   integer, interpressMaster, file, fileType, token, help,
   interscriptScript, interscriptFragment, serializedFile, name, firstFree, last(1777B)};
```

Target describes the type of data to which a selection may be converted (see **Convert**). Modules that manage the current selection may choose not to implement conversion to some (or even most) of these types. The values described below are those stored in the **value** field of the **Selection.Value** returned by **Convert**.

Special note for **Targets** that produce a **Stream.Handle**: The **Stream.Object** pointed to by the **Stream.Handle** is read-only. Thus the requestor cannot even read the stream because that alters the stream state and thus the **Stream.Object**. Before using the stream, the requestor must do a **Copy**, after which the ownership of the storage for the **Stream.Object** and any of its ancillary data moves to the requestor. Note also that the stream itself is read-only even after the **Copy**. The requestor should never attempt to write to the stream. After reading the stream, the requestor can free the stream and any associated resources by calling **Stream.Delete**. Thus a typical stream requestor will do **Convert[stream]; Copy[]; <read stream>; Stream.Delete[];** Note for selection managers: this last point means that the **Stream.Delete** must be able to free any ancillary data associated with the stream.

Note that some **Target** values refer to types that are not defined within the context of ViewPoint. Such targets so far include **pieceList**, **help**, **interscriptScript**, and **interscriptFragment**. Popular target types are included in the **Selection** interface as a convenience for clients. New target types will be put either into a **SelectionExtras** interface or, for little-used types, into private interfaces negotiated between managers and requestors and using **Selection.UniqueTarget**. The **TYPE** associated with each **Target** is determined by system-wide convention. Several of these **TYPE/Target** conventions are defined here. Other **TYPE/Target** conventions are documented elsewhere, see §39.2.2.8, **UniqueTarget**.

Fine Point: This **Selection** interface is intended to support both Tajo and ViewPoint clients, so there may be **Targets** that do not make sense in one domain or the other. **Targets** that only make sense in one domain show that domain in parentheses.

window	yields a **Window.Handle** for the window containing the selection.
shell	yields a **StarWindowShell.Handle** for the window containing the selection. (Star)
subwindow	yields a **Window.Handle** for the subwindow containing the selection. (Tajo)
string	yields a **LONG POINTER TO XString.ReaderBody** (an **XString.Reader**) representing the text of the selection. If the current selection is too large, the manager of the selection may return **nullValue** when asked to convert to a **string**. The requestor should then ask to enumerate the selection as a sequence of smaller **strings**. **Note:** The requestor must copy the **ReaderBody** before altering it.
length	yields a **LONG POINTER TO LONG CARDINAL** containing the length of the selection in characters.
position	yields a **LONG POINTER TO LONG CARDINAL** containing the position within the source.
pieceList	yields a list of pieces, understood by the internals of Tajo's **PieceSource** interface. (Tajo)
integer	yields a **LONG POINTER TO LONG INTEGER** containing the result of converting the contents of the selection to a number.
interpressMaster	yields a **Stream.Handle** onto an Interpress master, according to the Interpress standard.
file	yields a **LONG POINTER TO NSFile.Reference** for the file (if any) associated with the selection, e.g., the backing file for a Star document icon. When calling **Copy**, **Move**, or **CopyMove**, the **data** parameter must be a **LONG POINTER TO NSFile.Reference** of the parent directory to where the file should be copied or moved. (Star)
fileType	yields a **LONG POINTER TO NSFile.Type** for the file (if any) associated with the selection. (Star)
token	yields a **LONG POINTER TO XString.ReaderBody** (an **XString.Reader**) that contains the first token of the current selection. **Note:** The requestor must copy the **ReaderBody** before altering it.
help	yields a **LONG POINTER** to a value or data structure that specifies what should happen if the **HELP** key is pressed. Consult the Help documentation (not in this manual) for the exact **TYPE**.

interscriptScript	yields a **Stream.Handle** onto a complete script, according to the Interscript standard. It begins with the "Interscript 1.0 . . .", and is in machine code.
interscriptFragment	yields a **Stream.Handle** onto a single Interscript node, in machine code.
serializedFile	A **Target** of **serializedFile** results in a **Stream.Handle**. **Stream.GetXXX** operations can be performed on the stream. This is useful for retrieving files from non-**NSFile** mediums such as a floppy disk.
name	A **Target** of **name** results in a **XString.Reader** that contains the name of the object.
firstFree	is used internally by **UniqueTarget** and should not be used by clients.

```
ConvertNumber: PROCEDURE [target: Target]
  RETURNS [ok: BOOLEAN, number: LONG UNSPECIFIED];
```

This procedure lets the requestor streamline his code in many cases. **ConvertNumber** calls **Convert** and assumes that the resulting **value.value** references a 32-bit object. (This is true of the targets **length**, **position**, **integer**, and **fileType**, and may also be true of targets defined using **UniqueTarget**.) The object is returned as **number**, and the **Value** is then freed (**Selection.Free**). If the selection manager does not support the desired conversion (that is, it returns **nullValue**), or if the selection could not be converted to a number, **ConvertNumber** returns **ok:FALSE**; otherwise, it returns **ok:TRUE**.

```
Free: PROCEDURE [v: ValueHandle];
```

```
ValueHandle: TYPE = LONG POINTER TO Value;
```

Free frees any storage associated with **v**. If the requestor has not done a **Copy**, **Move**, or **CopyMove**, that storage is owned by the manager. After doing a **Copy**, **Move**, or **CopyMove**, that storage is owned by the requestor.

39.2.1.2 Query

A requestor can determine exactly which **Targets** the current selection can be converted to and how difficult the conversion would be. The most common way to do this is **CanYouConvert**, which takes a **Target** and returns a **BOOLEAN** indicating whether the selection can be converted to that **Target**. **HowHard** is similar to **CanYouConvert** but returns a **Difficulty**. **Query** allows a requestor to determine the **Difficulty** of conversion for an **ARRAY** of **Targets**.

Note: For all these queries, the manager is indicating how hard it would be *to attempt* to convert the selection to that target type. Attempt is a key word. The manager might be willing to attempt to convert the selection to an Interpress master and yet run out of disk space when the conversion is actually requested. Likewise, the manager might support conversion to integer, but the conversion could still fail if the selection contains invalid characters.

```
CanYouConvert: PROCEDURE [target: Target, enumeration: BOOLEAN ← FALSE]
  RETURNS [yes: BOOLEAN] = INLINE {
    RETURN [ HowHard [ target, enumeration ] # impossible ] };
```

CanYouConvert determines whether the selection manager supports conversions to the specified **target**. **enumeration** = TRUE means the requestor wants to know if the manager supports enumerating the selection in the specified target form. (See the section on Enumeration below.)

```
HowHard: PROCEDURE [target: Target, enumeration: BOOLEAN ← FALSE]
  RETURNS [difficulty: Difficulty];

Difficulty: TYPE = {easy, moderate, hard, impossible};
```

HowHard determines the **difficulty** the selection manager would have attempting to convert to the specified **target**. **enumeration** = TRUE means the requestor wants to know the **difficulty** of enumerating the selection in the specified target form. (See the section on Enumeration below.)

The difficulty ratings are interpreted roughly as follows:

easy	Requires virtually no computation (other than allocating storage for the **Value**). Example: **length** when the selection is being maintained as two character indices within a string.
moderate	Requires some amount of computation but nothing outrageously time-consuming. Example: converting the above-mentioned substring representation to a **string** or **integer** target.
hard	Requires extensive computation. Example: **interpressMaster**.
impossible	The selection manager does not support this conversion.

```
Query: PROCEDURE [targets: LONG DESCRIPTOR FOR ARRAY OF QueryElement];

QueryElement: TYPE = RECORD [
  target: Target,
  enumeration: BOOLEAN ← FALSE,
  difficulty: Difficulty ← TRASH];
```

Query allows a requestor to determine the difficulty of conversion for several **Targets**. The requestor should construct the ARRAY OF **QueryElement**, filling in **target** and **enumeration** for each **QueryElement**. The manager will then store a **Difficulty** in each **QueryElement** indicating how hard it would be to attempt to convert the selection to that **target**. The requestor can then examine the **difficulty** field of each **QueryElement** after the call to **Query**.

39.2.1.3 Enumeration

The selection is sometimes a collection of items (for example, several rows of a folder) or a single large item that can be split up (for example, a long string can be broken into several smaller ones). A requestor can request that each item or part of such selections be converted to some **Target** by calling **Selection.Enumerate**. **Enumerate** is logically similar to calling **Convert** for each item and the same storage ownership rules apply (see **Convert**). Not all selection managers support enumerating the selection; for example, they do not support a selection that is more than one item. Often a requestor will call **Convert** and if that fails (returns **nullValue**), call **Enumerate**.

```
Enumerate: PROCEDURE [
   proc: EnumerationProc, target: Target, data: RequestorData ← NIL,
   zone: UNCOUNTED ZONE ← NIL]
   RETURNS [aborted: BOOLEAN];

EnumerationProc: TYPE = PROCEDURE [element: Value, data: RequestorData]
   RETURNS [stop: BOOLEAN ← FALSE];

RequestorData: TYPE = LONG POINTER;
```

Enumerate is a request to the selection manager to enumerate the current selection, converting each **element** to **target**. **proc** is called for each **element**. **data** is passed back to **proc** each time it is called. As with the **Value** returned by **Convert**, *the requestor must consider each* **element** *to be read-only* until **Copy**, **Move**, or **CopyMove** is called, and the requestor may free the value by calling **Free**.

stop is returned from **proc** by the requestor and indicates whether the enumeration should be stopped. **aborted** indicates whether the enumeration completed normally or terminated prematurely.

If the manager cannot convert the selection to the target type or if the manager does not implement enumeration, **proc** will not be called.

```
Reconversion: SIGNAL [
   target: Target, zone: UNCOUNTED ZONE] RETURNS [Value];

ReconvertDuringEnumerate: PROCEDURE [
target: Target, zone: UNCOUNTED ZONE ← NIL] RETURNS [Value];
```

A requestor may wish to reconvert the current item during an enumeration of the selection. The requestor should call **ReconvertDuringEnumerate**, which will raise the signal **Reconversion**. If the manager supports reconversion, it should catch the signal and return the reconverted value. If the manager does not support reconversion, it should ignore the signal. **Enumerate** will catch the signal and return **nullValue**. **ReconvertDuringEnumerate** acts like **Convert** with respect to **zone**.

```
maxStringLength: CARDINAL = 200;
```

maxStringLength is the largest string that is produced by a **Convert[string]**. Further, a manager that supports **target: string** should be prepared to yield strings up to this length, and should never yield a string longer than this. Thus the requestor knows that (1) **Convert[string]** will never produce too large a string, and (2) if **Convert[string]** fails but the selection manager claims to support conversion to strings, the selection must be rather long (and thus might be deemed uninteresting without further examination). If the requestor wants the selection as a string regardless of its length, he should use **Enumerate**.

39.2.1.4 Copy, Move, Free, etc.

The **Values** produced by **Convert** and **Enumerate** are *strictly read-only. The storage is owned by the manager*. The requestor may examine the data referenced by the **value** field but must not alter it.

If the requestor wishes to (1) keep the value past when it returns to the system, or (2) pass the value to another process, it must call **Copy**, **Move**, or **CopyMove**. These in turn invoke a procedure supplied by the selection manager that modifies the **Value** such that the requestor may then make changes to **value.value↑** without affecting the selection manager. Fine Point: This procedure is returned by the manager as part of the **Value** record, but the requestor never needs to know about these details. If a **Move** is performed, the item is also deleted from the manager's domain. After the **Move** or **Copy**, any storage associated with the **Value** is now owned by the requestor. This storage may be freed by calling **Free**.

For example, if the current selection is a document icon, then **Convert[file]** yields a **Value** containing a LONG POINTER TO **NSFile.Reference** for the file containing the document. If the requestor were to create a new document and associate it with the same file, it would probably have undesirable effects. Instead, the requestor should call **Copy**, giving it a LONG POINTER TO **NSFile.Reference** for the destination directory of the new file. When **Copy** returns, the **Value** contains a reference to a copy of the original file, and the requestor can use this freely. Furthermore, whereas calling **Free** with the original **Value** might have deleted the file (since the file then belonged to the manager, who might have created it solely for the **Convert** request), calling **Free** for the new **Value** frees only the **NSFile.Reference** storage (since the file is now a permanent object belonging to the requestor).

```
Copy: PROCEDURE [v: ValueHandle, data: LONG POINTER] = INLINE {
  CopyMove[v, copy, data]};

Move: PROCEDURE [v: ValueHandle, data: LONG POINTER] = INLINE {
  CopyMove[v, move, data]};

CopyMove: ValueCopyMoveProc;

ValueCopyMoveProc: TYPE = PROCEDURE [
  v: ValueHandle, op: CopyOrMove, data: LONG POINTER];

CopyOrMove: TYPE = {copy, move};
```

Copy, **Move**, and **CopyMove** request the manager to make a copy of the converted selection value (**v.value↑**) and, for **Move**, also delete the selection from the manager's domain. A requestor may call these procedures after calling **Convert** or from an **EnumerationProc** while doing an **Enumerate**. **data** will be passed to the manager; what it points to depends on the particular **Target**. **data** often points to a destination container for the copied value. For example, for **Target file**, **data** is a LONG POINTER TO **NSFile.Reference** for the destination directory. The exact meaning of **data** for each target is specified in the description of that target under **Target** above. **Copy**, **Move**, and **CopyMove** may raise **Error [invalidOperation]**.

39.2.2 Manager Items

39.2.2.1 Set

```
Set: PROCEDURE [pointer: ManagerData, conversion: ConvertProc, actOn: ActOnProc];

ManagerData: TYPE = LONG POINTER;
```

The **Set** procedure allows a client to become the manager of the current selection by supplying the **Selection** interface with a pair of procedures. The **ActOnProc** is called to modify or manipulate the current selection. The **ConvertProc** is called to get the value of the current selection. The value of **pointer** passed to **Set** is used as the **data** argument in calls to **conversion** or **actOn**. **pointer** typically points to a record that describes what part of the manager's domain is currently selected. If there is already a selection manager when **Set** is called, **Set** first calls that manager with **ActOn[unmark]** and **ActOn[clear]**. **Set** automatically calls the new **ActOnProc** with an action of **mark**.

Either **conversion** or **actOn** can be explicitly NIL. If **conversion** is NIL, then **Convert** always returns **nullValue**, **Enumerate** is a no-op, and **Query** will always respond **impossible**. If **actOn** is NIL, then **ActOn** is a a no-op for all actions.

```
ConvertProc: TYPE = PROCEDURE [
   data: ManagerData,
   target: Target,
   zone: UNCOUNTED ZONE,
   info: ConversionInfo ← [convert[]] ]
   RETURNS [value: Value];

ConversionInfo: TYPE = RECORD [SELECT type: * FROM
   convert = > NULL,
   enumeration = > [proc: PROCEDURE [Value] RETURNS [stop: BOOLEAN]],
   query = > [query: LONG DESCRIPTOR FOR ARRAY OF QueryElement],
   ENDCASE];
```

A **ConvertProc** is provided by a manager when becoming the manager; that is, when calling **Set** or **SaveAndSet**. The manager's **ConvertProc** is called when a requestor calls **Convert**, **Enumerate**, or **Query**. The **ConvertProc** should perform the conversion, the enumeration, or the query. **info** is a variant record indicating which operation to perform; it contains data appropriate to each operation. The **ConvertProc** should use WITH **info** SELECT to determine which operation is requested. Each operation is described in detail in the following sections. **data** is the pointer that was passed to **Set** or **SaveAndSet** and typically points to a record that describes what part of the manager's domain is currently selected. **target** indicates the TYPE of object that the selection should be converted to and is meaningful only for conversion and enumeration. **zone** should be used to allocate any storage for the converted selection value and is meaningful only for conversion and enumeration.

```
ActOnProc: TYPE = PROCEDURE [data: ManagerData, action: Action]
  RETURNS [cleared: BOOLEAN ← FALSE];
```

An **ActOnProc** is provided by the manager of the selection to perform various actions on the selection. **ActOnProc** is fully described later in this chapter.

39.2.2.2 Conversion

```
ConversionInfo: TYPE = RECORD [SELECT type: * FROM
  convert = > NULL,
  . . .
  ENDCASE];

Value: TYPE = RECORD [
  value: LONG POINTER,
  ops: LONG POINTER TO ValueProcs ← NIL,
  context: LONG UNSPECIFIED ← 0];
```

Convert calls the manager's **ConvertProc** with **convert ConversionInfo** to perform the requested conversion. The **ConvertProc** returns a **value: Value**. If the conversion can be performed, **value.value** should point to the converted selection value; **value.ops** should point to a pair of procedures, a **ValueFreeProc** that will release any resources that were allocated to perform the conversion and a **ValueCopyMoveProc** that will copy or move the converted value; **value.context** can be used to save any information that the pair of procedures might need. **value.ops** and **value.context** are described in much more detail later. If the manager does not support the requested **Target** or there is some problem with the conversion, the **ConvertProc** should return **nullValue**. See **Target** for the effect of different conversion targets.

If the conversion requires that an object be allocated, the **ConvertProc** should allocate it out of **zone**. If the requestor passed a NIL zone to **Convert**, **Convert** passes the system zone to **ConvertProc**. The **ConvertProc** can assume that it is always given a valid **zone**.

39.2.2.3 Query

```
ConversionInfo: TYPE = RECORD [SELECT type: * FROM
  . . .,
  query = > [query: LONG DESCRIPTOR FOR ARRAY OF QueryElement],
  ENDCASE];

QueryElement: TYPE = RECORD [
  target: Target,
  enumeration: BOOLEAN ← FALSE,
  difficulty: Difficulty ← TRASH];
```

Query, **HowHard**, and **CanYouConvert** call the manager's **ConvertProc** with **query ConversionInfo**. The **ConvertProc** should examine the **target** and **enumeration** fields of each **QueryElement** (these were filled in by the requestor) and fill in the **difficulty** field indicating how hard it would be to attempt to convert the selection to that **target** (**enumeration** = FALSE) or to convert the selection to an enumeration of that target (**enumeration** = TRUE).

All managers are expected to implement queries; the assumption is that most difficulty ratings can be determined simply by indexing into a constant array. The **Value** actually returned by the **ConvertProc** in response to a query is ignored; **nullValue** or TRASH may be returned.

Note that the manager is indicating how hard it would be to attempt to convert the selection to that target type. Attempt is a key word. The manager might be willing to attempt to convert the selection to an Interpress master, and yet run out of disk space when the conversion is actually requested. Likewise, the manager might support conversion to integer, but the conversion could still fail if the selection contains invalid characters.

39.2.2.4 Enumeration

```
ConversionInfo: TYPE = RECORD [SELECT type: * FROM
  ...,
  enumeration = > [proc: PROCEDURE [Value] RETURNS [stop: BOOLEAN]],
  ...,
  ENDCASE];
```

Enumerate calls the manager's **ConvertProc** with **enumeration ConversionInfo**. The **ConvertProc** should convert each element or part of the selection according to **target** and call **proc** for each element. The **Value** passed to **proc** is just as it is for conversion (see the section on **Conversion** above and the following section). If **proc** returns **stop** = TRUE, the **ConvertProc** should stop the enumeration and return. The **Value** returned by the **ConvertProc** after an enumeration is ignored; **nullValue** or TRASH may be returned. Not all selection owners are expected to implement enumerations; if an enumeration is requested and not supported, the **ConvertProc** should simply return and take no other action. Fine Point: The **ConvertProc** does not call the requestor's **EnumerationProc** directly; rather, **proc** is inside **Enumerate** and **Enumerate** calls the requestor's **EnumerationProc**. This lets **Enumerate** insert the **zone** into the **Value.context** if it is zero, just as **Convert** does for **Values** produced by a simple conversion.

```
maxStringLength: CARDINAL = 200;
```

maxStringLength is the largest string that should be produced by a **ConvertProc**. Further, a **ConvertProc** that supports **target: string** should be prepared to yield strings up to this length, and should never yield a string longer than this. Thus the requestor knows that (1) **Convert[string]** will never produce too large a string, and (2) if **Convert[string]** fails but the selection manager claims to support conversion to strings, the selection must be rather long (and thus might be deemed uninteresting without further examination).

39.2.2.5 Free, Copy, Move, etc.

```
ValueHandle: TYPE = LONG POINTER TO Value;

Value: TYPE = RECORD [
  value: LONG POINTER,
  ops: LONG POINTER TO ValueProcs ← NIL,
  context: LONG UNSPECIFIED ← 0];
```

The selection manager provides the value of the selection, or other selection-related information, to the requestor by means of **Value** records. These records are typically either returned by a **ConvertProc** or passed as elements to the requestor's **EnumerationProc**. The **ops** field defines the effect of **Free**, **Copy**, **Move**, and **CopyMove**. The **context** field may be used to store data for use by the **ops** procedures. If the **context** field is defaulted (zero) by the selection manager, **Selection** stores the **zone** that was passed to the **ConvertProc** there before the **Value** is handed to the requestor.

```
ValueProcs: TYPE = RECORD [
   free: ValueFreeProc ← NIL,
   copyMove: ValueCopyMoveProc ← NIL];
```

ValueProcs are returned by the manager as part of a **Value** record. If the manager allocated any resources to produce the converted selection value, then a **ValueFreeProc** must be returned with the **Value** so that the resources can be released. **free** is called when the requestor calls **Free**. If the converted selection value can be copied or moved, the manager must return a **ValueCopyMoveProc** with the **Value**. For example, **Targets string** and **file** can be moved or copied, while it does not make sense to move or copy **Targets window** and **fileType**. **copyMove** will be called when the requestor calls **Copy**, **Move**, or **CopyMove**.

39.2.2.5.1 Free

```
ValueFreeProc: TYPE = PROCEDURE [v: ValueHandle];
```

If any resources were allocated to produce the converted selection value, they should be released in the manager's **ValueFreeProc**. The **ValueFreeProc** is returned as part of the **ops** field of a **Value**. The **ValueFreeProc** will be called when the requestor calls **Free**. **v** points to the **Value** that represents the converted selection.

Defaults are provided such that for the most common case when the **ConvertProc** simply allocates one node of storage from the passed **zone**, the manager need not supply a **ValueFreeProc**. **Selection** takes care of freeing the storage when the requestor calls **Free**. The details of how this works are as follows:

The manager's **ConvertProc** takes a **zone** that **Selection** guarantees is valid. The manager should allocate any storage for the converted selection value from that **zone**. The **ConvertProc** can store the **zone** in the **context** field of the **Value** record (or in a record pointed to by the **context** field); then the **ValueFreeProc** can retrieve this **zone** to free the storage. **Selection** stores this **zone** in the **context** field if **context** is zero (the default) in the **Value** returned by the **ConvertProc** (or passed to the **EnumerationProc**). **v.value** points at the converted selection object to be freed. Now, **Free** calls **FreeStd** if the **Value** passed to **Free** has **ops = NIL** or **ops.free = NIL**. **FreeStd** treats **v.context** as a **ZONE** and calls **v.context.FREE[@v.value]**.

If there are in fact no resources that should be freed (for example, after **Convert[window]**), the selection manager should use **NopFree** as the **ValueFreeProc**. (See also **nopFreeValueProcs**.)

FreeStd: ValueFreeProc;

FreeStd assumes the resources of the **Value** can be freed by treating **v.context** as a **ZONE** and calling **v.context.FREE[@v.value]**. If a **Value** has **ops = NIL** or **ops.free = NIL**, **Free** will call **FreeStd**.

NopFree: ValueFreeProc;

The **NopFree** procedure should be used as the **ops.free** for a **Value** involving no temporary resources owned by the selection manager. Thus, a **Value** created by **Convert[window]** would probably use **NopFree**, as would **Convert[string]** if the **Value.value** pointed to a permanent **XString.ReaderBody** belonging to the manager.(See also **nopFreeValueProcs**.)

39.2.2.5.2 Copy and Move

```
ValueCopyMoveProc: TYPE = PROCEDURE [
  v: ValueHandle, op: CopyOrMove, data: LONG POINTER];
```

```
CopyOrMove: TYPE = {copy, move};
```

The manager's **ValueCopyMoveProc** is called to copy or move the converted selection value. A **ValueCopyMoveProc** is returned by the manager's **ConvertProc** as part of the **ops** field of a **Value**. The **ValueCopyMoveProc** is called when the requestor calls **Copy**, **Move**, or **CopyMove**. The **ValueCopyMoveProc** should modify the **Value** such that it no longer involves any manager-owned storage. If a **Move** is performed, the item is also deleted from the manager's domain. (Some managers may implement **Copy** but raise **Error[invalidOperation]** if asked to do a **Move**.) **data** is the **data** parameter that the requestor passed to copy or move. It is often a pointer to the destination container for the copied value. The interpretation of **data** depends on the **Target**; it is specified in the description of each target under **Target** above. **v** points to the **Value** representing the converted selection. **op** indicates whether to do a copy or move. **Note: v.context** can be used by the manager to save information between the **ConvertProc** and the **ValueCopyMoveProc**.

The **ValueCopyMoveProc** should release (or perhaps simply turn over control of) any resources that were allocated by the **ConvertProc** to produce the original converted value. Conceptually, the **ValueCopyMoveProc** makes a copy of the converted value, then releases any resources that were used to produce the original converted value. If the original converted value itself was a copy produced by the conversion process, this effect might be achieved by doing nothing -- the requestor just becomes the owner of the copy.

If the converted value can only be copied once (the typical case), the **ValueCopyMoveProc** should also set **v.ops.copyMove** to **NIL** to prevent the manager's **ValueCopyMoveProc** from being called again. If the requestor does call **Copy** or **Move** again, **Selection** raises **Error [invalidOperation]**.

The **ValueCopyMoveProc** should also ensure that **v.ops.free** and **v.context** have appropriate values so that when the requestor calls **Free**, the right thing happens. For example, if the newly copied selection was allocated from a zone, **v.ops.free** should free it from that zone (see **ValueFreeProc** and **FreeStd**); or if the newly copied selection has no storage allocated for it, **v.ops.free** should be **NopFree**.

```
nopFreeValueProcs: READONLY LONG POINTER TO ValueProcs; -- @[NopFree, NIL]
```

This is provided for use as the **ops** vector in **Values** that require no temporary storage and that cannot be moved or copied. The **window** and **subwindow Targets** typically produce such values.

```
FreeContext: PROCEDURE [v: ValueHandle, zone: UNCOUNTED ZONE] = INLINE {
  zone.FREE[LOOPHOLE[@v.context, LONG POINTER TO LONG POINTER]];
  v.context ←LOOPHOLE[zone]};
```

When the requestor calls **Copy** or **Move**, the manager's **ValueCopyMoveProc** is expected to modify the **Value** that it no longer involves any manager-owned storage. If the manager has been using the **context** field as a pointer to additional private data, this private data must be freed. This would normally require merely a **zone.FREE[@v.context]**; however, since the context is a **LONG UNSPECIFIED**, a **LOOPHOLE** is needed. **FreeContext** hides this **LOOPHOLE** from the implementor and does the required **zone.FREE**. It also stores the **zone** in place of **v.context**, for possible later use by **FreeStd**.

39.2.2.6 ActOn

```
ActOnProc: TYPE = PROCEDURE [data: ManagerData, action: Action]
  RETURNS [cleared: BOOLEAN ← FALSE];
```

An **ActOnProc** is provided by the manager of the selection to perform various actions on the selection. **data** is the pointer that was passed to **Set** or **SaveAndSet** and typically points to a record that describes what part of the manager's domain is currently selected. **action** indicates what action to perform (see **Action** below). An **ActOnProc** should return **cleared: TRUE** if the action resulted in the selection being cleared; that is, the manager is no longer responsible for the selection. (This should always be the case for **action: clear** and may also occur for **delete** or **clearIfHasInsert**.)

```
Action: TYPE = MACHINE DEPENDENT{
  clear(0), mark, unmark, delete, clearIfHasInsert, save, restore, firstFree, last(255)};
```

clear	unselects the current selection by freeing any associated private data, undoing **TIP** notification changes, etc.
mark	highlights the current selection. If the selection is already highlighted, this is a no-op.
unmark	dehighlights the current selection. If the selection is not already highlighted, this is a no-op.
delete	deletes the contents of the current selection. The selection manager may decide against actually deleting it.
clearIfHasInsert	same as **unmark** plus **clear**, but only if the insertion point (input focus) is in the selection. This action is used when a secondary selection has been completed (for copy-from); if the place to which the secondary selection is to be copied (the insertion point) is within the selection itself, the selection is

cleared after obtaining its contents and before the insertion takes place.

save	unselects the current selection, but does not necessarily free any associated private data, because the selection is expected to be restored later. This action will often be a no-op, but the manager might need to undo a special **TIP** notifier, for example.
restore	restores a previously saved selection.
firstFree	is used internally by **UniqueAction** and should not be used by clients.

Observe that, contrary to the interpretations used in the *XDE* **Selection** interface, the **clear** action does not dehighlight the selection. **Selection.Clear** (usually) does an explicit **unmark** before clearing the selection. Likewise, **save** does not imply **unmark**, nor does **restore** imply **mark**. This lets a client choose to leave a primary selection highlighted while a secondary selection is being made.

39.2.2.7 Save and Restore

```
SaveAndSet: PROCEDURE [
  pointer: ManagerData, conversion: ConvertProc, actOn: ActOnProc,
  unmark: BOOLEAN ← TRUE]
  RETURNS [old: Saved];
```

SaveAndSet is the same as **Selection.Set** except that the existing selection, if any, is told to **ActOn[save]** rather than **ActOn[clear]**. That is, the existing selection is expected to retain any private state so that it can later be restored via **Selection.Restore**. If it subsequently turns out that the saved selection is never going to be restored, it should be given to **Selection.Discard** so that the former selection manager will have a chance to discard any associated private data. A saved selection must *always* be given eventually to either **Restore** or **Discard**; furthermore, once that has been done, the **Selection.Saved** must not be used for anything else.

It is perfectly acceptable to call **SaveAndSet** when there is no selection. If the resulting **Selection.Saved** is passed to **Selection.Restore**, it acts like **Selection.Clear**. Also, unlike for **Clear**, **ClearOnMatch**, and **Restore**, it is quite reasonable to call **SaveAndSet** with **unmark: FALSE**, thereby requesting that the saved selection remain highlighted while a secondary selection is performed. If this is done, the caller will usually wish to specify **mark: FALSE** when the saved selection is restored. **Note:** Calling **SaveAndSet** with **unmark: FALSE** does *not necessarily* mean that the old selection is marked. The selection manager, or some other client, might have unmarked it. The present caller is simply saying, "Do not change the highlighting on *my* account," but has no way of knowing whether the saved selection is in fact highlighted. That is why it is always up to the selection manager to decide whether **ActOn[mark]** or **ActOn[unmark]** is a no-op.

```
Saved: TYPE [6];
```

Objects of this type are created by **Selection.SaveAndSet** to encapsulate a selection that is to be restored later. It is opaque to prevent requestors from invoking the manager directly.

Restore: PROCEDURE [saved: Saved, mark, unmark: BOOLEAN ←TRUE];

This procedure re-institutes a previously saved selection as the current manager. The existing selection, if any, is requested to **ActOn[unmark]** (unless **unmark** is FALSE; see **Selection.Clear**) and then **ActOn[clear]**. The selection being restored is asked to **ActOn[restore]** and then **ActOn[mark]** (unless **mark** is FALSE).

Discard: PROCEDURE [saved: Saved, unmark: BOOLEAN ←TRUE];

If a client, having saved somebody else's selection (see **SaveAndSet**), determines that it should never be restored, he should call this procedure to free the associated resources. The current selection is not affected. The **ActOnProc** of the saved selection is called with **action: unmark** (unless **unmark** is FALSE; see **Clear**) and again with **action: clear**. Thus the **ActOnProc** must be prepared to handle these operations while the corresponding selection is saved.

39.2.2.8 Miscellaneous

On all of the procedures below, use **unmark: FALSE** only if you know the area of the screen containing the selection is going to be repainted soon anyway; for example, if the window is going away.

Clear: PROCEDURE [unmark: BOOLEAN ←TRUE];

The **Clear** procedure requests that the current selection be cleared. It is equivalent to calling **ActOn[clear]**, preceded by **ActOn[unmark]** if **unmark** is TRUE. The only time **unmark** should be FALSE is if the caller knows the area of the screen containing the selection is going to be repainted soon anyway; for example, if the window containing the selection is going away.

ClearOnMatch: PROCEDURE [pointer: ManagerData, unmark: BOOLEAN ←TRUE];

It is sometimes difficult to determine if you are the manager of the current selection. The **ClearOnMatch** procedure is the same as **Clear** except that no action is taken unless **pointer** matches the **ManagerData** of the current selection. **ClearOnMatch** is equivalent to IF **Selection.Match[pointer]** THEN **Selection.Clear[unmark]**.

ActOn: PROCEDURE [action: Action];

The **ActOn** procedure communicates a request for an action to the manager of the current selection. (See also **UniqueAction**.) Calling **ActOn[clear]** is not recommended, since there would be a tendency to forget to **unmark** first. Use **Selection.Clear** instead.

Match: PROCEDURE [pointer: ManagerData] RETURNS [match: BOOLEAN];

This procedure returns TRUE if the caller is the current selection manager, which is assumed to be the case if and only if **pointer** is equal to the **ManagerData** associated with the current selection (as specified by **Set**, **SaveAndSet**, or **Restore**). **Note:** A selection manager may opt to have NIL as the **ManagerData**. In this case, the manager should not use **Match** since it would not be able to distinguish itself from other managers using NIL.

However, **Match[NIL]** *always* returns **FALSE** if there is no selection; that is, after **Selection.Clear**.

UniqueTarget: PROCEDURE RETURNS [Target];

The **UniqueTarget** procedure allows a client to define its own private conversion type. It returns a new **Target** in **[firstFree..last]**. May raise **Error [tooManyTargets]**. The use of private target types severely limits the exchange of information between applications and should be avoided if possible.

UniqueAction: PROCEDURE RETURNS [Action];

The **UniqueAction** procedure allows an application to define its own private operations on the selection. It returns a new **Action** in **[firstFree..last]**. May raise **Error [tooManyActions]**.

39.2.3 Errors

Error: ERROR [code: ErrorCode];

```
ErrorCode: TYPE = {
  tooManyActions, tooManyTargets, invalidOperation,
  operationFailed, didntAbort, didntClear};
```

tooManyActions	may be raised by **UniqueAction**.
tooManyTargets	may be raised by **UniqueTarget**.
invalidOperation	raised if **Copy** or **Move** is called with a **Value** that does not implement the operation.
operationFailed	may be raised by a **ValueCopyMoveProc** if the operation is permitted but nevertheless fails, for example due to an **NSFile** error.

didntAbort and **didntClear** are never raised.

39.3 Usage/Examples

39.3.1 What Selection Is NOT

The trash bin and insertion features of the Mesa interface are not supported. If they are needed, a separate (smaller) interface should be created for them, as they do not really require the generality available for actual selections.

The **Selection** interface could, in theory, be extended to keep track of objects other than the current selection. A parameter could be added to **Set, Convert, Enumerate**, etc., that would describe the data object to be manipulated; the default would be the highlighted selection. Thus general information handles could be passed among modules, allowing one module to access another's data in whatever target format is most convenient. If there is sufficient demand for such a facility, it may be added someday. (It would probably call for a more suitable name than "Selection". Perhaps "OpaqueData"?)

39.3.2 Random Details

Requestors need to understand one slightly tricky concept: if they want the selection as a **string** and are prepared to handle very large strings, they should also be prepared to get the selection as an enumeration of **strings** if the selection is longer than Selection.maxStringLength. (The XDE Selection.Source mechanism has been eliminated.)

39.3.3 Examples of Storage Allocation for Manager's ConvertProc

Here the various storage allocation cases are discussed that arise, depending on **Target**, how the selection is maintained by the manager, etc.

- Simplest case: no storage associated with this **Target**, no copy/move.
  - Example: selection is a string in a window and **Target** = **window**.
  - Manager's **ConvertProc** should have:

    ```
    RETURN [ [value: window, ops: Selection.nopFreeValueProcs] ]
    ```

  There is nothing allocated, nothing to free, so **ops.free** is Selection.**NopFree**. It makes no sense to copy or move a window this way, so **ops.copyMove** is NIL.

- Slightly more complex case: no storage associated with this **Target**, allow copy/move.
  - Example: selection is a piece of a larger backing string and is maintained as an XString.**ReaderBody** and **Target** = **string**.
  - Manager's global frame:

    ```
    myValueProcs: Selection.ValueProcs ← [
        free: Selection.NopFree, copyMove: CopyMoveString ];
    SelectionData: TYPE = RECORD [ substring: XString.ReaderBody,... ];
    -- substring points at the same bytes as the backing string
    ```

  - Manager's **ConvertProc**:

    ```
    OPEN selectionData: NARROW [data, LONG POINTER TO SelectionData];
    RETURN [ [value: @selectionData.substring, ops: @myValueProcs] ];
    -- Selection will put zone into the context field.
    ```

  Here the requestor points directly at the **SelectionData.substring**. The **value.value↑** cannot be changed by the requestor until after the **CopyMoveString** is called.

  - Manager's **CopyMoveString**:

```
v.value ← XString.CopyReader [r: NARROW [v.value, XString.Reader],
    z: NARROW [v.context, UNCOUNTED ZONE] ];
v.ops.free ← NIL;
```

After doing the copy, **v.ops.free** is replaced with **NIL**, which causes **Free** to call **FreeStd**, which frees the copied **ReaderBody** and bytes. **Note: CopyReader** allocates both the **ReaderBody** and the bytes from a single allocation unit.

Note: The storage for the **SelectionData** is allocated when he **Selection.Set** is done and deallocated when **ActOn [clear]** is called.

- Typical case: some storage associated with this **Target**, allow copy/move
  - Example: selection is a piece of a larger backing string and is maintained as an **Environment.Block** and **Target = string**.
  - Manager's global frame:

```
myValueProcs: Selection.ValueProcs ← [ free: NIL, copyMove: CopyMoveString ];
SelectionData: TYPE = RECORD [ block: Environment.Block,... ];
-- block represents the selection.
 -- block.pointer points to the backing string.
```

  - Manager's **ConvertProc**:

```
OPEN selectionData: NARROW [data, LONG POINTER TO SelectionData];
RETURN [ [
    value: zone.NEW [XString.ReaderBody ←
        XString.FromBlock [selectionData.block],
    ops: @myValueProcs] ];
    -- Selection will put zone into the context field.
    -- ops.free = NIL means that FreeStd will be called.
```

Here we allocate a **ReaderBody** that points directly into our backing string. Free will call **FreeStd**, which will free the **ReaderBody**.

  - Manager's **CopyMoveString**:

```
OPEN zone: NARROW [v.context, UNCOUNTED ZONE] ;
OPEN selectionSubstring: NARROW [v.value, XString.Reader] ;
v.value ← XString.CopyReader [ selectionSubstring, zone ];
zone.FREE [ @selectionSubstring ]; -- frees the ReaderBody
```

CopyReader copies both the **ReaderBody** and the bytes. After doing the copy, we free the **ReaderBody**. **Note:** After the copy, **Free** will still call **FreeStd**, which will free the copied **ReaderBody** and bytes.

39.3.4 Detailed Flowchart of a Selection.Convert

Following is the exact sequence of events that takes place in performing a **Selection.Convert**, showing what the requestor does, what the manager does, and what **Selection** does. Various storage allocation cases arise, depending on the **Target**, what the requestor wants to do, etc.Most of the cases are covered here. This will be most useful to managers, but anyone desiring an overall understanding of **Selection** will benefit from following these details.

- Requestor calls **Selection.Convert**.
- **Convert** calls the manager's **ConvertProc**. If the requestor provided a **NIL** zone, **Convert** passes **Heap.systemZone**.
- Manager constructs a **Value**, potentially allocating storage for **value.value↑** and/or for **value.context↑**. **value.ops** may or may not be provided, depending on the selection **Target** and the manager. Manager returns **value** to **Convert**.
- If **value.context** is defaulted, **Convert** puts **zone** into **value.context** and returns to requestor.
- If requestor just wants to look at the converted value (not copy or move it):
    - Requestor looks at **value.value↑**.
    - Requestor calls **Selection.Free [@value]**;
    - If **value.ops** is **NIL** or **value.ops.free** is **NIL**:
        - **Free** calls **FreeStd**.
        - **FreeStd** recovers the **zone** from **value.context**, does a **zone.FREE [@value.value]**, and replaces **value.ops** with **[free: NopFree, copyMove: NIL]**.
    - If **value.ops.free** is not **NIL**:
        - **Free** calls **value.ops.free [@value]** (that is, the manager's **ValueFreeProc**).
        - The manager's **ValueFreeProc** recovers the **zone** from **value.context** (possibly a field in a record pointed to by **value.context**) and releases any resources that were allocated in the **ConvertProc**. This includes not only the obvious freeing of storage from the zone (**zone.FREE [@value.value]** and/or **Selection.FreeContext [@value, zone]**), but also, for example, closing or deleting any files that were created.
    - END
- If the requestor wants to move or copy the selection:
    - Requestor calls **Selection.Move**, **Selection.Copy**, or **Selection.CopyMove**, perhaps passing in **data: LONG POINTER**, which points to a destination for the move/copy.
    - If **value.ops** is **NIL** or **value.ops.copyMove** is **NIL**, **CopyMove** raises **Error [InvalidOperation]**. Otherwise, **CopyMove** calls **value.ops.copyMove [@value, {copy, move}, data]** (that is, the manager's **ValueCopyMoveProc**).
    - The manager's **ValueCopyMoveProc** recovers the **zone** from **value.context**, gets the destination of the move/copy from **data** (if appropriate), does the move or copy,

calls Selection.FreeContext [@value, zone] if necessary, does a zone.FREE [@oldValue.value] if necessary. **Note:** This is freeing the original value.value, not the copied one! Now the manager can either leave value.ops.free as is, or replace value.ops.free with Selection.FreeStd (if the newly copied value was allocated from zone and zone is in value.context), or replace value.ops.free with Selection.NopFree (if there is nothing left to free).

- CopyMove replaces value.ops.copyMove with NIL to prevent another copy or move from being done.
- Requestor may retain the copied value indefinitely and/or call Selection.Free to free the copied value after using it (see above).
- END

39.3.5 Sample ConvertProc and Requestor

In this example of a simple selection manager, the selection is represented internally as a pair of indices within a single Mesa STRING. The string is inside a window. The indices designate the first character selected and the position beyond the last character selected. It isassume that there are several windows of this type, and that each contains a single string within which selections may be made. It is also assumed that the manager's module contains a procedure TextForWindow that obtains the string associated with a window, and various other obvious utilities and signals. The procedure Select makes a new selection.

A ConvertProc is shown that implements the common targets. Observe the extremely heavy use of the defaults for the ops and context fields in the Value records. Since the Selection interface detects these defaults and applies the most common interpretations for Copy, Move, and Free, both the requestor and the manager are spared much of the coding effort.

```
-- use dynamic storage for data; global variables make save/restore awkward
myZone: UNCOUNTED ZONE = ... ;
SelectionData: TYPE = RECORD [
  w: Window.Handle, -- window containing this selection
  left, right: CARDINAL,
  marked: BOOLEAN ← FALSE];

ValueContext: TYPE = RECORD [ -- for use in Value.context fields
  zone: UNCOUNTED ZONE,
  w: Window.Handle];

Select: PROCEDURE [w: Window.Handle, left, right: CARDINAL] = {
  text: LONG STRING = TextForWindow[w];
  IF text = NIL OR left > text.length OR right NOT IN [left..text.length] THEN
    ERROR BogusSelection;
  Selection.Set[
    myZone.NEW[SelectionData ← [w, left, right]],
    ConvertSelection, ActOnSelection]};
```

```
ConvertSelection: Selection.ConvertProc = {
  <<[data: ManagerData, target: Target, zone: UNCOUNTED ZONE, info: ConversionInfo]
    RETURNS [value: Value]>>
  OPEN selectionData: NARROW [data, LONG POINTER TO SelectionData];
  WITH i:info SELECT FROM
    query = >
      FOR c: CARDINAL IN [0..LENGTH[i.query]) DO
        i.query[c].difficulty ←
          IF ~i.query[c].enumeration THEN SELECT i.query[c].target FROM
            window, string, length, position = > easy,
            integer = > moderate,
            ENDCASE = > impossible
          ELSE --enumerated-- IF i.query[c].target = string THEN moderate
          ELSE impossible;
        ENDLOOP;
    convert = >
      SELECT target FROM
        window = > RETURN[[ selectionData.w, Selection.nopFreeValueProcs]];
        length = > RETURN[[zone.NEW[LONG CARDINAL ←
          selectionData.right - selectionData.left]]];
        position = > RETURN[[zone.NEW[LONG CARDINAL ← selectionData.left]]];
        string, integer = >
          IF selectionData.right - selectionData.left > Selection.maxStringLength THEN
            RETURN[Selection.nullValue]
          ELSE {
            blk: Environment.Block = [LOOPHOLE[@TextForWindow[rec.w].text],
                selectionData.left, selectionData.right];
            r: XString.ReaderBody ← XString.FromBlock[blk];
            IF target = integer THEN {
                bad: BOOLEAN ← FALSE;
                num: LONG INTEGER;
                num ← XString.StringToNumber[@r
                    ! XString.InvalidNumber, XString.Overflow = >
                        {bad ← TRUE; CONTINUE}];
                RETURN[IF bad THEN Selection.nullValue ELSE
                    [zone.NEW[LONG INTEGER ← num]]]};
            -- target = string
            RETURN[[
                value: zone.NEW[XString.ReaderBody ← r],
                ops: @stringOps,
                context: zone.NEW[ValueContext ← [zone, selectionData.w]] ]]};
        ENDCASE;
    enumeration = > IF target = string THEN {
      blk: Environment.Block ← [LOOPHOLE[@TextForWindow[selectionData.w].text],
        selectionData.left, TRASH];
      WHILE block.startIndex < selectionData.right DO
        block.stopIndexPlusOne ←
          MIN[block.startIndex + Selection.maxStringLength, selectionData.right];
        IF i.proc[[
          value: zone.NEW[XString.ReaderBody ← XString.FromBlock[blk]],
          ops: @stringOps,
          context: zone.NEW[ValueContext ← [zone, selectionData.w]] ]
```

```
            ].stop THEN EXIT;
            block.startIndex ← block.stopIndexPlusOne;
            ENDLOOP};
        ENDCASE;
    RETURN[Selection.nullValue]};

stringOps: Selection.ValueProcs ← [FreeString, CopyString];

FreeString: Selection.ValueFreeProc -- [v: ValueHandle] -- = {
    context: LONG POINTER TO ValueContext = v.context;
    context.zone.FREE[@v.value]; -- free the ReaderBody, but not the text bytes
    Selection.FreeContext[ v, context.zone]};

CopyString: Selection.ValueCopyMoveProc = {
    <<[v: ValueHandle, op: CopyOrMove, data: LONG POINTER]>>
    context: LONG POINTER TO ValueContext = v.context;
    old: XString.Reader = v.value;
    IF op = move THEN ERROR Selection.Error[invalidOperation];
    v.value ← XString.CopyReader[old, context.zone];
    context.zone.FREE[@old];
    Selection.FreeContext[ v, context.zone];
    v.ops.free ← NIL};

ActOnSelection: Selection.ActOnProc = {
    <<[data: ManagerData, action: Action] RETURNS [cleared: BOOLEAN ← FALSE]>>
    OPEN selectionData: NARROW [data, LONG POINTER TO SelectionData];
    SELECT action FROM
        mark, unmark => IF selectionData.marked # (action = mark) THEN
            InvertHighlighting[rec];
        save, restore => NULL; -- no special action need be taken
        delete => NULL; -- deletion is not allowed via this interface
        clearIfHasInsert => NULL; -- assume that this tool never has the insertion point
        clear => {myZone.FREE[@data]; cleared ← TRUE};
        ENDCASE};
```

Here are three sample requestors that might invoke the above manager code. The first requestor wishes to interpret the selection, if possible, as a string of digits and obtain the corresponding integer value. The second wishes to open a file whose name is the current selection. (Assume the existence of an **NSFile** routine that deals with **XString**-format file names.) The third wishes to copy the current selection to a Stream unless the selection comprises more than 10000 characters. Since copying an **NSFile** to an arbitrary Stream is awkward at best, it does not use **Convert[file]**, but rather attempts to get the selection as one or more strings to send to the Stream.

```
-- Example 1: obtain selection as an integer and do something with it
num: LONG INTEGER;
ok: BOOLEAN;
[ok, num] ← Selection.ConvertNumber[integer] ;
IF ok THEN {
    << do whatever it was we wanted to do with num >>}
```

```
ELSE {
   <<report error, or ignore it>>};

-- Example 2: use current selection as name of file to open
v: Selection.Value ← Selection.Convert[string];
file: NSFile.Handle ← NSFile.nullHandle;
-- if v.value is NIL it means there's no selection, or it can't be converted to a string,
-- or the string would be so long it's not a reasonable name anyway
IF v.value # NIL THEN {
   file ← NSFile.OpenByName[v.value ! NSFile.Error => CONTINUE];
   Selection.Free[@v]};

-- Example 3: copy selection to a Stream (handle is in sH) unless length > 10000
bytes: LONG CARDINAL; ok: BOOLEAN;
v: Selection.Value;
[ok, bytes] ← Selection.ConvertNumber[length] ;
IF ok AND bytes <= 10000 THEN {
   v ← Selection.Convert[string];
   IF v.value # NIL THEN PutReader[v, sH]
   ELSE [] ← Selection.Enumerate[PutReader, string, sH]};
 . . .
PutReader: Selection.EnumerationProc = {
   <<[element: Value, data: RequestorData] RETURNS [stop: BOOLEAN ← FALSE]>>
   sH: Stream.Handle = data;
   sH.PutBlock[XString.Block[element.value].block
    ! Stream.TimeOut, Volume.InsufficientSpace => {stop ← TRUE; CONTINUE}];
   Selection.Free[@element]};
```

39.3.6 Sample Use of Enumeration

In this example of the use of the enumeration facility, the user has asked to COPY or MOVE the selection to the desktop. The desktop does not particularly care what the selection is; it simply requires that it be rendered as one or more files. If the operation is a MOVE, it is better not to do it as a copy-then-delete; instead, obtain the existing files and relocate them.

```
op: Selection.CopyOrMove ← ... ;  -- setting is determined by the TIP table interpretor
IF Selection.Enumerate[CopyMoveFileToDesktop, file, @op].aborted THEN { -- error -- };
.
.
.
CopyMoveFileToDesktop: Selection.EnumerationProc = {
   op: LONG POINTER TO Selection.CopyOrMove = data;
   file: LONG POINTER TO NSFile.Reference ← element.value;  -- this is readonly until Copied
   or Moved
   Selection.CopyMove[@element, op↑, handleForDesktop
         ! Selection.Error => SELECT code FROM
              -- owner will not let us have it for some reason
              invalidOperation, operationFailed => {stop ← TRUE; CONTINUE};
              ENDCASE => REJECT];
   IF stop THEN {Selection.Free[@element]; RETURN};
   file ← element.value;  -- the value was probably changed by Copy/Move
-- file is now a Reference to a file that is of no interest to the selection manager
<< create any associated structures necessary for keeping track of the icon >>
<< might also need to set position attributes, etc.; it would be more efficient
   to set the attributes as part of the Copy or Move, but this would probably
   require an awkward structuring of CopyMove's data parameter >>
Selection.Free[@element]; -- free the storage associated with the Reference
};
```

Here are two cases where the above code might be invoked. First, assume the selection is a set of documents in an open folder. The folder's conversion proc calls **CopyMoveFileToDesktop** once for each document, with **element** being the **NSFile.References** for the already existing files. The **ops.copyMove** provided by the folder implementation either does an **NSFile.Copy** or an **NSFile.Move** to transfer the file to the desktop directory, and updates **element.value** if necessary to refer to the new file. If the operation is a **move**, **copyMove** also reflects the deletion in the folder's window. It might also update the selection data if, for instance, the selection is represented internally as a range of positional indices within the directory.

If the selection is a set of printers in the Star directory icon, no files exist for them until they are copied to the desktop. For each printer, the conversion procedure creates a file from scratch and passes it to **CopyMoveFileToDesktop**. This time, however, **ops.copyMove** calls **NSFILE.Move** regardless of the operation requested, since it is not actually possible to remove objects from the Star directory. (Alternatively, it could call **NSFile.Move** to do a copy and raise **Error[invalidOperation]** if asked to do a move.) Meanwhile, the **ops.free** originally included with each element is **Selection.NopFree**; if the user chooses not to do anything with the printer, the Star directory enumeration code simply changes the attributes of the file to refer to the next printer in the enumeration and uses the same file again. Thus **ops.copyMove** must also set a flag indicating that a new dummy file must be created if there are any more elements in the enumeration.

The important thing to note is that, in the first example, doing a **copy** involved creating a new file, whereas in the second example it didn't. (Instead, it needed to ensure that the file not be re-used when the enumeration continued.) There was no way for the requestor to decide whether the object needed to be copied. The decision was left up to the selection manager by means of the **ops** procedure.

39.4 Index of Interface Items

Letters in parentheses indicate a description for a requestor (R) or a manager (M).

40

SimpleTextDisplay

40.1 Overview

The **SimpleTextDisplay** interface provides facilities for displaying, measuring, and resolving strings of *Xerox Character Code Standard* text. **SimpleTextDisplay** deals with text in a single font--normally the standard system font--and does not support boldface, italic, sub- and superscript, and other text properties. **SimpleTextDisplay** does not implement editable or selectable text, but it provides the building blocks that can be used to implement such things. (See **SimpleTextEdit**.)

Most clients will be interested mainly in the procedure **StringIntoWindow**, which simply displays one or more lines of text at a given location in a window.

More sophisticated clients may want to use **StringIntoBuffer**, which formats text into a special bitmap buffer rather than painting it into a window; **MeasureString**, which determines how wide a string would appear if painted into a window without actually painting it; or **FillResolveBuffer**, which computes the position of each character of an already-displayed line of text.

All width values taken or returned by **SimpleTextDisplay** procedures are in terms of screen pixels (bits).

40.2 Interface Items

40.2.1 Simplest Way to Display Text

```
StringIntoWindow: PROCEDURE [
   string: XString.Reader,
   window: Window.Handle,
   place: Window.Place,
   lineWidth: CARDINAL ← CARDINAL.LAST,
   maxNumberOfLines: CARDINAL ← 1,
   lineToLineDeltaY: CARDINAL ← 0, -- default: systemFontHeight
   wordBreak: BOOLEAN ← TRUE,
  flags: BitBlt.BitBltFlags ←Display.paintFlags]
  RETURNS [lines, lastLineWidth: CARDINAL];
```

Displays **string** in **window**, starting at **place**. Each line will be no more than **lineWidth** pixels wide, and there will be no more than **maxNumberOfLines** lines. If **wordBreak** is TRUE, **StringIntoWindow** will try to break lines between, rather than within, words. The **flags** determine what **BitBlt** function will be used to place the new bits in the window; the default is to OR them into the window's existing bitmap. When a new line is started, its y-position will be **lineToLineDeltaY** below the y-position of the previous line; if **lineToLineDeltaY** is defaulted to 0, each line will be **systemFontHeight** pixels below the previous one. **lines** is the number of lines that were actually painted. **lastLineWidth** is the width of the last line displayed. If the string ends with a carriage return and **maxNumberOfLines** are not exceeded, then **lastLineWidth** is 0 and **lines** include an empty line following that carriage return. If the string is empty, **StringIntoWindow** returns **[lines: 0, lastLineWidth: 0]**.

StringIntoWindow always uses the standard system font, a **Flushness** of **fromFirstChar**, and a **StreakSuccession** of **fromFirstChar**. (See §40.2.4 for an explanation of **Flushness** and **StreakSuccession**.)

```
systemFontHeight: READONLY CARDINAL;
```

systemFontHeight is the height (in pixels) of the system font.

40.2.2 StringIntoBuffer

```
StringIntoBuffer: PROCEDURE [
  string: XString.Reader,
  bufferProc: BufferProc,
  lineWidth: CARDINAL ←CARDINAL.LAST,
  wordBreak: BOOLEAN ←TRUE,
  streakSuccession: StreakSuccession ←fromFirstChar,
  font: SimpleTextFont.MappedFontHandle ←NIL]
  RETURNS [lastLineWidth: CARDINAL, result: Result, rest: XString.ReaderBody];
```

Formats **string** into a bitmap buffer using **font** and calls **bufferProc** for each line. (See **BufferProc** below for a description of the parameters passed to **bufferProc**.) If **font** is NIL, the system font is used. **StringIntoBuffer** stops reading characters in the string and calls **bufferProc** when one of the following events occurs:

- A carriage return is encountered. **bufferProc** will be called with a **result** of **stop**. The **string** passed to **bufferProc** will end with the carriage return.

- The **lineWidth** (measured in pixels) would be exceeded by formatting the next character. **bufferProc** will be called with a **result** of **margin**. The **string** passed to **bufferProc** will end with the last character that did fit (if **wordBreak** is FALSE), or with the last character before the beginning of the word that did not fit (if **wordBreak** is TRUE).

- There are no more characters to be read. **bufferProc** will be called with a **result** of **normal**. The **string** passed to **bufferProc** will end with the last character of the string passed to **StringIntoBuffer**.

```
Result: TYPE = {normal, margin, stop};
```

If **result** = **normal**, or **bufferProc** returns **continue** = FALSE, **StringIntoBuffer** returns the following values: **result** = the result last passed to **bufferProc**, **rest** = a substring containing characters not yet processed (**rest.offset** will be the **string.limit** last passed to **bufferProc**), **lastLineWidth** = the dims.w last passed to **bufferProc**.

If **result** is not **normal**, and **bufferProc** returns **continue** = TRUE, **StringIntoBuffer** continues processing the remainder of **string** and calls **bufferProc** again.

If **string** is empty, **StringIntoBuffer** returns **[width: 0, result: normal, rest: XString.nullReaderBody]** and does not call **bufferProc** at all.

```
BufferProc: TYPE = PROCEDURE [
   result: Result,
   string: XString.Reader,
   address: Environment.BitAddress,
   dims: Window.Dims,
   bitsPerLine: CARDINAL]
   RETURNS [continue: BOOLEAN];
```

A **BufferProc** is called once on each line of text processed by **StringIntoBuffer**. The procedure should return TRUE if it wants **StringIntoBuffer** to process the remaining text (and to call the **BufferProc** again). The parameters should be interpreted as follows:

result explains why **StringIntoBuffer** decided to end the current line of text:

stop	if the line ends with a carriage return character.
normal	if there are no more characters to be processed after this line. In this case, **StringIntoBuffer** will ignore the **continue** boolean that the **BufferProc** returns.
margin	if the line was broken to avoid exceeding the **lineWidth** passed to **StringIntoBuffer**.

string is a substring of the string passed to **StringIntoBuffer**, which contains exactly those characters on this line. If the line ends with a carriage return, the carriage return is the last character in **string**.

address is the address of the bitmap buffer into which the current line's characters have been formatted.

dims is the dimensions of the formatted part of the bitmap buffer. **dims.h** will always be equal to the height of **font** passed to **StringIntoBuffer** (or to **systemFontHeight** if **font** was NIL). **dims.w** will always be < = the **lineWidth** passed to **StringIntoBuffer**.

bitsPerLine is the number of bits per bitmap line in the buffer; that is, how many bits to add to **address** to reach the beginning of the next bitmap line. This will always be a multiple of 16.

Fine point: If the string passed to **StringIntoBuffer** ends in a carriage return, and the **BufferProc** returns **TRUE**, the **BufferProc** will be called one last time with an empty **string** (offset and limit both equal to the passed string.**limit**), an empty bitmap (**dims.w = 0**), and **result = normal**.

40.2.3 Measure and Resolve

```
GetCharWidth: PROCEDURE [char: XChar.Character,
  font: SimpleTextFont.MappedFontHandle ← NIL]
  RETURNS [width: CARDINAL];
```

Returns the **width** of the specified character in the specified **font**. If font is **NIL**, the system font is used.

```
MeasureString: PROCEDURE [
  string: XString.Reader,
  lineWidth: CARDINAL ← CARDINAL.LAST,
  wordBreak: BOOLEAN ← TRUE,
  streakSuccession: StreakSuccession ← fromFirstChar,
  font: SimpleTextFont.MappedFontHandle ← NIL]
  RETURNS [width: CARDINAL, result: Result, rest: XString.ReaderBody];
```

MeasureString determines the number of horizontal pixels that would be taken up by displaying **string** in the specified **font**. If **font** is **NIL**, the system font is used. If **wordBreak** is **TRUE** and the string will not fit into **lineWidth** pixels, **MeasureString** attempts to end the line between words. **result** is one of the following:

stop	If a carriage return character is encountered in the string before **lineWidth** pixels have been measured out. In this case, **width** is the pixel width of those characters up to and including the carriage return, and **rest** begins with the first character following the carriage return.
margin	If the string will not fit within **lineWidth** horizontal pixels. In this case, **width** is the pixel width of those characters that do fit (possibly backed up to the end of the last word that entirely fits on the line, if **wordBreak** is **TRUE**), and **rest** begins with the first character that does not fit.
normal	If the string contains no carriage returns and fits entirely within **lineWidth** horizontal pixels. In this case, **rest** is empty.

If **string** is empty, **MeasureString** returns **[width: 0, result: normal, rest: XString.nullReaderBody]**.

```
FillResolveBuffer: PROCEDURE [
  string: XString.Reader,
  lineWidth: CARDINAL ← CARDINAL.LAST,
  wordBreak: BOOLEAN ← TRUE,
  streakSuccession: StreakSuccession ← fromFirstChar,
  resolve: ResovleBuffer,
  font: SimpleTextFont.MappedFontHandle ← NIL]
  RETURNS [width: CARDINAL, result: Result, rest: XString.ReaderBody];
```

FillResolveBuffer measures the x-offset of the left edge of each character of **string** relative to the left edge of the leftmost character and stores the measurements in the **resolve** array. The measurements are in units of pixels. The offset of the leftmost character is zero. There is one element in the resolve array for each of the bytes (not characters) of **string**. The measurement stored for each byte of **string** is the measure for the character that the byte is a part of. The measure stored for character set shift codes is that of the next actual character in the string. (For the meaning of the return values, see the description of **MeasureString**.)

The **resolve** buffer must be **string.limit-string.offset + 1** words long to avoid smashing memory.

If **string.context.suffixSize = 1** and the string contains no character set shifts (377Bs), that is,if there is one byte per character, then:

> **resolve[0]** is assigned x-offset of the character **string.bytes[string.offset]**,
> **resolve[1]** is assigned the x-offset of the character **string.bytes[string.offset + 1]**,
> ....,
> **resolve[string.limit-string.offset-1]** is assigned the x-offset of the character **string.bytes[string.limit-1]**.

If the string does contain 377Bs, then any character set shift bytes ([377B, chset] or [377B, 377B, 0]) are assigned the same resolve value as the following character code byte.

In any part of the string that is in Stringlet16 format (2 bytes per character), both bytes of each character are assigned the same resolve value.

If a sequence of characters would be displayed as a ligature--a single graphic representing several adjacent characters--then all of those characters are assigned the same resolve value.

In all cases, **resolve[string.limit-string.offset]** is assigned the pixel width of the string; the same value that is given to the returned value **width**.

If **string** is empty, **FillResolveBuffer** returns **[width: 0, result: normal, rest: XString.nullReaderBody]** and does not write into the resolve buffer at all.

ResolveBuffer: TYPE = LONG DESCRIPTOR FOR ARRAY [0..0) OF CARDINAL;

NewResolveBuffer: PROCEDURE **[words:** CARDINAL**]** RETURNS **[ResolveBuffer];**

Allocates a resolve buffer of the specified length for later use by **FillResolveBuffer**. Non-**SimpleTextDisplay** clients of **TextBlt** are also encouraged to obtain their resolve buffers by calling this procedure, since **SimpleTextDisplay** caches resolve buffers for efficiency.

FreeResolveBuffer: PROCEDURE **[ResolveBuffer];**

Frees a resolve buffer allocated by **NewResolveBuffer**.

40.2.4 Multinational Items

Flushness: TYPE = **{flushLeft, flushRight, fromFirstChar};**

A **Flushness** determines where to display a line of text that does not fill the entire bitmap width allotted to it. **flushLeft** means to place the leftmost character at the left edge of the bitmap. **flushRight** means to place the rightmost character at the right edge of the bitmap. **fromFirstChar** is equivalent to **flushLeft** if the first character of the text has **XChar.JoinDirection = nextCharToRight** (for example, Latin and most other alphabets); it is equivalent to **flushRight** if the first character of the text has **JoinDirection** = **nextCharToLeft** (for example, Arabic and Hebrew letters).

```
PeekForFlushness: PROCEDURE [requestedFlushness: Flushness, string: XString.Reader]
  RETURNS [Flushness];
```

Returns a real flushness (either **flushLeft** or **flushRight**, not **fromFirstChar**) appropriate for the passed **requestedFlushness** and **string**.

```
StreakSuccession: TYPE = {leftToRight, rightToLeft, fromFirstChar};
```

```
PeekForStreakSuccession: PROCEDURE [
  requestedStreakSuccession: StreakSuccession, string: XString.Reader]
  RETURNS [StreakSuccession];
```

Returns a real streak succession (either **leftToRight** or **rightToLeft**, not **fromFirstChar**) appropriate for the passed **requestedStreakSuccession** and **string**.

40.3 Usage/Examples

The only non-Xerox Character Code that is significant to **SimpleTextDisplay** is Carriage Return. No other control characters are recognized.

All width values taken or returned by **SimpleTextDisplay** procedures are in terms of screen pixels (bits). If the client passes his own font to **SimpleTextDisplay**, its mica widths should be equal to its pixel widths. Fonts passed to **SimpleTextDisplay** should have no measurements actually in micas.

40.3.1 StringIntoWindow

```
rb: XString.ReaderBody ← XString.FromSTRING ["This is an example."L];
[] ← SimpleTextDisplay.StringIntoWindow [
  string: @rb,
  window: window,
  place: [10,10]];
```

40.3.2 StringIntoBuffer

This example shows an implementation of **StringIntoWindow** using **StringIntoBuffer**.

```
MyStringIntoWindow: PROCEDURE [
  string: XString.Reader,
  window: Window.Handle,
  place: Window.Place,
  lineWidth: CARDINAL ← CARDINAL.LAST,
  maxNumberOfLines: CARDINAL ← 1,
  lineToLineDeltaY: CARDINAL ← 0,
  wordBreak: BOOLEAN ← TRUE,
  flags: BitBlt.BitBltFlags ← Display.paintFlags]
```

```
RETURNS [lines: CARDINAL, lastLineWidth: CARDINAL] = {

MyBufferProc: SimpleTextDisplay.BufferProc = {
   Display.Bitmap [window, [place, dims], address, bitsPerLine, flags];
   lines ← lines + 1;
   place.y ← place.y + lineToLineDeltaY;
   RETURN [continue: lines < maxNumberOfLines];
   };

IF lineToLineDeltaY = 0 THEN lineToLineDeltaY ← SimpleTextDisplay.systemFontHeight;
lines ← 0;

[lastLineWidth: lastLineWidth] ← SimpleTextDisplay.StringIntoBuffer [
   string: @rb,
   bufferProc: MyBufferProc,
   lineWidth: lineWidth,
   wordBreak: wordBreak];
};
```

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41

SimpleTextEdit

41.1 Overview

The **SimpleTextEdit** interface provides facilities for presenting short editable pieces of text, known as fields, to the user. The user can select, move, copy, delete, and edit the text. Such text can contain any sequence of characters supported by the *Xerox Character Code Standard.*

All the text in a **SimpleTextEdit** field is displayed in a single font. Multiple fonts, boldface, italics, subscript, superscript, paragraph and character properties, and other elaborate editor features are not provided by **SimpleTextEdit**.

SimpleTextEdit fields are most appropriate for short pieces of text, preferably less than 30 lines long. They are not appropriate for editing entire files, for example.

SimpleTextEdit is primarily intended to support text items in the higher-level **FormWindow** interface, but is also provided as a public interface for those clients who may need it. Most clients will want to use **FormWindow** rather than **SimpleTextEdit**. **FormWindow** provides support for general forms, including choice, boolean, and command items. **FormWindow** also automatically adjusts the position of other fields when a text field becomes taller or shorter. The client of **SimpleTextEdit** must provide its own procedure to do this.

41.1.1 Creating Fields

Fields are created by calling **CreateField**. Before creating any fields, however, a **FieldContext** must first be created by calling **CreateFieldContext**. There must be one **FieldContext** for each window that will contain **Fields**. The **FieldContext** returned by **CreateFieldContext** should be passed to **CreateField** for each field to be created. When a field is created, only the desired **Window.Dims** of the field need to be supplied.

41.1.2 Displaying a Field

A field is displayed by calling **RepaintField**. Before a field can be displayed, it must be given a **Window.Place** by calling **SetPlace**. Failure to call **SetPlace** before displaying a field will result in **Error [fieldIsNoPlace]**.

41.1.3 Notifying a Field

Notifications are passed to a field by calling **TIPResults**. **SimpleTextEdit** does not attach a window **displayProc** nor a **TIP.NotifyProc** to a window. Rather, the client provides these procedures and then calls **RepaintField** for display and **TIPResults** for notifications. If there is more than one field in a window or a single field does not occupy an entire window, the client must resolve mouse buttons to determine which field should get the notification.

41.2 Interface Items

41.2.1 FieldContext

```
FieldContext: TYPE = LONG POINTER TO FieldContextObject;

FieldContextObject: TYPE;

CreateFieldContext: PROCEDURE [z: UNCOUNTED ZONE, window: Window.Handle,
   changeSizeProc: ChangeSizeProc, font: SimpleTextFont.MappedFontHandle ← NIL]
   RETURNS [fc: FieldContext];
```

A **FieldContext** holds information that is common to all **Fields** in a given window. There must be exactly one **FieldContext** associated with any window containing **Fields**. The **FieldContext** contains such information as the fields' font, the current input focus, the field containing the current selection, and so forth.

CreateFieldContext creates a **FieldContext** for **window**, which can be later used to create individual **Fields** (see **CreateField**). Only one **FieldContext** should be created for any window. All storage associated with the **FieldContext** and its **Fields** is allocated from **z**. The **changeSizeProc** is called whenever any field's height is changed (see **ChangeSizeProc** below). All text in the **FieldContext**'s fields will be displayed with the supplied **font**. If **font** is defaulted (the usual case), the standard system font is used.

```
DestroyFieldContext: PROCEDURE [fc: FieldContext];
```

DestroyFieldContext destroys a **FieldContext**. If any of **fc**'s fields has the input focus, it clears the input focus and turns off the blinking caret. If any of **fc**'s fields contains the current selection, it clears and dehighlights the selection. **DestroyFieldContext** does *not* destroy each field. The client should either call **DestroyField** on each field *before* calling **DestroyFieldContext** or else dispose of the associated **UNCOUNTED ZONE** *after* calling **DestroyFieldContext**. The client should not call **DestroyField** after calling **DestroyFieldContext**.

41.2.2 Creating Fields

```
Field: TYPE = LONG POINTER TO FieldObject;

FieldObject: TYPE;

CreateField: PROCEDURE [
   clientData: LONG POINTER,
   context: FieldContext,
   dims: Window.Dims,
   initString: XString.Reader ← NIL,
   flushness: SimpleTextDisplay.Flushness ← fromFirstChar,
   streakSuccession: SimpleTextDisplay.StreakSuccession ← fromFirstChar,
   readOnly, password: BOOLEAN ← FALSE,
   fixedHeight: BOOLEAN ← FALSE,
   font: SimpleTextFont.MappedFontHandle ← NIL,
   backingWriter: XString.Writer ← NIL,
   SPECIALKeyboard: BlackKeys.Keyboard ← NIL]
   RETURNS [f: Field];
```

A **Field** is an area within a window that contains editable text. It is the primary object manipulated by this interface.

CreateField creates a field with appropriate attributes. The field will use the window, font, zone, and **ChangeSizeProc** of the passed **FieldContext**.

clientData is a pointer which is not interpreted but is returned by **GetClientData**. Clients may use it to associate their own data with each individual field.

dims are the initial dimensions of the field. As the field's contents change, its height may change as well (unless **fixedHeight** is TRUE). However, the height will never become smaller than **dims.h**.

initString is the initial contents of the field, if any. **CreateField** copies the string; the caller continues to own it when **CreateField** returns.

flushness controls where to place lines of text that do not fill the entire width of the field. If **flushness = flushLeft**, the leftmost character is next to the field's left edge. If **flushness = flushRight**, the rightmost character is next to the field's right edge. If **flushness = fromFirstChar**, the field is **flushLeft** if its first character has **XChar.JoinDirection = nextCharToRight** (for example, Latin and most other alphabets), and **flushRight** if the first character has **JoinDirection = nextCharToLeft** (for example, Arabic and Hebrew letters).

streakSuccession indicates whether the text of the field flows **leftToRight** or **rightToLeft**. The default (**fromFirstChar**) causes the **streakSuccession** of the field to be determined from the first character in the field. Latin and most other alphabets flow **leftToRight**. Arabic and Hebrew flow **rightToLeft**.

If **readOnly** is TRUE, the user cannot change the field's contents. **SetInputFocus** is a no-op on a **readOnly** field, and any call on **TIPResults** that would normally set the input focus to this field, or change the field's contents will not do so. However, **SetValue** still works on a **readOnly** field.

If **password** is TRUE, each character of the field will be displayed as a *. If a selection is made within a password field, and that selection is moved or copied, * characters will be moved or copied rather than characters from the field's actual backing string.

Selection.Convert will also produce a string full of " characters. The only way to access a password field's actual content is to call **GetValue**.

If **fixedHeight** is TRUE, the field's height will never change regardless of the field's content. The context's **ChangeSizeProc** will never be called with this field as an argument.

font allows each field to be a different font. If **font** is NIL, then the system font is used. **Note:** This does not provide for general attributed text in **SimpleTextEdit** fields. The entire field is all the same font.

If **backingWriter** is NIL (the usual case), **SimpleTextEdit** allocates the field's backing string from the context's zone, expands it as needed, and deallocates it when the field is destroyed. If **backingWriter** is non-NIL, **SimpleTextEdit** uses it as the backing string and does not deallocate it when the field is destroyed. If **backingWriter.zone** is NIL, **TIPResults** raises **Error [noRoomInWriter]** whenever it tries to do an operation that would overflow the backing string.

SPECIALKeyboard allows a client-specified interpretation of the central keypad.

DestroyField: PROCEDURE [f: Field];

Destroys the passed field. If the field has the input focus, it clears the input focus and turns off the blinking caret. If the field contains the current selection, it clears and dehighlights the selection. **DestroyField** must not be called after the field's context has been destroyed.

GetValue: PROCEDURE [f: Field] RETURNS [XString.ReaderBody];

Returns the field's current contents. The returned string points directly into the field's backing storage; it is not copied.

SetValue: PROCEDURE [f: Field, string: XString.Reader, repaint: BOOLEAN ← TRUE];

Change the contents of the field. Copies the string, which the caller continues to own after **SetValue** returns. Repaints the field unless **repaint** is FALSE. In that case, the caller should call **RepaintField** before returning to the notifier. If the field has the input focus, it clears the input focus and turns off the blinking caret. If the field has the selection, it clears and dehighlights the selection. If **repaint** is TRUE, the field may become taller or shorter, triggering a call on the **ChangeSizeProc**.

41.2.3 Displaying a Field

RepaintField: PROCEDURE [f: Field];

Repaints the field.

SetPlace: PROCEDURE [f: Field, place: Window.Place];

Changes the window-relative location of the field. This procedure must have been called at least once before calling **GetBox**, **RepaintField**, or **TIPResults**; otherwise, calling those procedures raises **Error [fieldIsNoplace]**. Does not repaint the field. **SetPlace** is intended for two primary uses: to set the initial location of a field, and to change it from within a **ChangeSizeProc** when another field is getting taller or shorter.

41.2.4 Notifying a Field

TIPResults: PROCEDURE [f: Field, results: TIP.Results]
RETURNS [tookInputFocus, changed: BOOLEAN];

Passes **results** to the specified field. The field is changed as appropriate. For example, if **results** contains a PointDown atom, the character closest to the cursor is highlighted. Details of the exact processing performed for each possible result are described below. If the field's contents are changed while processing the results, **changed** will be **TRUE**. If the input focus was set to this field, **tookInputFocus** will be **TRUE**. Both booleans start out **FALSE** but may become **TRUE** when strings or atoms are encountered in **results**. Any **TIP.Results** that change the field's contents also cause the field to be repainted; this may cause the field to become taller or shorter, triggering a call on its **ChangeSizeProc**.

If a string is encountered in **results**, the string is inserted into the field at the current insertion point. This clears the selection if the current insertion point is at either end of the selection. The passed field must be the current input focus and not **readOnly**; otherwise, the string is ignored.

The following atoms in **results** cause actions to be taken. An * indicates that the passed field must be the current input focus; if not, the atom is ignored. Unless otherwise indicated, **tookInputFocus** and **changed** remains unaffected after this atom is processed.

AdjustDown (should be preceded by a **coords** result): Extends or contracts the current selection, depending on **coords** earlier in **results**. If there is no current selection, creates one extending from the current insertion point to a place determined by **coords**. This is a no-op if the passed field is not the current input focus or selection.

AdjustMotion (should be preceded by a **coords** result): Same effect as **AdjustDown**, although a different algorithm is used to determine which endpoint of the selection is being moved.

BackSpace*: If the field is not **readOnly**, deletes the character before the insertion point and sets **changed** to **TRUE**. This clears the selection if the current insertion point is at either end of the selection.

BackWord*: If the field is not **readOnly**, deletes the word before the insertion point and sets **changed** to **TRUE**. This clears the selection if the current insertion point is at either end of the selection. If the field is a password field, acts like a **BackSpace**.

CopyDown: Calls **TIPStar.SetMode [copy]**.

CopyModeDown (should be preceded by a **coords** result): If the field is not **readOnly**, places the caret at an appropriate place in the field, depending upon **coords** earlier in results, but leaves the selection alone. **tookInputFocus** will be **TRUE**. If the field is **readOnly**, this is a no-op and **tookInputFocus** is unchanged.

CopyModeMotion (should be preceded by a **coords** result): Same effect as **CopyModeDown**.

CopyModeUp*: If the field is not **readOnly**, inserts the current selection at the current insertion point, sets the selection to be the newly inserted text, and calls **TIPStar.SetMode**

[normal]. If the selection is not empty, repaints the field and sets **changed** to **TRUE**. If the field is **readOnly**, this is a no-op and **changed** remains unaffected.

DeleteDown: Calls **Selection.ActOn [delete]**. **changed** becomes **TRUE**.

MoveDown: Calls **TIPStar.SetMode [move]**.

MoveModeDown (should be preceded by a **coords** result): Same effect as **CopyModeDown**.

MoveModeMotion (should be preceded by a **coords** result): Same effect as **CopyModeDown**.

MoveModeUp*: Same effect as **CopyModeUp**, except that it does a **Selection.ActOn [delete]** on the current selection before setting the selection to be the newly inserted text. Note that if the current selection is in a **readOnly** field, no deletion occurs, and it acts exactly like a **CopyModeUp**.

NewLine*: If the field is not **readOnly**, inserts an **Ascii.CR** at the current caret position. This clears the selection if the current insertion point is at either end of the selection. **changed** will be **TRUE**. If the field is **readOnly**, is a no-op and **changed** is unaffected.

NewParagraph*: Same effect as **NewLine**.

PointDown (should be preceded by a **coords** result and a **time** result): Sets the current selection to be in the passed field. The location of the selection depends upon **coords** earlier in **results**; the extent (character, word, paragraph) depends on its current extent and **time** earlier in **results**. **tookInputFocus** is **TRUE** unless the field is **readOnly**.

PointMotion (should be preceded by a **coords** result): Moves the current selection within the field. If the current selection is not in the field, it sets it there. The location of the selection depends upon **coords** earlier in **results**. The extent of the selection (character, word, paragraph) remains unchanged. **tookInputFocus** is **TRUE** unless the field is **readOnly**.

PointUp (should be preceded by a **time** result): Sets the last-click time ,which determines whether a subsequent **PointDown** represents a multiple-click.

Stop: Calls **TIPStar.SetMode [normal]**.

41.2.5 Miscellaneous Get and Set Procedures

GetBox: PROCEDURE [f: Field] RETURNS [box: Window.Box];

Returns the box (dimensions and place) currently occupied by **f**. **box.place** will be relative to the field's window, and is always be the last value passed to **SetPlace**. Raises **Error [fieldIsNoplace]** if **SetPlace** has never been called on this field.

GetClientData: PROCEDURE [f: Field] RETURNS [clientData: LONG POINTER];

Returns the **clientData** that was passed to **CreateField**.

GetFieldContext: PROCEDURE [f: Field] RETURNS [FieldContext];

Returns the field context that was passed to **CreateField**.

GetFlushness: PROCEDURE [f: Field] RETURNS [SimpleTextDisplay.Flushness];

Returns the current **Flushness** of f.

**GetFont: PROCEDURE [f: Field]
RETURNS [SimpleTextFont.MappedFontHandle];**

GetInputFocus: PROCEDURE [fc: FieldContext] RETURNS [Field];

If some field associated with fc has the input focus, it returns that field; otherwise, it returns NIL.

**GetCaretPlace: PROCEDURE [context: FieldContext]
RETURNS [place: Window.Place];**

If any field in the **FieldContext** contains the current type-in point, this procedure returns the location of that point. If not, place=[-1,-1]. This is useful for determining that the window must be scrolled to make the caret visible to the user.

GetReadOnly: PROCEDURE [f: Field] RETURNS [BOOLEAN];

Returns the current value of **readOnly** for f.

GetStreakSuccession: PROCEDURE [f: Field] RETURNS [SimpleTextDisplay.StreakSuccession];

Returns the current **StreakSuccession** of f.

GetWindow: PROCEDURE [fc: FieldContext] RETURNS [window: Window.Handle];

Returns the window that was passed to **CreateFieldContext**.

GetZone: PROCEDURE [fc: FieldContext] RETURNS [UNCOUNTED ZONE];

Returns the UNCOUNTED ZONE that was passed to **CreateFieldContext**.

SetDims: PROCEDURE [f: Field, dims: Window.Dims];

SetDims sets the dimensions for f.

**SetFixedHeight: PROCEDURE [f: SimpleTextEdit.Field,
fixedHeight: BOOLEAN];**

Allows setting of the fixed height attribute for a field.

**SetFlushness: PROCEDURE [f: Field, new: SimpleTextDisplay.Flushness]
RETURNS [old: SimpleTextDisplay.Flushness];**

Changes the field's flushness and returns the old flushness. Does not repaint the field.

**SetFont: PROCEDURE [f: Field,
font: SimpleTextFont.MappedFontHandle ← NIL];**

If **font** = NIL, the system font is used.

SetInputFocus: PROCEDURE [f: Field, beforeChar: CARDINAL ← CARDINAL.LAST];

Sets the current input focus to be in this field and places the blinking caret before the specified character. If **beforeChar** is 0, puts the caret before the first character; if it is CARDINAL.LAST or otherwise larger than the length of the backing string, the caret is placed after the last character in the field. Does not affect the current selection.

SetReadOnly: PROCEDURE [f: Field, readOnly: BOOLEAN] RETURNS [old: BOOLEAN];

Changes the field's **readOnly** attribute and returns its old value. If this field has the input focus and **readOnly** is TRUE, clears the input focus and turns off the blinking caret. If this field has the selection and **readOnly** is FALSE and **old** is TRUE, sets the input focus to this field and places the caret after the last character in the selection.

**SetSelection: PROCEDURE [f: Field,
firstChar: CARDINAL ← 0, lastChar: CARDINAL ← CARDINAL.LAST];**

Sets the current selection to be in this field, covering the specified range of characters. If **firstChar** is 0, the selection begins with the first character of the field. If **lastChar** is CARDINAL.LAST or otherwise larger than the length of the backing string, the selection extends to the end of the string. Highlights the selection if it is not empty. Does not affect the input focus or caret.

**SetStreakSuccession: PROCEDURE [f: Field, new: SimpleTextDisplay.StreakSuccession]
RETURNS [old: SimpleTextDisplay.StreakSuccession];**

Changes the field's **StreakSuccession** and returns the old **StreakSuccession**. Does not repaint the field.

41.2.6 ChangeSizeProc

**ChangeSizeProc: TYPE = PROCEDURE [f: Field, oldHeight, newHeight: INTEGER,
repaint: BOOLEAN];**

Each **FieldContext** has a **ChangeSizeProc** associated with it. This procedure is called whenever any of its fields is redisplayed and finds that the number of lines of text being displayed has changed. It may be called as a result of calling either **RepaintField**. **TIPResults**, or **SetValue** with **repaint** = TRUE. The client is expected to update any affected data structures (such as the Window.**Place** of other fields) and then optionally repaint any part of the window that is invalid. (There are two exceptions: the **ChangeSizeProc** is never called on a field for which **CreateField** was called with **fixedHeight** = TRUE, and it is not called if both the old and new number of text lines require fewer vertical pixels than the height **dims.h** that was specified to **CreateField**.)

The **oldHeight** and **newHeight** parameters are in vertical pixels. **inDisplayProc** is TRUE if the **ChangeSizeProc** is being called as a result of calling **RepaintField** with **repaint** = TRUE (that is, is being called indirectly by Window.**Validate**).

If **repaint** is TRUE, the **ChangeSizeProc** should not do a **Window.Validate**, since this would cause undesirable recursion.

41.2.7 Errors

Error: ERROR **[type: ErrorType];**

ErrorType: TYPE **= {fieldIsNoplace, noRoomInWriter, lastCharGTfirstChar};**

Error [fieldIsNoplace] is raised by **GetBox**, **RepaintField**, and **TIPResults** if **SetPlace** has never been called on the passed field. **Error [noRoomInWriter]** is raised by **CreateField**, **SetValue**, and **TIPResults** if a non-NIL **backingWriter** was passed to **CreateField**, the **backingWriter** has a NIL zone, and the desired operation would overflow the string.

41.3 Usage/Examples

41.3.1 Selection Management

If certain atoms (**PointDown**, **PointMotion**, **AdjustDown**, **AdjustMotion**, **CopyModeUp**, **MoveModeUp**) are in the **TIP.Results** passed to **TIPResults**, **SimpleTextEdit** may become the manager of the current selection. The procedure **SetSelection** also causes **SimpleTextEdit** to manage the curent selection.

While **SimpleTextEdit** is managing the current selection, it supports conversions to the following **Selection.Targets**: **shell**, **subwindow**, **length**, and **string**. It also supports **Selection.Enumerate** with a target of **string**.

SimpleTextEdit implements the following **Selection.Actions**:**mark**, **unmark**, **clear**, **delete**, **clearIfHasInsert**, **restore**, and **save**. All other **Actions** are ignored.

Selection.ActOn [delete] automatically repaints the field that contained the current selection; the field may become taller or shorter, triggering a call on its **ChangeSizeProc**. **Selection.ActOn [delete]** is a no-op if the current selection is in a **readOnly** field.

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SimpleTextFont

42.1 Overview

The **SimpleTextFont** interface provides access to the default system font that is used to displayViewPoint's text, such as the text in menus, the attention window, window name stripes, containers, property sheet text items, and so forth. This interface is a specialization of the regular font management subsystem.

42.2 Interface Items

42.2.1 System Font

MappedFontDescriptor: TYPE;

MappedFontHandle: TYPE = LONG POINTER TO **MappedFontDescriptor;**

MappedFontDescriptor is an opaque type that contains all of the information about a font. (All metrics, including the width of each character, are in screen dots, not micas.)

MappedDefaultFont: PROCEDURE RETURNS **[MappedFontHandle];**

MappedDefaultFont returns the client a handle onto the system default font. May raise **FontNotFound** or **Problem[badFont]**. The implementation of **SimpleTextFont** expects that the default font is available on the system volume, in the System catalog, with the name System.Font.

MappedFont: PROCEDURE **[name:** XString.**Reader**← NIL**]**
  RETURNS **[MappedFontHandle];**

MappedFont returns a handle onto the **named** system font. Supplying NIL is the equivalent of calling **MappedDefaultFont**. May raise **FontNotFound** or **Problem[badFont]**.

UnmapFont: PROCEDURE **[MappedFontHandle];**

Unmaps a font that was mapped with SimpleTextFont.**MappedFont**.

42.2.2 Client-Defined Characters

```
AddClientDefinedCharacter: PROCEDURE [
  width, height: CARDINAL,
  bitsPerLine: CARDINAL,
  bits: LONG POINTER,
  offsetIntoBits: CARDINAL ← 0 ]
  RETURNS [XString.Character];
```

AddClientDefinedCharacter adds the client's bitmap to the system font as a new character and returns the sixteen-bit value of the character position it is assigned. The new character's **TextBlt** flags indicate that it is neither a stop nor a pad character. At start-up time, at least 100 slots are available for these new characters. [0,26] normally displays as the blob character. May raise **Problem[clientCharacterBitsExhausted]** or **Problem[clientCharacterCodesExhausted]**. If RESUMEd the character [0,26] is returned.

The *Xerox Character Code Standard* sets aside a block of character codes for user definition. (See the *Xerox Rendering Code Standard,* XSIS 068208 page 6.) In Star, it is often useful to include a small picture, for example, a 13x13 icon drawing, within a message or other text.

The **AddClientDefinedCharacter** procedure provides a convenient way of presenting such little pictures within formatted system text. You create a character for the picture, say in initialization code, and then simply use that (16-bit) character within ordinary text sequences, such as window titles.

42.2.3 Signals and Errors

```
FontNotFound: SIGNAL [name: XString.Reader];
```

If **FontNotFound** is resumed, the system font is used.

```
Problem: SIGNAL [code: ProblemCode];

ProblemCode: TYPE =
 {badFont, clientCharacterCodesExhausted, clientCharacterBitsExhausted};
```

42.3 Usage/Examples

SimpleTextFont is a specialization of the regular font management subsystem.

The font file format is easily parsed, it can be mappable into read-only virtual memory for use, and it can be extended. A single file defines the bitmaps for the Xerox characters in one font face and one font size, such as Bodoni Italic 10. Fine Point: In the case in which several different font face/sizes have the same pictures, as can occur with some printwheel fonts, you would wish to use the same file for more than one font/face. This subject is outside the scope of this specialized interface, since we are only dealing with one font.

The font file begins with a header that identifies the font and describes the subsequent sections. Each subsequent section then contains **TextBlt**-style information about one character set's characters. Fine Point: Descriptions of the font management subsystem and the ViewPoint font format are to be found elsewhere.

42.3.1 Adding a Client-Defined Character

The following example creates a small (13x13) icon and displays it as part of a string:

```
myBits: ARRAY [0..13) OF WORD ← [--some bits--];
wb: XString.WriterBody ← XString.WriterBodyFromSTRING[" is an icon."];
smallPicture:XString.Character ← SimpleTextFont.AddClientDefinedCharacter [
    width: 13,
    height: 13,
    bitsPerLine: 16,
    bits: @myBits,
    offsetIntoBits: 0];

XString.AppendChar[to: @wb, c: smallPicture];

[] ← SimpleTextDisplay.StringIntoWindow [
  string: XString.ReaderFromWriter[@wb],
  window: window,
  place: place];
```

42.3.2 Acquiring the System Font

The following example acquires a handle to the system font:

```
systemFont: SimpleTextFont.MappedFontHandle = SimpleTextFont.MappedFont[];
```

42.4 Index of Interface Items

43

SoftKeys

43.1 Overview

The **SoftKeys** interface provides for client-defined function keys designated to be the isolated row of function keys at the top of the physical keyboard. It also provides a **SoftKeys** window whose "keytops" may be selected with the mouse to simulate pressing of the physical key on the keyboard. Such a window will be displayed on the user's desktop whenever an interpretation other than the default **SoftKeys** interpretation is in effect. [The default is assumed to be the functions inscribed on the physical keys.]

43.2 Interface Items

43.2.1 Data Structures for SoftKey Labels

numberOfKeys: CARDINAL = 8 ; -- *This number is dependent on the physical keyboard.*

Fine Point: **SoftKeysExtra** also exports a variable, **numberOfKeys** of type **CARDINAL**. This interface supports applications responding to both the 6085 and 8010 keyboards. See §43.3.2 for more details.

Represents the number of keys in the soft key row.

```
LabelRecord: TYPE = RECORD [
   unshifted: XString.ReaderBody ← XString.nullReaderBody,
   shifted: XString.ReaderBody ← XString.nullReaderBody];
```

LabelRecord provides a record of two **XString.ReaderBody** arrays so that both the shifted and unshifted key meanings may be labeled. It is expected that any individual key will have either a single **unshifted** label centered on the picture of the appropriate keytop *or* both **shifted** and **unshifted** labels painted in two lines on the keytop *or* no label at all (**XString.nullReaderBody** for both **shifted** and **unshifted**).

Labels: TYPE = LONG DESCRIPTOR FOR ARRAY OF **LabelRecord**;

Client-owned array of strings to be used as labels on the **SoftKeys** virtual keytops. The **SoftKeys** procedures will expect an array of up to **numberOfKeys** **LabelRecord**'s at a time.

Clients should see to it that string deallocation does not occur between calls to create and delete a **SoftKeys** instance.

Bitmaps may be specified for individual labels by using **SimpleTextFont.AddClientDefinedCharacter**. The current **SimpleTextFont** implementation has a somewhat limited number of available slots for client-defined keys. (See the **SimpleTextFont** interface for more information.)

43.2.2 Creating and Deleting SoftKeys

```
Push: PROCEDURE [
   table: TIP.Table ← NIL,
   notifyProc: TIP.NotifyProc ← NIL,
   labels: Labels← NIL,
   highlightedKey: CARDINAL ← nullKey,
   outlinedKey: CARDINAL ← nullKey]
   RETURNS[window: Window.Handle];
```

Push installs the **SoftKeys** interpretation by: (1) If there is a non-NIL **table**, it will be installed in the TIP watershed (see **TIPStar**); (2) if there is a non-NIL **notifyProc**, it will be attached to **NormalKeyboard.TIP**. The latter has the effect of passing all productions matched in **NormalKeyboard.TIP** to your **notifyProc**. (See Appendix A for a complete listing of **NormalKeyboard.TIP**.)

A **SoftKeys** window is displayed using **labels** to "inscribe" the keytop pictures with the new names of the keys. Both the shifted and unshifted state of a key may be labeled. If only the unshifted state is relevant, the shifted state may be defaulted to **XString.nullReaderBody**. If there are fewer strings than keytops needing them, the remaining keys are left blank. Extra strings are ignored. Fine Point: Bitmaps may be placed on the keytops by using **SimpleTextFont.AddClientDefinedCharacter**. Storage for the **label** strings is the responsibility of the client. Care should be taken to ensure that this storage is kept intact between a **Push** and a **Remove** of any given **SoftKeys** interpretation.

outlinedKey and **highlightedKey** appear highlighted and/or outlined when the window is initialized. The default is no outlining or highlighting. Key values assume zero indexing [0..**SoftKeysExtra.numberOfKeys**). (That is, the key marked Center is key 0, Bold is key 1, etc.)

Push returns a handle to the client's **SoftKeys window**. **Note:** There may be more than one **SoftKeys** window, with each client holding the handle to his own. The last **Push**ed interpretation is the one in effect until it is **Remove**d or superseded by another **Push**.

```
Remove: PROCEDURE [window: Window.Handle];
```

The **Remove** procedure removes the **SoftKeys** interpretation and associated **SoftKeys window**. The client is responsible for removing his **SoftKeys** interpretation when he relinquishes control of the selection/input focus [see **Selection** interface descriptions of **ActOn** and **Clear**] or the user's attention (as in the case of the keyboard and font keys). A **SoftKeys window** and its associated **SoftKeys** interpretation constitute a unique **SoftKeys** instance. Any **SoftKeys** instance may be removed from the stackof **SoftKeys** instances in an order other than the order pushed.

Attempts to **Remove** without the corresponding valid **window** handle from a **Push** results in the error **InvalidHandle**.

Fine Point: **Remove**, rather than **Pop**, was chosen to describe the function opposite **Push** to clarify that this is not a true stack. While **Push**, as the name implies, acts on the top of the stack, **Remove** does not. It is possible to **Remove** a **SoftKeys** window from other than the top of the stack.

```
Swap: PROCEDURE [
   window: Window.Handle,
   table: TIP.Table ←NIL,
   notifyProc: TIP.NotifyProc ←NIL,
   labels: Labels←NIL,
   highlightedKey: CARDINAL ← nullKey,
   outlinedKey: CARDINAL ← nullKey];
```

The **Swap** procedure is a means of exchanging **SoftKeys** interpretations without changing the **SoftKeys** instance. Current examples of use include the keyboard key implementation where pressing the "More" key brings up another group of **SoftKeys** choices. It is strongly suggested that a client utilizing a "More" key place it on the first soft key (the key marked CENTER on the physical keyboard) for a consistent user interface.

At the time when *no* **SoftKeys** interpretation is desired, a single **Remove** is expected corresponding to the original **Push**. Any number of **Swaps** may occur in between. Attempts to **Swap** without the corresponding valid **window** handle from a **Push** results in the error **InvalidHandle**.

43.2.3 Highlighting and Outlining a SoftKeys Keytop Picture

```
HighlightThisKey: PROCEDURE [
   window: Window.Handle
   key:CARDINAL ← nullKey];
```

```
OutlineThisKey: PROCEDURE [
   window: Window.Handle,
   key: CARDINAL ← nullKey];
```

These procedures are provided for those clients where permanent highlighting and/or outlining of certain soft keys is desired. (Do not confuse these procedures with the highlighting done when a key is selected with the mouse. That highlighting is done without client participation.) The first parameter, **window**, refers to the client's **SoftKeys** window returned from a **Push**. The **CARDINAL** corresponds to the **key** (zero indexing) to be outlined or highlighted whenever the chosen key changes. A **key** value of **nullKey** has the effect of undoing a key that is currently highlighted (or outlined). A number other than **nullKey** or [0..**SoftKeysExtra.numberOfKeys**) results in NoOp.

Attempts to call **HighlightThisKey** or **OutlineThisKey** without a valid **handle** from a **Push** will result in the error **InvalidHandle**.

```
nullKey: CARDINAL = LAST[CARDINAL];
```

A default value meaning no key, to be used for **outlinedKey** and **highlightedKey**.

43.2.4 Retrieving Information About a SoftKeys Window Instance

```
Info: PROCEDURE [
  window: Window.Handle]
  RETURNS [
  table: TIP.Table,
  notifyProc: TIP.NotifyProc,
  labels: Labels,
  highlightedKey:CARDINAL,
  outlinedKey:CARDINAL];
```

The **Info** procedure returns information relevant to the **SoftKeys** instance related to **window**. If the **window** handle is not valid, the error **InvalidHandle** will be returned.

43.2.5 Errors

```
InvalidHandle: ERROR;
```

This error is raised if the **SoftKeys window** handle passed to **Remove**, **Swap**, **Info**, **HighlightThisKey**, or **OutlineThisKey** is invalid.

43.3 Usage/Examples

43.3.1 Graphics Example

```
--When the selection is such that the graphics code takes control,
-- the initial graphics code should put up the graphics softkeys:
  graphicsSoftKeysWindow ← Push[
   table: graphicsSoftKeysTIPTable,
   labels: graphicsSoftKeyLabels];

--where the core of the graphics TIP.Table looks something like:
  --left side values are defined in the LevelIVKeys interface
  SELECT TRIGGER FROM
    CenterDown => Stretch;
    BoldDown => Magnify;
    ItalicsDown => Grid;
    CaseDown, UnderlineDown => Line;
    DbkUnderlineDown, SuperscriptDown => Curve;
    StrikeoutDown, SubscriptDown => Join;
    SuperSubDown, SmallerDown => Top;
    ENDCASE;

--and part of the graphics TIP.NotifyProc resembles the following:
  --left side values are the atom results from the TIP.Table
  atom => SELECT result FROM
    Stretch => DoMyStretchRoutine[];
    Magnify => DoMyMagnifyRoutine[];
    Grid => DoMyGridRoutine[];
    Line => DoMyLineRoutine[];
    Curve => DoMyCurveRoutine[];
    Join => DoMyJoinRoutine[];
    Top => DoMyTopRoutine[];
    ENDCASE;

--When graphics loses the selection, it must clear away its SoftKeys interpretation.
  Remove[graphicsSoftKeysWindow];
```

A client using More as one of his soft keys handles it in his TIP.Tables and TIP.NotifyProc:

```
  TIP.Table entry:
    Center Down => More;

  NotifyProc entry:
    More => Swap[
    window: mySoftKeysWindow,
    table: myNextSoftKeysTIPTable,
    labels: myNextSoftKeyLabels,
    highlightedkey: 1];
```

This entry results in an exchange of the client's last **SoftKeys** interpretation for the next one specified, (namely, the installation of the new TIP.Table and new labels on the keytops.) The second key (bold on the physical keyboard) will be highlighted in the **SoftKeys** window. The outlinedKey parameter has been left blank. This defaults to nullKey, in which case no key will be outlined.

43.3.2 Keyboard Manager Example

This client's (Keyboard Manager) SELECT arm does the right thing for both the 8010 and 6085 workstation keyboards.

```
  atom => SELECT z.a FROM
    CenterDown => IF more THEN SoftKeys.Swap [] ELSE InstallKeyboard [label1];
    BoldDown => InstallKeyboard [label2];
    ItalicsDown => InstallKeyboard [label3];
    CaseDown, UnderlineDown => InstallKeyboard [label4];
    DbkUnderlineDown, SuperscriptDown => InstallKeyboard [label5];
    StrikeoutDown, SubscriptDown => InstallKeyboard [label6];
    SuperSubDown => InstallKeyboard [label7]; -- No label7 if the machine is an
                                                          8010.
    DbkSmallerDown => InstallKeyboard [label8]; -- No label8 for 8010 either.
    MarginsDown, SmallerDown => ShowKeyboard [];
    FontDown, DefaultsDown => SetKeyboard [];
```

If the user presses the MarginsDown on a 6085 or the SmallerDown on an 8010, he has actually invoked the soft key that is labeled SHOW in the soft keys window visible on the screen.

43.4 Index of Interface Items

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44

StarDesktop

44.1 Overview

The **StarDesktop** interface provides access to assorted facilities related to the ViewPoint desktop.

44.2 Interface Items

44.2.1 General

```
AddReferenceToDesktop: PROCEDURE [
   reference:NSFile.Reference,
   place:Window.Place ← nextPlace];

nextPlace: Window.Place = [-1,-1];
```

Adds an icon to the desktop. The file (**reference**) must be a child of the desktop file (see **GetCurrentDesktopFile** below.) If there is already an icon at **place**, the next available place is used.

```
GetPlaceFromReference: PROCEDURE [ref: NSFile.Reference]
   RETURNS [Window.Place];
```

This returns the location of an icon on the desktop. It may be used with **AddReferenceToDesktop** to place an icon near another icon by passing the return value from **GetPlaceFromReference** to **AddReferenceToDesktop**. **AddReferenceToDesktop** places the new icon at the next available spot after the place passed in.

```
SelectReference: PROCEDURE [reference: NSFile.Reference]
   RETURNS [ok: BOOLEAN];
```

Selects the icon associated with the specified reference. **SelectReference** returns FALSE if selection fails (for example, if the reference is not found on the desktop).

GetWindow: PROCEDURE RETURNS [window: Window.Handle];

Returns the desktop window (that is, the root window for ViewPoint).

**GetShellFromReference: PROCEDURE [ref: NSFile.Reference]
RETURNS [sws: StarWindowShell.Handle];**

If an icon has a shell currently opened, **GetShellFromReference** returns this shell.

**CreateDesktop: PROCEDURE [name: XString.Reader]
RETURNS [fh: NSFile.Handle];**

Creates a new desktop directory and returns a handle to it. **name** is typically a fully qualified three-part user name. It is used by logon plug-in clients, a friends-level facility (as opposed to a public facility).

GetCurrentDesktopFile: PROCEDURE RETURNS [NSFile.Reference];

Every available desktop is an **NSFile** with **attribute.isDirectory = TRUE**. Desktops have children that are also **NSFiles** and show up as icons on the desktop (see the *ViewPoint Programmer's Guide*, chapter 3, for more information). **GetCurrentDesktopFile** returns the **NSFile.Reference** for the desktop **NSFile** that is currently installed and displayed to the user.

GetNextUnobscuredBox: PROCEDURE [height: INTEGER] RETURNS [Window.Box];

GetNextUnobscuredBox returns the next available vertical segment of the desktop window of height, **height**, and **width** the width of the desktop. This is intended for such things as the Attention window and the typing feedback window for. JStar There is no guarantee that the box returned will be visible, i.e., the client must ensure that the returned box is within the desktop window.

SetDisplayBackgroundProc: PROCEDURE [PROCEDURE [Window.Handle]];

SetDisplayBackgroundProc allows a client to change the procedure that displays the background for the desktop.

44.2.2 Atoms

Several **ATOMs** are exported by the **StarDesktop**:

attemptingLogoff	"AttemptingLogoff": Event just before logoff. Can be vetoed. Gives clients a chance to veto logoff.
desktopWindowAvailable	"DesktopWindowAvailable": Event notified when the desktop window has been initialized and inserted into the window tree. Cannot be vetoed.
fullUserName	"FullUserName": This atom is to be used with **AtomicProfile**.

newIcon	"NewIcon": Event notified when an icon has been added to the desktop, either by user copy/move, or by a client call to **AddReferenceToDesktop**.
logoff	"Logoff": Event occurs after logoff. Cannot be vetoed.
logon	"Logon": Event notified after successful Star logon. Cannot be vetoed.
userPassword	"UserPassword": Also to be used with **AtomicProfile**.

44.3 Usage/Examples

44.3.1 Adding a Reference to the Desktop

```
BuildFile: PROCEDURE [--parms--] = {
   reference: NSFile.Reference ←
      InitializeFile [parent: StarDesktop.GetCurrentDesktopFile[] ]; -- local proc
   place:Window.Place ← [...];
   .
   .
   .
   StarDesktop.AddReferenceToDesktop [reference, place];
   };
```

44.3.2 LogonProc and Display-Background-Proc Use

```
MyLogonProc: ENTRY StarDesktop.LogonProc = {
   -- perform a logon and if successful returns TRUE.
   -- probably entails use of AtomicProfile interface.
   fullName: XString.ReaderBody ← ...;
   password: XString.ReaderBody ← ...;
   AtomicProfile.SetString [StarDesktop.fullUserName, @fulllName];
   AtomicProfile.SetString [StarDesktop.userPassword, @password];
   .
   .
   .
   };

-- Mainline code
IF StarDesktop.GetLogonProc [] = NIL THEN [] ← StarDesktop.SetLogonProc [MyLogonProc];
```

44.4 Index of Interface Items

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StarWindowShell

45.1 Overview

StarWindowShell allows a client to create a Star-like window. A **StarWindowShell** window has a header that contains a title, commands, and popup menus. It may have both horizontal and vertical scrollbars. It has interior window space that may contain anything the client desires (see Figure 45.1.) **StarWindowShell** also supports the notion of "opening within." The client is insulated from the implementation-specific details of exactly how these features are represented on the display as well as how windows are arranged on the screen (for example, whether they overlap).

45.1.1 Client overview

A **StarWindowShell** is a window (see **Window** interface) that is a child of the desktop window. A **StarWindowShell** has an interior window that is a child of the **StarWindowShell** and is exactly the size of the available window space in the shell; that is, the **StarWindowShell** minus its borders and header and scrollbars. The interior window may have child windows created by the client. These children of the interior window are called *body windows*. The client may create an arbitrary number of body windows and may arrange them in an arbitrary fashion. **Note:** Since the body windows are children of the interior window, they are clipped by the interior window. Therefore a client could, for example, create a body window that is very much taller than the interior window and accomplish scrolling by simply sliding the body window around inside the interior window (This is actually what the default **StarWindowShell** scrolling does; for more detail, see the section on scrolling).

The **StarWindowShell** interface provides a number of facilities for manipulating **StarWindowShells** and their various parts: creating and destroying a **StarWindowShell**; using body windows, commands and popup menus; client **TransitionProcs** (called whenever a **StarWindowShell** changes state--is opened or closed for example); scrolling ; **AdjustProcs** and **LimitProcs**; and displaying and stacking (that is, open-within) **StarWindowShells**. The most commonly used facilities (creating a **StarWindowShell** and body windows) are described here and in the section on interface items. The less commonly used facilities are described in each subsection of the interface items.

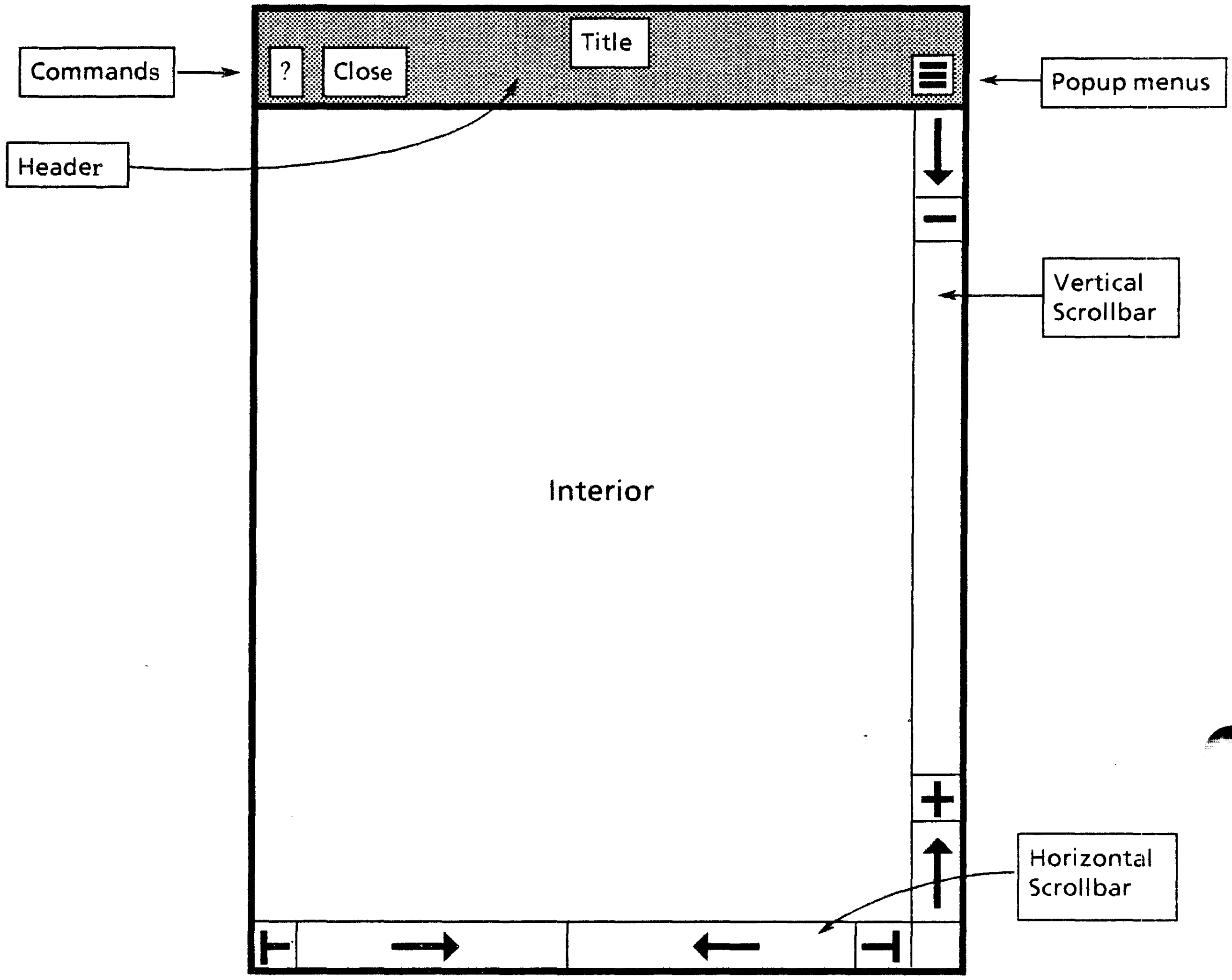

Figure 45.1 A Star window shell

45.1.2 Creating a StarWindowShell, Handles, etc.

A **StarWindowShell** is created by calling **StarWindowShell.Create**. There are no required parameters, but it is quite common to provide a **name** and a **transitionProc**. The **name** is displayed as the title in the **StarWindowShell** header. The **transitionProc** is called whenever the **StarWindowShell** is opened, destroyed, or "put to sleep," giving the client an opportunity to allocate and deallocate storage, open and close files, and so forth.

StarWindowShell.Create returns a **StarWindowShell.Handle**. A **StarWindowShell.Handle** is a **RECORD [Window.Handle]**. Thus any procedure that takes a **Window.Handle** also takes a **StarWindowShell.Handle**, but not the other way around. (The Mesa compiler automatically strips off the brackets and passes the **Window.Handle** if a **StarWindowShell.Handle** is passed). In particular, a context may be hung directly off a **StarWindowShell**(see the **Context**

interface). The **Handle** returned by **Create** is then used as the first parameter to most other calls to **StarWindowShell**.

The **StarWindowShell** returned by **Create** is not displayed on the screen; that is, it. is not inserted into the visible window tree. A **StarWindowShell** may be inserted into the window tree by calling **StarWindowShell.Push**. This is usually not done by the client but rather by some other part of ViewPoint, such as the desktop implementation. For example, when the user selects an icon and presses OPEN or PROPS, the application (actually the application's **Containee.GenericProc**) creates a **StarWindowShell** and returns it. The desktop implementation then displays the **StarWindowShell** by doing a **StarWindowShell.Push**.

45.1.3 Body Windows

Body windows are created by calling **StarWindowShell.CreateBody**. This returns a **Window.Handle**. The client can create an arbitrary number of body windows. Each body window will be a child of the **StarWindowShell**'s interior window. The body windows may overlap or not. They can actually be in any arrangement the client finds useful. Some common arrangements of body windows are as follows:

- One very long body window.
  This is easy to scroll by simply sliding the body window, which is what the **StarWindowShell** default scolling does.
- One body window with **BodyWindowJustFits = TRUE**.
  This is one way to display an infinite amount of data, such as a Tajo-like editor. The client must keep track of what is currently in the window, use AdjustProcs, do scrolling, and so forth. This is difficult to implement.
- Several body windows about the size of the interior, adjacent, non-overlapping.
  This is another way to display an infinite amount of data. The client lets **StarWindowShell** do default scrolling, which slides the body windows up or down and then calls the client to supply more body windows when it runs out. The client might put one page of text into each body window, supplying pages to **StarWindowShell** scrolling as needed.
- Several body windows smaller than the interior, adjacent, non-overlapping.
  This can be used to simulate subwindows.

Note: Body windows can themselves have child windows, and so on. A client might implement frames in a document editor by making each frame a child of a body window.

The eldest body window may be obtained by calling **StarWindowShell.GetBody**. All the body windows may be enumerated by calling **StarWindowShell.EnumerateBodiesInDecreasingY** or **StarWindowShell.EnumerateBodiesInIncreasingY**. To get the **StarWindowShell** from any body window, use **StarWindowShell.ShellFromChild**. Fine point: The client's body windows may not be the only child windows of the interior window, and the interior window may not be the only child of the **StarWindowShell** window. Therefore the client should never try to enumerate body windows by calling **Window.GetChild** and **Window.GetSibling** starting with the **StarWindowShell**, and the client should never try to get the **StarWindowShell** from a body window by calling **Window.GetParent**.

The client may provide a **repaintProc** and a **bodyNotifyProc** with each body window. The **repaintProc** is the display procedure that is called by the Window implementation whenever part or all of the window needs to be displayed (see **Window.SetDisplayProc**). The **bodyNotifyProc** is a **TIP.NotifyProc** that is attached to the window along with the normal set of **TIP** tables and receives notifications for the window (see **TIP.SetNotifyProcAndTable**).**Note:** If the client is going to use some ViewPoint interface to turn the body window into a particular type of window (such as **FormWindow** or **ContainerWindow**), these procedures should not be supplied by the client, but rather will be supplied by that interface.

A single body window can be set to fit into the interior window. Any time the **StarWindowShell**'s size is changed, the body window's size is changed accordingly. (See **SetBodyWindowJustFits**.)

45.1.4 Commands and Menus

Every **StarWindowShell** can have commands and popup menus, as in Figure. 45.1. Commands are actually individual menu items (**MenuData.ItemHandle**), where the **MenuData.ItemName** appears with a rounded corner box around it. When the user clicks over a command, the **MenuData.MenuProc** for that item is called. Commands are specified by calling **StarWindowShell.SetRegularCommands**, which takes a **MenuData.MenuHandle**. Each item in the menu is displayed as a command on the left side of the header.

A popup menu is an entire menu. The menu's title appears with a rounded corner box around it on the right side of the shell's header. When the user buttons down over the menu's title, a small window appears next to the poimter with one line for each menu item. When the user selects one of the items, that item's **MenuData.MenuProc** is called. Popup menus are specified by calling **StarWindowShell.AddPopupMenu**.

Facilities are also provided for specifying commands that should appear when a shell has other shells opened on top of or within it. See the section on Push and Pop for a full discussion of the "open within" illusion, and the section on commands and menus for a full discussion of these extra commands.

45.2 Interface Items

45.2.1 Create a StarWindowShell, etc.

```
Create: PROCEDURE [
  transitionProc: TransitionProc ← NIL,
  name:XString.Reader ← NIL,
  namePicture:XString.Character ← XChar.null,
  host: Handle ← NIL,
  type: ShellType ← regular,
  sleeps: BOOLEAN ← FALSE,
  considerShowingCoverSheet: BOOLEAN ← TRUE,
  currentlyShowingCoverSheet: BOOLEAN ← FALSE,
  pushersAreReadonly: BOOLEAN ← FALSE,
  readonly: BOOLEAN ← FALSE,
  scrollData: ScrollData ← vanillaScrollData,
    garbageCollectBodiesProc: PROCEDURE [Handle] ← NIL,
    isCloseLegalProc: IsCloseKegalProc ← NIL,
    bodyGravity: Window.Gravity ← nw,
  zone: UNCOUNTED ZONE ← NIL]
    RETURNS [Handle];
```

Create makes a StarWindowShell and returns a Handle to it. The StarWindowShell returned by Create is not displayed on the screen (is not inserted into the window tree). A StarWindowShell may be inserted into the window tree by calling StarWindowShell.Push. This is usually not done by the client, but rather by some other part of ViewPoint, such as the desktop implementation. For example, when the user selects an icon and presses OPEN or PROPS, the application (actually the application's Containee.GenericProc) creates a StarWindowShell and returns it. The desktop implementation then displays the StarWindowShell by doing a StarWindowShell.Push.

transitionProc is a procedure that is called whenever the state of the shell is about to change. In particular, it is called just before the shell is destroyed. The client uses a transitionProc to free any data structures that may have been allocated and associated with the shell. TransitionProcs are discussed in later in this chapter.

name appears as the title in the header of the StarWindowShell.

namePicture appears just before the title in the header. It is common for this character to be a small icon picture created by SimpleTextFont.AddClientDefinedCharacter.

host is a StarWindowShell that this shell is logically attached to. The host shell will not be destroyed while this shell is open. This is typically used by property sheets to indicate the shell that the property sheet is displaying properties of. If host is NIL, closing this shell will not depend on any other shell.

type is the type of the shell. Shell placement algorithms may be affected by the type. For example, regular shells will not overlap when displayed with Star-style window management, while psheet shells may overlap other shells.

sleeps indicates whether this shell can go into the sleeping StarWindowShell.State. If it is FALSE, we assume that the client software does not take advantage of the possibilities of the sleeping State (by remembering data from open to open). This argument is used in conjunction with the client's transitionProc, discussed later in this chapter.

considerShowingCoverSheet and currentlyShowingCoverSheet indicate whether the shell should ever possess a cover sheet and, if so, whether the cover sheet should be currently visible. What appears in any cover sheet is governed by a cover sheet implementation. See the section on Errors.

The two readonly arguments define whether this shell is uneditable, and whether all shells pushed onto this one should be uneditable. readonlyness is really up to client interpretation. This information is simply maintained for client convenience. If a shell below this one in a push stack has pushersAreReadonly set TRUE, then the implementation forces readonly to TRUE.

scrollData indicates whether vertical or horizontal scrollbars should appear and allows the client to supply procedures to be called for various user scrolling actions. (See the section on scrolling for full details.) The default will cause vertical scrollbars to appear, but not horizontal. The default scrolling procedures simply slide body windows up or down, left or right, as appropriate.

garbageCollectBodiesProc is called when a scroll action causes a body window to be placed so that it is completely outside the shell's interior window. The call thus allows the client an opportunity to garbage-collect the body window and associated data structures. (See the section on Scrolling.)

isCloseLegalProc is called when the user attempts to close the **StarWindowShell**, or when a client calls **StandardClose**, **StandardCloseAll**, or **StandardCloseEverything**. This allows the client to veto the user's attempt to close the window. If the **isCloseLegalProc** returns TRUE, the shell is closed; if the **isCloseLegalProc** returns FALSE, the shell is not closed. The **isCloseLegalProc** is also a convenient way for the client to get control when the window is being closed.

bodyGravity argument indicates what value for gravity should be used when the implementation adjusts the size of a body window.

All storage related to the shell will be allocated out of **zone**. If **zone** = NIL, **StarWindowShell** will provide its own zone. Fine point: The **Window.Objects** themselves are not allocated out of the client's zone. This means that if the client allocates child windows using a zone (**Window.Create** or **Window.New** with non-NIL zone), these child windows must be removed from the shell before it is destroyed. When the shell's **TransitionProc** is called with a state of dead, the client should remove those windows.

Handle: TYPE = RECORD [Window.Handle];

Create returns a **Handle**. Any procedure that takes a **Window.Handle** also takes a **StarWindowShell.Handle**, but not the other way around. (The Mesa compiler automatically strips off the brackets and passes the **Window.Handle** if a **StarWindowShell.Handle** is passed). In particular, a **Context** may be hung directly off a **StarWindowShell** (see the **Context** interface). The **Handle** returned by **Create** is then used as the first parameter to most other calls to **StarWindowShell**.

nullHandle: Handle = [NIL];

nullHandle is provided as a convenience, since NIL is often not an appropriate value for a **StarWindowShell.Handle**.

IsCloseLegalProc: TYPE = PROCEDURE [sws: Handle,
closeAll: BOOLEAN ← FALSE] RETURNS [BOOLEAN];

closeAll indicates whether the user selected Close or CloseAll.

Destroy: PROCEDURE [sws: Handle];

Destroys the **StarWindowShell** and associated data. Will call the client's **transitionProc** with **state** = **dead**. May raise **Error [notASWS]**.

ShellType: TYPE = {regular(0), keyboard, psheet, attention, static, last(15)};

ShellType influences how a shell behaves in several regards. **regular** shells have a ? command, a Close command, and a CloseAll command if opened on top of another shell. With Star-like overall screen management, **regular** shells do not overlap; rather they change size whenever a window is opened or closed. **psheet** shells do not have any **StarWindowShell**-supplied commands and freely overlap other shells. **psheet** shells are used by the **PropertySheet** interface to create property sheets. **static** shells are exempted from any overall screen management; for example, a **static** shell is not shrunk to make room for a **regular** shell when the overall screen management is Star-like. Some clients may find this useful. Most clients will not use **keyboard**, **psheet**, or **attention** types.

StandardClose: PROCEDURE [sws: Handle] RETURNS [Handle];

StandardCloseAll: PROCEDURE [sws: Handle] RETURNS [Handle];

StandardClose and **StandardCloseAll** provide procedural access to the Close and Close All commands that are placed in a shell's header automatically by **StarWindowShell**. These procedures call the client's **isCloseLegalProc** and **transitionProc**, just as if the user had selected the command. May raise **Error [notASWS]**.

StandardCloseEverything: PROCEDURE RETURNS [notClosed: Handle];

StandardCloseEverything closes all open **StarWindowShells**. Logoff uses this procedure. **notClosed** is the first window that could not be closed because its **IsCloseLegalProc** returned FALSE. All windows that can be closed will be. If **notClosed** is NIL, then all windows were closed.

NewStandardCloseEverything: PUBLIC PROCEDURE
RETURNS [numberLeftOpen: CARDINAL ← 0, lastNotClosed: Handle ← nullHandle];

This procedure is the same as **StandardCloseEverything** except that it also returns the number of shells that vetoed close. Fine Point: This procedure is currently exported through **StarWindowShellExtra**.

SetPreferredDims: PROCEDURE [sws: Handle, dims: Window.Dims];

SetPreferredPlace: PROCEDURE [sws: Handle, place: Wndow.Place];

SetPreferredDims and **SetPreferredPlace** provide a suggestion as to the desired size and location of the shell. Depending on the overall screen management in effect at the time the shell is displayed, these preferred values may be ignored. May raise **Error [notASWS]**.

SetPreferredInteriorDims: PROCEDURE [sws: Handle, dims: Window.Dims];

SetPreferredInteriorDims makes the shell just big enough to fit around **dims**. This means the interior window will be of size **dims**. Fine Point: This procedure is currently exported through **StarWindowShellExtra2**.

45.2.1.1 IsCloseLegalProc

The client may supply an **isCloseLegalProc** when a **StarWindowShell** is created or later by calling **SetIsCloseLegalProc**. This client procedure is called when the user attempts to close the StarWindowShell, or when a client calls **StandardClose**, **StandardCloseAll**, or **StandardCloseEverything**. This allows the client to veto the user's attempt to close the window. If the **isCloseLegalProc** returns TRUE, the shell is closed; if the **isCloseLegalProc** returns FALSE, the shell is not closed. The **isCloseLegalProc** is also a convenient way for the client to get control when the window is being closed.

IsCloseLegal: PROCEDURE [sws: Handle, closeAll: BOOLEAN] RETURNS [BOOLEAN];

IsCloseLegal calls the client's **isCloseLegalProc** and returns the value returned from that call. If there is no **isCloseLegalProc**, **IsCloseLegal** returns TRUE. May raise **Error [notASWS]**.

IsCloseLegalProcReturnsFalse: IsCloseLegalProc;

GetIsCloseLegalProc: PROCEDURE [sws: Handle]
  RETURNS [IsCloseLegalProc];

GetIsCloseLegalProc returns the current **isCloseLegalProc** associated with **sws**. May raise **Error [notASWS]**.

SetIsCloseLegalProc: PROCEDURE [
  sws: Handle,
  proc: IsCloseLegalProc];

SetIsCloseLegalProc sets the **isCloseLegalProc** for **sws**. May raise **Error [notASWS]**.

Note: IsCloseLegalProc: TYPE = PROCEDURE [... should be in this interface and will be added in the next release.

45.2.1.2 Miscellaneous Get and Set Procedures

Several procedures are provided that set and return values logically associated with a StarWindowShell.

GetContainee: PROCEDURE [sws: Handle] RETURNS [Containee.Data];

GetHost: PROCEDURE [sws: Handle] RETURNS [Handle];

GetReadonly: PROCEDURE [sws:Handle] RETURNS [BOOLEAN] ;

GetType: PROCEDURE [sws:Handle]RETURNS[ShellType];

These procedures return the obvious value associated with **sws**. May raise **Error [notASWS]**.

GetZone: PROCEDURE [sws: Handle] RETURNS [UNCOUNTED ZONE];

The **StarWindowShell** implementation creates a zone when a**StarWindowShell** is created and uses the zone as storage for all shell-related items, such as name strings. The client can use this zone, knowing that the zone will be completely garbage-collected when the shell is destroyed. **GetZone** returns this zone. May raise **Error [notASWS]**.

HaveDisplayedParasite: PROCEDURE [sws: Handle] RETURNS [BOOLEAN];

HaveDisplayedParasite returns TRUE if a shell is displayed that has this shell (**sws**) as its host. (See **host** under **StarWindowShell.Create**.) For example, if a property sheet is currently displayed that was created with **host** = **sws**, then **HaveDisplayedParasite [sws]** returns TRUE. May raise **Error [notASWS]**.

SetContainee: PROCEDURE [sws: Handle, file: Containee.DataHandle];

SetHost: PROCEDURE [sws, host: Handle] RETURNS [old: Handle];

SetName: PROCEDURE [sws: Handle, name: XString.Reader];

SetNamePicture: PROCEDURE [sws: Handle, picture: XString.Character];

SetReadOnly: PROCEDURE [sws: Handle, yes: BOOLEAN];

**SetSleeps: PROCEDURE [sws: StarWindowShell.Handle, sleeps: BOOLEAN]
RETURNS [old: BOOLEAN];**

sleeps = **TRUE** means the shell can be put to sleep. This is the same as the **sleeps** parameter to **Create**. Fine Point: This procedure is currently exported through **StarWindowShellExtra**.

These procedures set the obvious value associated with **sws**. May raise **Error [notASWS]**.

45.2.2 Body Windows

A **StarWindowShell** is a window (see **Window** interface) that is a child of the desktop window. A **StarWindowShell** has an interior window that is a child of the **StarWindowShell**and is exactly the size of the available window space in the shell, that is, the **StarWindowShell** minus its borders and header and scrollbars. The interior window may have child windows created by the client. These children of the interior window are called *body windows*. The client may create an arbitrary number of body windows and may arrange them in an arbitrary fashion. **Note:** Since the body windows are children of the interior window, they are clipped by the interior window. Therefore, a client could, for example, create a body window that is very much taller than the interior window and accomplish scrolling by simply sliding the body window around inside the interior window. (This is actually what the default **StarWindowShell** scrolling does; for more detail, see the section on scrolling).

Body windows are created by calling **StarWindowShell.CreateBody**. This returns a **Window.Handle**. The client can create an arbitrary number of body windows. Each body window will be a child of the **StarWindowShell**'s interior window. The body windows may overlap or not. They can actually be in any arrangement the client finds useful. Some common arrangements of body windows are as follows:

- One very long body window.
  This is easy to scroll by simply sliding the body window, which is what the **StarWindowShell** default scrolling does.
- One body window with **BodyWindowJustFits** = **TRUE**.
  This is one way to display an infinite amount of data, such as. a Tajo-like editor. The client must keep track of what is currently in the window, use AdjustProcs, do scrolling, and so forth. This is difficult to implement.
- Several body windows about the size of the interior, adjacent, non-overlapping.
  This is another way to display an infinite amount of data. The client lets **StarWindowShell** do default scrolling, which slides the body windows up or down and then calls the client to supply more body windows when it runs out. The client might

put one page of text into each body window, supplying pages to **StarWindowShell** scrolling as needed.

- Several body windows smaller than the interior, adjacent, non-overlapping. This can be used to simulate subwindows.

Note: Body windows can themselves have child windows, and so on. A client might implement frames in a document editor by making each frame a child of a body window.

```
CreateBody: PROCEDURE [
  sws: Handle,
  repaintProc: PROCEDURE [Window.Handle] ← NIL,
  bodyNotifyProc: TIP.NotifyProc ← NIL,
  box: Window.Box ← [[0,0],[0,29999]] ] RETURNS [Window.Handle];
```

CreateBody creates a body window that is a child of the interior window of **sws**. **repaintProc** is the display proc that is called by the Window implementation whenever part or all of the body window needs to be displayed (see **Window.SetDisplayProc**). **bodyNotifyProc** is a **TIP.NotifyProc** that is attached to the window along with the normal set of **TIP** tables and receive notifications for the window (see **TIP.SetNotifyProcAndTable** and **TIPStar.NormalTable**). **Note:** If the client is going to use some ViewPoint interface to turn the body window into a particular type of window (such as **FormWindow** or **ContainerWindow**), these procedures should not be supplied by the client, but rather will be supplied by that interface. **box** indicates the size and location of the body window within the shell's interior window. If **box.dims.w** and/or **box.dims.h** is zero, the body window will take on the **dims.w** and/or **dims.h** of the shell's interior window. May raise **Error [notASWS]**.

```
DestroyBody: PROCEDURE [body: Window.Handle];
```

DestroyBody destroys **body** and any **Context** data associated with it. May raise **Error [notASWS]**.

```
GetBody: PROCEDURE [sws: Handle] RETURNS [ Window.Handle];
```

GetBody returns the eldest body window of **sws**. Fine Point: The client's body windows may not be the only child windows of the interior window and the interior window may not be the only child of the **StarWindowShell** window. Therefore, the client should never try to enumerate body windows by calling **Window.GetChild** and **Window.GetSibling** starting with the **StarWindowShell**. May raise **Error [notASWS]**.

```
ShellFromChild: PROCEDURE [child: Window.Handle] RETURNS [ Handle];
```

ShellFromChild returns the shell given any body window. Fine Point: The client's body windows may not be the only child windows of the interior window and the interior window may not be the only child of the **StarWindowShell** window. Therefore, the client should never try to get the **StarWindowShell** from a body window by calling **Window.GetParent**. May raise **Error [notASWS]**.

```
EnumerateBodiesInIncreasingY: PROCEDURE [
  sws: Handle, proc: BodyEnumProc] RETURNS [Window.Handle ← NIL];

EnumerateBodiesInDecreasingY: PROCEDURE [
  sws: Handle, proc: BodyEnumProc] RETURNS [Window.Handle ← NIL];
```

BodyEnumProc: TYPE = PROCEDURE [victim: Window.Handle]
  RETURNS [stop: BOOLEAN ← FALSE];

The **EnumerateBodiesIn...** procedures enumerate all the body windows of **sws**, calling **proc** for each body window until **proc** returns **stop** = TRUE. **EnumerateBodiesInIncreasingY** enumerates the body windows in increasing order of **Window.GetBox [body].place.y**, and **EnumerateBodiesInDecreasingY** enumerates the body windows in decreasing order of **Window.GetBox [body].place.y**. Each procedure returns the last body window enumerated, or NIL if all body windows were enumerated. These procedures are especially handy for clients that do their own scrolling. To minimize repainting when scrolling a set of body windows upward it is important to move the upper ones first, and vice versa. May raise **Error [notASWS]**.

GetBodyWindowJustFits: PROCEDURE [sws: Handle] RETURNS [BOOLEAN];

SetBodyWindowJustFits: PROCEDURE [sws: Handle, yes: BOOLEAN];

Some clients may wish to have a single body window that is automatically resized by the **StarWindowShell** implementation to just fit within the interior of the shell. Such a body window is said to have **BodyWindowJustFits** = TRUE. If **BodyWindowJustFits** = FALSE (the default for **CreateBody**), the body window's dimensions are left alone by **StarWindowShell**, even though the body window may stick out or not fill the shell. **GetBodyWindowJustFits** and **SetBodyWindowJustFits** allow the client to determine and set this just-fits behavior for a single body window. Setting just-fits when there is more than one body window yields undefined results. May raise **Error [notASWS]**.

GetAvailableBodyWindowDims: PROCEDURE [sws: Handle]
  RETURNS [Window.Dims];

GetAvailableBodyWindowDims returns the current dimensions of the interior window of **sws**. May raise **Error [notASWS]**.

IsBodyWindowOutOfInterior: PROCEDURE [body: Window.Handle]
  RETURNS [BOOLEAN];

IsBodyWindowOutOfInterior returns TRUE if any part of **body** is sticking out of the interior window of its shell. May raise **Error [notASWS]**.

InstallBody: PROCEDURE [sws: Handle, body: Window.Handle];

InstallBody installs a previously created window into a **StarWindowShell**, thus making the window a body window. Most clients will not need to use this procedure. May raise **Error [notASWS]**.

DestallBody: PROCEDURE [body: Window.Handle];

DestallBody removes **body** from its **StarWindowShell**. Most clients will not need to use this procedure. May raise **Error [notASWS]**.

45.2.3 Commands and Menus

Every **StarWindowShell** can have commands and popup menus, as in Figure 47.1. Commands are actually individual menu items (**MenuData.ItemHandle**), where the **MenuData.ItemName** appears with a rounded corner box around it. When the user clicks over a command, the **MenuData.MenuProc** for that item is called. Commands are specified by calling **StarWindowShell.SetRegularCommands**, which takes a **MenuData.MenuHandle**. Each item in the menu is displayed as a command on the left side of the header.

A popup menu is an entire menu. The menu's title appears with a rounded corner box around it on the right side of the shell's header. When the user buttons down over the menu's title, a small window appears next to the pointer with one line for each menu item. When the user selects one of the items, that item's **MenuData.MenuProc** is called. Popup menus are specified by calling **StarWindowShell.AddPopupMenu**.

The **Window.Handle** that is passed to the **MenuData.MenuProc** for a command or popup menu item is the **Window.Handle** for the **StarWindowShell** that the command or popup menu is currently displayed in.

StarWindowShells that are of **type regular** (see **StarWindowShell.ShellType**) will always have system commands leftmost in the header. When a shell is directly on the desktop, the system commands are ? (help) and Close. When a shell is opened within another, the system commands are ? (help), Close, and Close All.

Note: Commands may be added to and removed from a **StarWindowShell** by using **MenuData.AddItem**, etc. Fine Point for current Star implementors: This is *not* the way to get such commands as ShowNext to appear and dissappear. See the sections on Push and Pushee Commands below.

The implementation automatically overflows the rightmost commands into an overflow popup menu when all of them will not fit in the header. If all the popup menus won't fit in the header, the items from the leftmost ones are overflowed into the rightmost popup menu. The rightmost popup menu is always guaranteed to be displayed, since shells are not allowed to be so small that no popup menu will fit.

```
SetRegularCommands: PROCEDURE [
  sws: Handle, commands: MenuData.MenuHandle] ;
```

SetRegularCommands associates **commands** with **sws**. May raise **Error [notASWS]**.

```
GetRegularCommands: PROCEDURE [sws: Handle]
  RETURNS [MenuData.MenuHandle];
```

GetRegularCommands returns the regular commands associated with **sws**. May raise **Error [notASWS]**.

```
AddPopupMenu: PROCEDURE [
  sws: Handle, menu: MenuData.MenuHandle] ;
```

AddPopupMenu adds **menu** to the available popup menus in **sws**. The title of **menu** is displayed in the **StarWindowShell** header with the small popup menu symbol (≡) just to the left of it, all enclosed in a rounded corner box. **Note:** Any arbitrary symbol (less than the height of the system font) can be part of the title by using SimpleTextFont.AddClientDefinedCharacter. May raise Error [notASWS].

```
SubtractPopupMenu: PROCEDURE [
   sws: Handle, menu: MenuData.MenuHandle] ;
```

SubtractPopupMenu removes menu from sws. May raise Error [notASWS].

```
EnumeratePopupMenus: PROCEDURE [sws: Handle, proc: MenuEnumProc];
```

Enumerates the popup menus associated with the shell.

```
EnumerateAllMenus: PROCEDURE [sws: Handle, proc: MenuEnumProc];
```

Enumerates every menu visible in the shell. This includes popups, regular commands, topPushee commands from the shell underneath, etc. Fine Point: This procedure is currently exported through StarWindowShellExtra.

```
MenuEnumProc: TYPE = PROCEDURE [menu: MenuData.MenuHandle]
   RETURNS [stop: BOOLEAN ← FALSE];
```

45.2.3.1 Pushee Commands

Facilities are also provided for specifying commands that should appear when a shell has had other shells opened on top of or within it. These facilities are useful only to a client that implements some type of open-within capability, such as folders and file drawers. (See the section on commands and menus for a full discussion of the "open within" illusion.) These extra commands come in three sets: the set that should be displayed when this shell is just below the top of the install stack, the set that should be displayed when this shell is anywhere in the install stack, and the set that should be displayed if this shell is at the bottom of an install stack. These are the so-called TopPushee, MiddlePushee, and BottomPushee commands.

Figure 47.2 depicts how these pushee commands, if supplied, will affect the commands visible in a given shell's header. In Figure 47.2, Shell B is Pushed on top of Shell A and Shell C is Pushed on top of Shell B. If Shell A is the only shell displayed, Shell A's system and regular commands appear in the shell's header. With Shell B Pushed on top of Shell A, Shell B's system and regular commands appear as well as Shell A's bottom pushee, middle pushee, and top pushee commands. This is because Shell A is on the bottom, in the middle, and just below the top of the stack of shells. With Shell C Pushed on top of Shell B, Shell A's bottom pushee and middle pushee commands appear, but not Shell A's top pushee commands. Shell B's top pushee and middle pushee commands appear, but *not* its bottom pushee commands.

Caution: The Window.Handle passed to the MenuData.MenuProc for any pushee command is the Window.Handle of the StarWindowShell that the command is currently displayed in, *not* the StarWindowShell that the command was originally associated with. If the client wants to be able to recover the StarWindowShell that the command was originally associated with, it may be saved as the MenuData.ItemData.

```
SetBottomPusheeCommands: PROCEDURE [
  sws: Handle, commands: MenuData.MenuHandle] ;

SetMiddlePusheeCommands: PROCEDURE [
  sws: Handle, commands: MenuData.MenuHandle] ;

SetTopPusheeCommands: PROCEDURE [
  sws: Handle, commands: MenuData.MenuHandle] ;

GetPusheeCommands: PROCEDURE [sws: Handle]
  RETURNS [bottom, middle, top: MenuData.MenuHandle];
```

May raise **Error [notASWS]**.

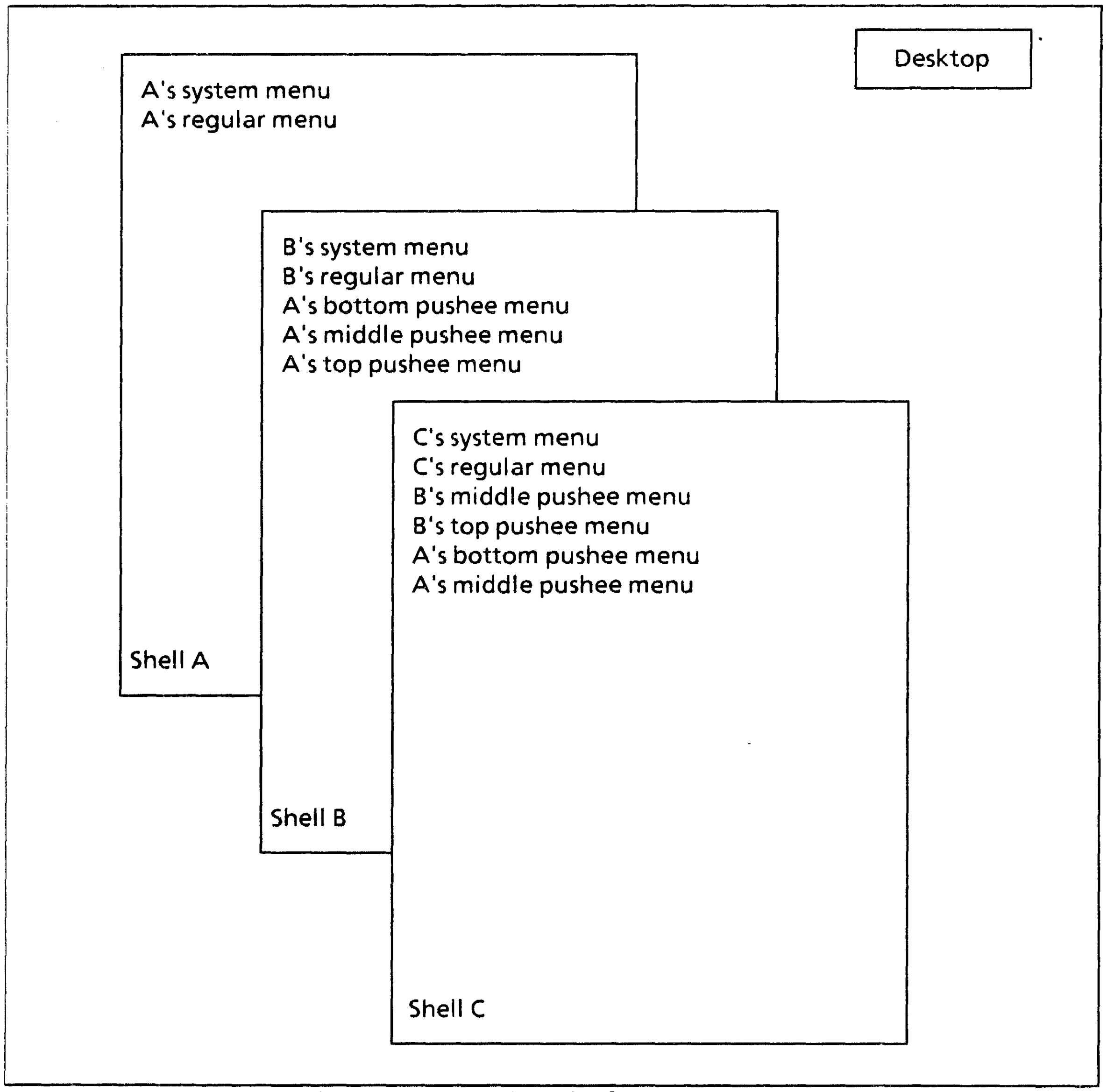

Figure 45-2. Install Stack of Window Shells

45.2.4 TransitionProcs

A **StarWindowShell** is always in one of three states: **awake**, **sleeping**, or **dead**. The **awake** state indicates that the shell is currently displayed. The **sleeping** state indicates that the shell still exists but is not being displayed and therefore resources associated with the display state should be freed. The **dead** state indicates the shell is about to be destroyed and therefore all resources associated with the shell should be freed.

Every **StarWindowShell** can have a client supplied **TransitionProc** associated with it. This **TransitionProc** will be called whenever the shell's state changes. The client may then do whatever is necessary in terms of allocating or freeing resources.

The client may call **StarWindowShell.Create [... sleeps: FALSE ...]** to indicate that the application does nothing interesting with the **sleeping** state. This may cause routines that would otherwise put the shell in **sleeping** state (say on a close, where it might be quickly reopened) to put it in **dead** state instead.

State: TYPE = {awake(0), sleeping, dead, last(7)};

TransitionProc: TYPE = PROCEDURE [sws: Handle, state: State];

The **TransitionProc** is a client-supplied procedure responsible for allocating or deallocating client data structures when **sws**'s state changes. **state** is the new state of **sws**.

GetSleeps: PROCEDURE[sws: Handle] RETURNS [BOOLEAN];

GetSleeps returns the value of the **sleeps** parameter that was passed to **Create** when **sws** was created. If TRUE, then the application responsible for this shell can deal with the **sleeping** state. May raise **Error [notASWS]**.

GetState: PROCEDURE [sws: Handle] RETURNS [State] ;

GetState returns the current state of **sws**. May raise **Error [notASWS]**.

GetTransitionProc: PROCEDURE [sws:Handle] RETURNS [TransitionProc];

GetTransitionProc returns the current **TransitionProc** associated with **sws.** May raise **Error [notASWS]**.

SetTransitionProc: PROCEDURE [sws: Handle, new: TransitionProc]
   RETURNS [old: TransitionProc];

SetTransitionProc sets the current **TransitionProc** for **sws** and returns the old one. May raise **Error [notASWS]**.

SetState: PROCEDURE [sws: Handle, state: State] ;

SetState sets the state of **sws** and calls the client's **TransitionProc** as appropriate. Most clients will not call this procedure. May raise **Error [notASWS]**.

SleepOrDestroy: PROCEDURE [Handle] RETURNS[Handle];

SleepOrDestroy either puts the shell in the **sleeping** state or destroys the shell, depending on the value of the **sleeps** BOOLEAN that was passed to **Create** when the shell was created. If the shell has the ability to sleep (**sleep** = TRUE), then the shell is put into the **sleeping** state. Otherwise the shell is destroyed. The same shell is returned if the shell was put in the sleeping state. A NIL handle is returned if the shell was destroyed. This procedure might be used by the desktop implementation when a shell is closed. May raise **Error [notASWS]**.

45.2.5 Scrolling

Usually, only part of an object is visible to the user at any one moment in the interior of a **StarWindowShell**. The user can request to see more of the object by scrolling the contents up or down inside the shell. The user can perform three kinds of scrolling using the scrollbars pictured in Figure 47.1. The contents can be moved a little at a time by pointing at the arrows (up, down, left, right) in the scrollbars. The contents can be moved a page or screenful at a time by pointing at the plus (+) and minus (-) signs. The user can jump to any arbitrary place within the entire extent of the object being viewed by pointing in the blank part of the vertical scrollbar (this latter operation is called *thumbing*).

StarWindowShell provides various levels of support to a client for performing these scrolling operations. The client can allow **StarWindowShell** to do all the scrolling functions, or the client can do some of them and leave the rest to **StarWindowShell**, or the client can do all scrolling operations. Much of this decision will be based on how the client chooses to arrange body windows within the shell (see the section on body windows above and more discussion below). First, we will describe the various types of scrolling and scrolling procedures that a client can supply;, then we will describe the default scrolling procedures provided by **StarWindowShell**.

In the simplest (for the client) case, one body window contains the entire extent of the object being viewed. **StarWindowShell** can handle all scrolling in this case. The client simply defaults the **scrollData** parameter in the call to **StarWindowShell.Create**. When the user points at an arrow, **StarWindowShell** moves the body window a small amount. When the user point at plus or minus, **StarWindowShell** moves the body window by one interior window's height. When the user thumbs, **StarWindowShell** will move the body window to an appropriate place based on its overall height.

In a slightly more complex case, body windows are butted up against one another. When the user points at an arrow, **StarWindowShell** moves all the body windows a small amount. When the user point at plus or minus, **StarWindowShell** moves all the body windows by one interior window's height. When the user thumbs, **StarWindowShell** moves all the body windows to an appropriate place based on the combined overall height of the body windows. However, in this case the client will often not have the entire extent of the object displayed in these body windows, but rather will want to tack new body windows on each end as these body windows are scrolled off. The client can do this by providing a **MoreScrollProc** for the shell. **StarWindowShell** will call the client's **MoreScrollProc** whenever it runs out of body windows.

In the most complex case, the client has a single body window that "just fits" (see **SetBodyWindowJustFits** in the section on body windows), and only part of the entire object is displayed at any one time. The client must provide *all* the scrolling functions for this case. This means providing an **ArrowScrollProc** (to handle the user's pointing at the arrows, plus, and minus), and a **ThumbScrollProc** (to handle the user's thumbing).

Of course, the client may provide its own scrolling procedures for any of the above cases, even the simple one, to override the type of scrolling that **StarWindowShell** provides.

```
ScrollData: TYPE = RECORD [
   displayHorizontal: BOOLEAN ← FALSE,
   displayVertical: BOOLEAN ← FALSE,
   arrowScroll: ArrowScrollProc ← NIL,
   thumbScroll: ThumbScrollProc ← NIL,
   moreScroll: MoreScrollProc ← NIL ];
```

ScrollData is passed to **Create** and **SetScrollData** to specify the desired scrolling. **displayHorizontal** indicates whether the shell should have a horizontal scrollbar. **displayVertical** indicates whether the shell should have a vertical scrollbar. **arrowScroll** is called when the user points at the arrows or at the plus or minus signs. **thumbScroll** is called when the user thumbs. These procedures are expected to perform the appropriate scroll, probably by moving body windows with **Window.Slide**. If either **arrowScroll** or **thumbScroll** are NIL, **StarWindowShell** provides default scrolling procedures (**VanillaArrowScroll** and **VanillaThumbScroll**) that operate as described above. **moreScroll** is called when **VanillaArrowScroll** or **VanillaThumbScroll** needs more body windows to be supplied by the client. The client should never need to supply both an **arrowScroll** and a **moreScroll**.

```
ArrowScrollProc: TYPE = PROCEDURE [
   sws: Handle,
   vertical: BOOLEAN,
   flavor: ArrowFlavor,
   arrowScrollAction: ArrowScrollAction ← go];
```

```
ArrowFlavor: TYPE = {pageFwd, pageBwd, forward, backward};
```

An **ArrowScrollProc** is called whenever the user points at an arrow or the plus or minus sign in a scrollbar. The **ArrowScrollProc** is expected to scroll the contents of **sws** as appropriate. **vertical** indicates whether to scroll vertically (TRUE) or horizontally (FALSE). **flavor** indicates what type of scrolling the user requested. **pageFwd** means the user pointed at the plus sign (**vertical** = TRUE) or the right margin symbol (**vertical** = FALSE). **pageBwd** means the user pointed at the minus sign (**vertical** = TRUE) or the left margin symbol (**vertical** = FALSE). **forward** means the user pointed at the up-pointing arrow (**vertical** = TRUE) or the left-pointing arrow (**vertical** = FALSE). **backward** means the user pointed at the down-pointing arrow (**vertical** = TRUE) or the right-pointing arrow (**vertical** = FALSE). The **ArrowScrollProc** will be called repeatedly as long as the user has the mouse button down over one of the arrows, thus producing continuous scrolling. **Note: EnumerateBodiesInIncreasingY** and **EnumerateBodiesInDecreasingY** are quite useful when scrolling body windows (see the section on body windows).

```
ArrowScrollAction: TYPE = {start, go, stop};
```

start indicates the user just buttoned down. **go** indicates the user still has the button down. **stop** indicates the user just buttoned up. This allows clients to scroll body windows without repainting until the **ArrowScrollProc** is called with **arrowScrollAction = stop**.

```
ThumbScrollProc: TYPE = PROCEDURE [
  sws: Handle, vertical: BOOLEAN, flavor: ThumbFlavor, m, outOfN: INTEGER];

ThumbFlavor: TYPE = {downClick, track, upClick};
```

A **ThumbScrollProc** is called whenever the user points in the thumbing part of the vertical scrollbar. **vertical** will always be TRUE (horizontal thumbing is not currently allowed). **flavor** indicates whether the user has just buttoned down (**downClick**), is moving the mouse with the button down (**track**), or has just released the button (**upClick**). Usually, the actual scrolling does not take place until the **upClick**. **downClick** and **track** give the client an opportunity to display information to the user, such as what page number the current cursor location corresponds to (see **Cursor.NumberIntoCursor**). **m** and **outOfN** indicate where the cursor is with respect to the entire extent of the thumbing area. For example, if **m** = 200 and **outOfN** = 400, this indicates that the user wants to thumb to the middle of the entire object. **Note:** **EnumerateBodiesInIncreasingY** and **EnumerateBodiesInDecreasingY** are quite useful when scrolling body windows (see the section on body windows).

```
MoreScrollProc: TYPE = PROCEDURE [
  sws: Handle, vertical: BOOLEAN, flavor: MoreFlavor, amount: CARDINAL];

MoreFlavor: TYPE = {before, after};
```

A **MoreScrollProc** is called by the default **StarWindowShell** scrolling procedures, **VanillaArrowScroll** and **VanillaThumbScroll**, whenever more body windows are needed to continue scrolling. This is used when the client has several body windows butted against one another. When the user points at an arrow, **VanillaArrowScroll** moves all the body windows a small amount. When the user point at plus or minus, **VanillaArrowScroll** moves all the body windows by one interior window's height. When the user thumbs, **VanillaThumbScroll** will move all the body windows to an appropriate place based on the combined overall height of the body windows. However, the client will often not have the entire extent of the object displayed in these body windows, but rather will want to tack on new body windows on each end as these body windows are scrolled off. This is when the client's **MoreScrollProc** is called. **vertical** indicates whether the user was scrolling vertically or horizontally. **flavor** indicates whether to tack on more body windows **before** (i.e., user was scrolling down for **vertical** = TRUE, right for **vertical** = FALSE), or **after** (i.e., user was scrolling up for **vertical** = TRUE, left for **vertical** = FALSE). **amount** indicates how much extra body window is needed, in screen dots.

The client's **moreScroll** procedure is responsible for adding and deleting body windows from the shell. The case being handled is that in which the client has a large number of pages to display to the user and wishes to only manifest a few. Then we need to handle the case in which system scrolling would make a non-manifest page visible, and there is no body window for it. Whenever the system is about to perform a scroll function, it checks to see if the scroll action would move the visible portion of the bodies off the end of the existent body windows. If so, it calls a non-nil client **MoreScrollProc**, indicating how much more body window may be displayed. The client may augment the collection of body windows or not. The system routines will not scroll past the end of the body windows. The client may also use this opportunity to garbage-collect body windows that have been scrolled off the other end and are no longer visible.

```
noScrollData: ScrollData ← [];
```

noScrollData indicates no scrollbars at all.

```
vanillaScrollData: ScrollData ← [
  displayHorizontal: FALSE,
  displayVertical: TRUE,
  arrowScroll: NIL, -- actually VanillaArrowScroll
  thumbScroll: NIL,-- actually VanillaThumbScroll
  moreScroll: NIL ];
```

vanillaScrollData is the default for the **scrollData** parameter to **Create**. It indicates vertical scrollbar with the **StarWindowShell.VanillaXXXScroll** procedures described above.

```
GetScrollData: PROCEDURE [sws: Handle] RETURNS [scrollData: ScrollData];
```

GetScrollData returns the current **ScrollData** associated with **sws**. May raise **Error [notASWS]**.

```
SetScrollData: PROCEDURE [sws: Handle, new: ScrollData]
  RETURNS [old: ScrollData];
```

SetScrollData sets the current **ScrollData** for **sws** and returns the previous. May raise **Error [notASWS]**.

```
VanillaArrowScroll: ArrowScrollProc;
```

```
VanillaThumbScroll: ThumbScrollProc;
```

The default scrolling procedures provided by **StarWindowShell** are exported here. This allows a client to insert its own scroll procedures, check for certain conditions that the client wants to handle, and call **StarWindowShell** to do the scrolling for other conditions.

45.2.6 Push, Pop, etc.

The **StarWindowShell** returned by **Create** is not displayed on the screen; i.e, is not inserted into the visible window tree. A **StarWindowShell** may be inserted into the window tree by calling **Push**. This is usually not done by the client, but rather by some other part of ViewPoint, such as the desktop implementation. For example, when the user selects an icon and presses OPEN or PROPS, the application (actually the application's **Containee.GenericProc**) creates a **StarWindowShell** and returns it. The desktop implementation then displays the **StarWindowShell** by doing a **Push**.

A **StarWindowShell** is removed from the screen by calling **Pop**. Clients will almost never call **Pop**. Rather, **StarWindowShell** calls **Pop** when the user selects Close, or PropertySheet calls **Pop** when the user selects Done or Cancel.

Push allows one shell to be pushed on top of another shell, thus providing the illusion of "open-within." For example, Star folders and file drawers make heavy use of this illusion.

StarWindowShell has provisions for a shell to display commands in the header of the shells pushed on top of it. (See the Pushee Commands section.) Most clients will not make use of this feature of **Push**, since the **ContainerWindow** interface takes care of this for applications that appear as a list of items that may be opened. Fine Point: We simplify things here by replacing the entire shell. When the shell on top is closed, the shell below still exists and is simply redisplayed.

```
Push: PROCEDURE [
   newShell: Handle, topOfStack: Handle ← NIL,
   poppedProc: PoppedProc ← NIL];
```

Push displays **newShell** by inserting it into the visible window tree. If **topOfStack** is **NIL**, **newShell** is placed directly on the desktop. If **topOfStack** is *not* **NIL**, then **newShell** is pushed on top of **topOfStack** and **topOfStack** is removed from the display (but see the fine point below). If **topOfStack** is not **NIL**, it must be currently visible, i.e,. does not have another shell **Pushed** on top of it. If **poppedProc** is not **NIL**, it is called when **newShell** is **Pop**ped. The **poppedProc** *must* either sleep the shell or destroy the shell, usually by calling **SleepOrDestroy**. If **poppedProc** is **NIL**, **newShell** will be destroyed when it is **Pop**ped. Note that **Push** can be called repeatedly with **topOfStack** being the **newShell** from the previous call, thus producing a stack of StarWindowShells. May raise **Error [notASWS]**.

Fine point: For open-within, we are experimenting with opening the **newShell** overlapping the **topOfStack** shell, allowing the user to look at the container and the thing contained at the same time. This has some rather complex implications with respect to having two views of the same things, being able to open several contained items at once, etc.

```
PushedMe: PROCEDURE [pushee: Handle]
   RETURNS [pusher: Handle];
```

PushedMe returns the next lower shell below **pushee** in the stack (**NIL** if none). Fine Point: This procedure is currently exported through **StarWindowShellExtra**.

```
PushedOnMe: PROCEDURE [pusher: Handle]
   RETURNS [pushee: Handle];
```

This procedure returns the next higher shell above **pusher** in the stack (**NIL** if none) Note: This procedure is currently exported through **StarWindowShellExtra**.

```
PoppedProc: TYPE = PROCEDURE [popped, newShell: Handle,
   popOrSwap: PopOrSwap ← pop];
```

```
PopOrSwap: TYPE = {pop, swap};
```

popped is the shell that is being taken out of the visible window tree. **newShell** is the shell that will become visible because of **popped** being popped. This will be **NIL** if **popped** was not opened within another window. **popOrSwap** indicates the action that caused the shell to be popped, either **StarWindowShell.Pop** or **StarWindowShell.Swap**.

```
Pop: PROCEDURE [popee: Handle] RETURNS [Handle];
```

Pop removes **popee** from a stack of shells and returns the shell that is now on top of the stack. If **popee** was **Pushed** with a **poppedProc**, this **poppedProc** is called. If **popee** is not the top of a stack, then all shells above it in the stack are **Pop**ped. May raise **Error [notASWS]**.

```
Swap: PROCEDURE [
   new, old: Handle,
   poppedProc: PoppedProc ← NIL] ;
```

Swap replaces **old**, which must be the top of a stack, with **new**. Equivalent to a **Pop** followed by a **Push**, but with a lot less screen flashing. May raise **Error [notASWS]**.

```
Replace: PROCEDURE [new, old: Handle];
```

Replaces the **old** shell with **new** without calling **old's PoppedProc**. **old's PoppedProc** becomes the **PoppedProc** for **new**. Fine Point: This procedure is currently exported through **StarWindowShellExtra**.

45.2.7 Limit and Adjust Procs

Limit and Adjust procs are client-supplied procedures that allow a client to get control whenever a **StarWindowShell** is going to change size or location. A **LimitProc** gives the client control over the size and placement of a shell. An **AdjustProc** gives the client an opportunity to fix up the data structures and display for the shell's body window(s).

```
LimitProc: TYPE = PROCEDURE [sws: Handle, box: Window.Box] RETURNS [Window.Box];

GetLimitProc: PROCEDURE [sws: Handle] RETURNS [LimitProc];

SetLimitProc: PROCEDURE [sws: Handle, proc: LimitProc] RETURNS [old: LimitProc];
```

Whenever the size or location of a shell is going to change, the client's **LimitProc** is called. This allows the client to exercise veto or modification rights over the size and location of a StarWindowShell. This is useful, for example, to prohibit a shell from becoming smaller than some certain size or being moved completely off the screen. **box** is the requested size of the shell. The **LimitProc** should return the desired size of the shell. The **LimitProc** is called before the **AdjustProc**. The interior box of the shell box returned by the **LimitProc** is passed to the **AdjustProc**. **GetLimitProc** and **SetLimitProc** may raise **Error [notASWS]**.

```
StandardLimitProc: LimitProc;
```

A **StandardLimitProc** is provided that keeps shells on the screen and keeps them from getting too small.

```
AdjustProc: TYPE = PROCEDURE [sws: Handle, box: Window.Box, when: When];

When: TYPE = {before, after};

GetAdjustProc: PROCEDURE [sws: Handle] RETURNS [AdjustProc];

SetAdjustProc: PROCEDURE [sws: Handle, proc: AdjustProc] RETURNS [old: AdjustProc];
```

The **AdjustProc** will be called whenever the shell is going to change size. It is called both before and after the window's size is changed. The **box** passed to the **AdjustProc** is the *interior* window's box (the client's viewing region in the shell). The **when** parameter indicates whether the current call is before or after the window's size has been changed. An **AdjustProc** is for those clients whose body window display depends on the size of the surrounding shell. For example, if the body window sticks out of the interior of the shell and the user must scroll the body window horizontally to see all the contents, then no **AdjustProc** is needed. If, on the other hand, the content of the body window is always kept visible regardless of the size of the shell (by wrapping the contents around as in the Tajo **FileWindow** editor), then the client will need an **AdjustProc**. **GetAdjustProc** and **SetAdjustProc** may raise **Error [notASWS]**.

45.2.8 Displayed StarWindowShells

```
EnumerateDisplayed: PROCEDURE [proc: ShellEnumProc] RETURNS [Handle ← [NIL]];

EnumerateDisplayedOfType: PROCEDURE [ShellType, proc: ShellEnumProc]
  RETURNS [Handle ← [NIL]];

EnumerateMyDisplayedParasites: [sws: Handle, proc: ShellEnumProc]
  RETURNS [Handle ← [NIL]];

ShellEnumProc: TYPE = PROCEDURE [victim: Window.Handle]
  RETURNS [stop: BOOLEAN ← FALSE];
```

These procedures enumerate visible **StarWindowShells**. Each one returns the last shell incurred in the enumeration if the **ShellEnumProc** returns TRUE, otherwise they return NIL. **EnumerateMyDisplayedParasites** may raise **Error [notASWS]**.

45.2.9 Errors

```
Error: ERROR[code: ErrorCode];

ErrorCode: TYPE = {desktopNotUp, notASWS, notStarStyle, tooManyWindows};
```

45.3 Usage/Examples

```
-- Create a StarWindowShell

CreateShell: PROCEDURE RETURNS [StarWindowShell.Handle] = {

    another: XString.ReaderBody ← XString.FromSTRING["Another"L];
    repaint: XString.ReaderBody ← XString.FromSTRING["Repaint"L];
    post: XString.ReaderBody ← XString.FromSTRING["Post A Message"L];
    sampleTool: XString.ReaderBody ← XString.FromSTRING["Sample Tool"L];

    -- Create the StarWindowShell
    shell: StarWindowShell.Handle = StarWindowShell.Create [name: @sampleTool];

    -- Create a body window inside the StarWindowShell
    body: Window.Handle = StarWindowShell.CreateBody [
        sws: shell,
    box: [ [0,0], bodyWindowDims ],
    repaintProc: Redisplay,
    bodyNotifyProc: NotifyProc ];

-- Create some menu items
z: UNCOUNTED ZONE ← StarWindowShell.GetZone [shell];
items: ARRAY [0..3) OF MenuData.ItemHandle ← [
    MenuData.CreateItem [zone: z, name: @another, proc: MenuProc],
    MenuData.CreateItem [zone: z, name: @repaint, proc: RepaintMenuProc],
    MenuData.CreateItem [zone: z, name: @post, proc: Post] ];
myMenu: MenuData.MenuHandle = MenuData.CreateMenu [
    zone: z,
    title: NIL,
    array: DESCRIPTOR [items]];
StarWindowShell.SetRegularCommands [sws: shell, commands: myMenu];

RETURN [shell];

};
```

45.4 Index of Interface Items

46

TIP

46.1 Overview

TIP provides basic user input facilities through a flexible mechanism that translates hardware-level actions from the keyboard and mouse into higher-level client action requests (result lists). The acronym TIP stands for *terminal interface package*. This interface also provides the client with routines that manage the input focus, the periodic notifier, and the **STOP** key.

46.1.1 Basic Notification Mechanism

The basic notification mechanism directs user input to one of many windows in the window tree. Each window has a **Table** and a **NotifyProc**. The table is a structure that translates a sequence of user actions into a sequence of results that are then passed to the notify procedure of the window.

There are two processes that share the notification responsibilities, the Stimulus process and the Notifier process. The Stimulus process is a high-priority process that wakes up approximately 50 times a second. When it runs, it makes the cursor follow the mouse and watches for keyboard keys going up or down, mouse motion, and mouse buttons going up or down, enqueuing these events for the Notifier process.

The Notifier process dequeues these events, determines which window the event is for, and tries to match the events in the window's table. If it finds a match in the table, it calls the window's notify procedure with the results specified in the table. If no match is found, it tries the next table in the window's chain of tables. If no match is found in any table, the event is discarded.

The Notifier process is an important process. To avoid multi-process interference, some operations in the system are restricted to happen only in the Notifier process. Setting the selection is one such operation. The Notifier process is also the one most closely tied to the user. If an operation will take an extended time to complete, it should be forked from the notifier process to run in a separate process so that the Notifier process is free to respond to the user's actions.

46.1.2 Tables

Tables provide a flexible method of translating user actions into higher-level client-defined actions. They are essentially large select statements in which the user's actions are matched against the left side of a table with a corresponding set of results on the right side. Left sides of tables specify *triggers*--changes in state of keys--and *enablers*--existing state of keys--to be matched with the user actions. Right sides of tables specify results that include mouse coordinates, atoms, and strings for keyboard character input. A complete syntax and semantics of tables are in § 46.3.2 and §46.3.3.

Tables have a user-editable filed representation that is parsed to build a runtime data structure for **TIP**. The user-editable filed representation must be in the system catalog and is assumed to have a file name extension of .TIP. When a table is created by calling the **CreateTable** operation, the tip file is parsed and its runtime data structure is created. In addition, a compiled version of the tip file is created in a file whose name has the character C appended to the name of the tip file. On subsequent calls to **CreateTable**, this tipc file is used to create the runtime data structure as long as the tip file has not been changed. By avoiding parsing the tip file, building the runtime data structure from the compiled file is much faster.

The table parser uses a macro package that allows macros to be defined and used in writing tables. It is described in §46.3.7.

Tables may be linked to form a chain of tables. The notifier process attempts to match user actions in the first table of the chain. If no match is found, it tries subsequent tables in the chain. If no match is found in any table, the user action is discarded. Clients can use the links of tables to build special processing on top of basic facilities. The client can write its own table to handle special user actions and, by linking the table to system-defined tables, let them handle the normal user actions. An example is in the Usage/Examples section. System-defined tables, which are accessable through the **TIPStar** interface, are described in **Appendix A**.

46.1.3 Input Focus

The input focus is a distinguished window that is the destination of most user actions. User actions may be directed either to the window with the cursor or to the input focus. Actions such as mouse buttons are typically sent to the window with the cursor. Most other actions, such as keystrokes, are usually sent to the current input focus.

The notifier process uses either the input focus window or the cursor window to obtain a table and a notify procedure. Results from matching the user actions with the table are normally passed to the window's notify procedure. Notify procedures may also be bound directly with a table. In this case, results from the table go to the table's notify procedure instead of to the window's notify procedure.

Clients may make a window be the current input focus and be notified when some other window becomes the current input focus.

46.1.4 Periodic Notification

The Notifier process is important because it responds directly to the user. To avoid multi-process interference, some operations in the system are restricted to happen only in the Notifier process. The periodic notification mechanism allows operations to happen within the Notifier process while the user is idle. A periodic notifier is created with a window, some results, and a time interval. The window's notify procedure is called with the results every time interval as long as the Notifier process is not processing user actions.

46.1.5 Call-Back Notification and Setting the Manager

Call-back notification and setting of the manager bypass the normal means of selecting a window as the destination of input and allow the client to receive all input. It is useful for something like mouse tracking when a menu is posted. This must be done only from the Notifier process.

Call-back notification is so named because the client calls back to the Notifier process with a special call-back notification procedure, a window and a table. The Notifier matches user actions with the table and sends the results to the call-back notify procedure. It continues to do this until the call-back notify procedure says it is done. User actions that are not matched are discarded.

Setting the manager makes the Notifier process use the manager's table for matching user actions and send the results to the manager's notify procedure. User actions that are not matched are discarded.

While both call-back notification and setting the manager results in all notifications being sent to a single place, they are different in the control structure. With call-back notification, the client's call stack is not unwound, while setting the manager does not take effect until the current notification is processed and its call stack unwound.

46.1.6 Attention and User Abort

While most notifications are sent to notify procedures from the notifier process, there is a mechanism that allows asynchronous notification of the STOP key. An **AttentionProc** may be set for a window that is called whenever the STOP key is depressed in that window. It is called from outside the notifier process as soon as the stimulus level sees the key go down. For those windows that do not set an **AttentionProc**, the system keeps a user abort flag that records whether the STOP key was depressed. Clients may call **UserAbort** to check if the flag is set. It is cleared when any notification is sent to the window's notify procedure.

46.1.7 Stuffing Input into a Window

TIP provides operations that allow a client program to call the notify procedure of a window with results that the client constructs. **StuffResults** allows a client to pass an arbitrary results list to a window. **StuffString**, **StuffSTRING**, and **StuffCharacter** allow strings and characters to be passed to a window.

46.2 Interface Items

46.2.1 Results

```
Results: TYPE = LONG POINTER TO ResultObject;

ResultObject: TYPE = RECORD [
  next: Results,
  body: SELECT type: * FROM
    atom = > [a: ATOM],
    bufferedChar = > NULL,
    coords = > [place: Window.Place],
    int = > [i: LONG INTEGER],
    key = > [key: KeyName, downUp: DownUp],
    nop = > [],
    string = > [rb: XString.ReaderBody],
    time = > [time: System.Pulses],
    ENDCASE];

ATOM: TYPE = Atom.ATOM;

DownUp: TYPE = LevelIVKeys.DownUp; -- {down, up}

KeyName: TYPE = LevelIVKeys.KeyName;
```

The right side of a statement in a table is a list of results to be passed to the notify procedure when there is a match on the left side. Each element of this list of results is described by a **ResultObject**. The **atom** variant contains the atom from the table's right side. The place in the **coords** variant is relative to the window receiving the results. The reader body of the **string** variant is either from the **bufferedChar** results or from a string constant in the table. The pulses of the time variant is the value of System.GetPulses at the time the event actually occurred.

Character input is buffered by the Notifier process. If the result of a match is a bufferedChar, the Notifier process buffers the character and proceeds to try and match the next user actions. If there are no more user actions and the buffer of character input is not empty, the Notifier process calls the notify procedure with the buffered character input. If the next action produces a result that is not another character input, the Notifier process calls the notify procedure with the buffered character input and then call it with the new result. If the notifier process gets behind the user and a lot of character input actions get queued up, it collects them and passes them together to the client instead of one at at time.

KeyName is an enumerated that describes the keyboard and mouse buttons. See §5.2 in the *Pilot Programmer's Manual* (610E00160) for a complete list of the elements.

46.2.2 Notify Procedure

```
NotifyProc: TYPE = PROCEDURE [window: Window.Handle, results: Results];
```

A **NotifyProc** is the means of notifying a window of user input. The parameters are the window that is receiving the input and the list of results that describe the input.

Normally, the results are from the tip table associated with the window. Notify procedures may also be bound directly with a table. In this case, results from the table go to the table's notify procedure instead of to the window's notify procedure.

46.2.3 TIP Tables

Table: TYPE = LONG POINTER TO **TableObject**;

TableObject: TYPE;

Table is a pointer to the internal representation of a table.

GetTableLink: PROCEDURE [**from**: **Table**] RETURNS [**to**: **Table**];

SetTableLink: PROCEDURE [**from**, **to**: **Table**] RETURNS [**old**: **Table**];

GetTableLink and **SetTableLink** allow the tables to be linked. **GetTableLink** returns the table following **from** in the chain, returning NIL if there is no successor table. **SetTableLink** sets the link of table **from** to **to** and returns the old value.

SetTableOpacity: PROCEDURE [**table**: **Table**, **opaque**: BOOLEAN]
  RETURNS [**oldOpaque**: BOOLEAN];

GetTableOpacity: PROCEDURE [**table**: **Table**] RETURNS [BOOLEAN];

SetTableOpacity sets the opacity of **table** and returns the old value, while **GetTableOpacity** returns its value. If a table is opaque, then unrecognized user actions are discarded without searching the table chain past the opaque entry.

46.2.4 Associating Notify Procedures, Tables, and Windows

SetTableAndNotifyProc: PROCEDURE [
  window: Window.**Handle**, **table**: **Table** ← NIL, **notify**: **NotifyProc** ← NIL];

SetTableAndNotifyProc makes window a TIP client and associates the table and notify procedure with the window. If **window** is already a TIP client and **table** or **notify** is NIL, then the old value is retained.

SetTable: PROCEDURE [**window**: Window.**Handle**, **table**: **Table**] RETURNS [**oldTable**: **Table**];

GetTable: PROCEDURE [**window**: Window.**Handle**] RETURNS [**Table**];

SetTable sets the table associated with **window** to be **table** and returns the old table. **GetTable** returns the table associated with **window**.

SetNotifyProc: PROCEDURE [**window**: Window.**Handle**, **notify**: **NotifyProc**]
  RETURNS [**oldNotify**:**NotifyProc**];

GetNotifyProc: PROCEDURE [**window**: Window.**Handle**] RETURNS [**NotifyProc**];

SetNotifyProc sets the notify procedure associated with **window** to be **notify** and returns the old notify procedure. **GetNotifyProc** returns the notify procedure associated with **window**.

SetNotifyProcForTable: PROCEDURE [table: Table, notify: NotifyProc]
RETURNS [oldNotify: NotifyProc];

GetNotifyProcFromTable: PROCEDURE [table: Table] RETURNS [NotifyProc];

SetNotifyProcForTable binds the notify procedure, **notify**, with **table** and returns the old value of bound notify procedure. Results from matches within the table will go to **notify** instead of to the notify procedure for the window this table is associated with. **GetNotifyProcFromTable** returns the notify procedure bound to **table**.

46.2.5 Creating and Destroying Tables

CreateTable: PROCEDURE [
file: XString.Reader, z: UNCOUNTED ZONE ← NIL, contents: XString.Reader ← NIL]
RETURNS [table: Table];

CreateTable generates a TIP table from the text file named by **file** (which may not be NIL). Storage for the table will be allocated in **z** or from the implementation's zone if **z** is NIL. **contents** is the default contents of **file**, and will be used if (1) the 'I boot switch is set, (2) the **file** cannot be read, or (3) the signal **InvalidTable** is resumed. (See **InvalidTable** for further details on how to treat that SIGNAL.)

When **file** is parsed, a compiled form of the table is written into a file with a name constructed by appending a C on the end of **file**. Fine Point: **file** should typically have the extension .TIP. When **CreateTable** is called, if a .TIPC file exists that was created from **file**, the .TIPC file is used to generate **table**.

This procedure may raise the SIGNAL **InvalidTable**.

CreateCharTable: PROCEDURE [
z: UNCOUNTED ZONE ← NIL, buffered: BOOLEAN ← TRUE] RETURNS [table: Table];

CreateCharTable creates a TIP table such that any down transition of any of the keystations (not key tops) in the main typing array have a right-hand side of BUFFEREDCHAR. Storage is allocated from **z** if it is non-NIL or from the TIP implementation's zone. The boolean **buffered** is ignored and will be removed when this interface is updated.

CreatePlaceHolderTable: PROCEDURE [z: UNCOUNTED ZONE ← NIL] RETURNS [table: Table];

CreatePlaceHolderTable creates a placeholder tip table. Placeholder tables contain no information themselves but allow other tables with information to be linked to them. Storage is allocated from **z** if it is non-NIL or from the TIP implementation's private zone.

DestroyTable: PROCEDURE [LONG POINTER TO Table];

DestroyTable frees the table addressed by the parameter and then sets the table to NIL.

46.2.6 Input Focus

SetInputFocus: PROC [
  w: Window.**Handle**, **takesInput**: BOOLEAN, **newInputFocus**: **LosingFocusProc** ← NIL,
  clientData: LONG POINTER ← NIL];

SetInputFocus makes the window **w** the input focus. If **w** allows type-in, **takesInput** should be set to TRUE; otherwise **takesInput** should be set to FALSE. **newInputFocus** is called when **w** loses the input focus. It is passed **clientData** as the value of its LONG POINTER parameter.

LosingFocusProc: TYPE = PROCEDURE [**w**: **Window.Handle**, **data**: LONG POINTER];

LosingFocusProc describes the procedure type that is used to let the input focus know it is no longer the input focus. **w** is the Window.**Handle** of the window that was the input focus, and **data** is the client data passed to **SetInputFocus**.

GetInputFocus: PROC RETURNS [Window.**Handle**];

GetInputFocus returns the window that currently has the input focus.

backStopInputFocus: READONLY Window.**Handle**;

The window **backStopInputFocus** gets all input focus notification when no other window requests to be the input focus. It may be NIL.

SetBackStopInputFocus: PROCEDURE [**window**: Window.**Handle**];

SetBackStopInputFocus sets **backStopInputFocus**, the window that gets all input focus notification if no other window requests to be the input focus.

FocusTakesInput: PROC RETURNS [BOOLEAN];

FocusTakesInput returns TRUE if the current input focus accepts input, FALSE otherwise.

ClearInputFocusOnMatch: PROC [**w**: Window.**Handle**];

ClearInputFocusOnMatch is used to clear the input focus in a window if that window has the input focus. This procedure is usually called by clients who are implementing their own window type when they are destroying a window.

46.2.7 Character Translation

CharTranslator: TYPE = RECORD [
  proc: **KeyToCharProc**, **data**: LONG POINTER];

KeyToCharProc: TYPE = PROCEDURE [
  keys: LONG POINTER TO **KeyBits**, **key**: **KeyName**, **downUp**: **DownUp**, **data**: LONG POINTER,
  buffer:XString.**Writer**];

A **CharTranslator** is used to construct characters from the state of the keyboard when a BUFFEREDCHAR result is encountered. The **KeyToCharProc** is called when the notifier needs to construct a character from the state of the keyboard. **keys** describes the current state of the keyboard. **key** and **downUp** describe the current character transition. The procedure should append the corresponding character(s) to **buffer**. There is a **CharTranslator** for each table.

KeyBits: TYPE = LevelIVKeys.KeyBits;

SetCharTranslator: PROCEDURE [table: Table, new: CharTranslator]
RETURNS [old: CharTranslator];

GetCharTranslator: PROC [table: Table] RETURNS [o: CharTranslator];

SetCharTranslator sets the character translator for **table**, returning the old value. **GetCharTranslator** returns the character translator for **table**.

46.2.8 Periodic Notification

PeriodicNotify: TYPE [1];

nullPeriodicNotify: PeriodicNotify;

PeriodicNotify is a handle for a periodic notifier. Periodic notifiers are a means of notifying windows at regular intervals from within the Notifier. **nullPeriodicNotify** is the null value for **PeriodicNotify**.

CreatePeriodicNotify: PROC [
window: Window.Handle, results: Results, milliSeconds: CARDINAL,
notifyProc: NotifyProc ← NIL]
RETURNS [PeriodicNotify];

CreatePeriodicNotify registers a periodic notification. If **notifyProc = NIL** then the notify proc associated with window is used. If **notifyProc # NIL,** is called; this is useful if the client is running in a background process but wants to perform some operation that must be done in the notifier process, such as obtaining the current selection. If there is a **COORDS** result and **window = NIL**, that result is [0, 0]. If **notifyProc = NIL** and **window = NIL**, the **Error[other]** is raised. The specified notify proc is called with parameters **window** and **results** once every **milliSeconds** milliseconds as long as no user action notifications are taking place. If **milliSeconds** = 0, it runs once and then destroys itself. The result list should not contain any entries of type **nop** or **bufferredChar**. Right-hand sides of type **coords** will be adjusted to reflect the actual mouse position relative to the window being notified. The results list will *not* be copied. Its allocation is up to the client.

CancelPeriodicNotify: PROC [
PeriodicNotify] RETURNS [null: PeriodicNotify];

CancelPeriodicNotify stops the periodic notification passed in by removing the notification from the list of registered procedures and returns **nullPeriodicNotify**. This procedure raises **Error[noSuchPeriodicNotifier]** if the handle passed in is not valid (calling it with **nullPeriodicNotify** has no effect).

46.2.9 Call-Back Notification

CallBack: PROCEDURE [window: Window.Handle, table: Table, notify: CallBackNotifyProc];

CallBackNotifyProc: TYPE = PROCEDURE [window: Window.Handle, results: Results]
RETURNS [done: BOOLEAN];

Call-back notification allows the client to receive all input. It is useful for something like mouse tracking when a menu is posted. **CallBack** uses **table** to match all user input and calls **notify** for each successful match in the table with **window** and the results from the table as parameters. **CallBack** will continue to send all notifications to **notify** as long as **notify** returns **done**: FALSE. Call-back notification is similar to setting the **Manager** except that the client's call stack is not unwound. User actions that are not matched are discarded.

46.2.10 Manager

Manager: TYPE = RECORD [
table: Table, window: Window.Handle, notify: NotifyProc];

nullManager: Manager = [NIL, TRASH, TRASH];

Manager is used to send all user actions through **table** and **notify**, using **window** instead of through the window, table, and notify procedure determined by **actionToWindow** and **TIPs** Match process. If **table** is NIL, as in **nullManager**, then the standard mechanisms will be used to determine where actions will be sent.

GetManager: PROC RETURNS [current: Manager];

GetManager returns the current manager.

ClearManager: PROCEDURE = INLINE ...;

ClearManager sets the manager to **nullManager**. It should only be called by clients who know that they set the manager from null to non-null.

SetManager: PROCEDURE [new: Manager] RETURNS [old: Manager];

SetManager does the obvious thing.

46.2.11 User Abort

UserAbort: PROC [Window.Handle] RETURNS [BOOLEAN];

UserAbort returns whether the user abort flag is set for the window. The bit may be set by calling **SetUserAbort** or by the system if the window does not have an attention procedure and the STOP key is depressed in that window. If **window** is NIL, the **UserInput** package checks to see whether the user has done a global abort. When a non-shift key goes down, this flag and the global abort flag are cleared.

ResetUserAbort: PROC [Window.Handle];

ResetUserAbort sets user abort flag for the window to FALSE.

SetUserAbort: PROC [Window.Handle]

SetUserAbort sets the user abort flag for the window. This does not call the window's attention procedure, if there is one.

46.2.12 Attention

AttentionProc: TYPE = PROC [window: Window.Handle];

An **AttentionProc** is a procedure called whenever the STOP key is depressed. It is called from a high-priority process--not the Notifier--as soon as the stimulus level sees the key go down.

SetAttention: PROC [Window.Handle, attention: AttentionProc]

SetAttention sets the attention procedure for the window. The procedure **attention** is called asynchronously whenever the STOP key is depressed.

46.2.13 Stuffing Input into a Window

StuffCharacter: PROC [
  window: Window.Handle, char: XString.Character] RETURNS [BOOLEAN]

StuffCharacter allows a client to drive the type-in mechanism as though a character were coming from the user. The notify procedure of **window** is called with a string result that contains **char**. The returned BOOLEAN is TRUE only if **window** was prepared to accept input.

StuffCurrentSelection: PROC [window: Window.Handle] RETURNS [BOOLEAN]

StuffCurrentSelection allows a client to drive the type-in mechanism as though the contents of the current selection were coming from the user. The selection is converted to a string and the string is passed to the window's notify proc. (See the **Selection** interface for a description of the current selection.) The returned BOOLEAN is TRUE only if **window** was prepared to accept input.

StuffResults: PROCEDURE [window: Window.Handle, results: Results];

StuffResults calls the notify proc of **window** with **results**.

StuffString: PROC [window: Window.Handle, string: XString.Reader] RETURNS [BOOLEAN]

StuffString allows a client to drive the type-in mechanism as though **string** were coming from the user. The notify procedure of **window** is called with a string result that contains **string↑**. The returned BOOLEAN is TRUE only if **window** was prepared to accept input.

StuffSTRING: PROCEDURE [window: Window.Handle, string: LONG STRING]
  RETURNS [BOOLEAN];

StuffSTRING calls the notify procedure of **window** with a results list that contains a **string ResultObject** whose reader body describes the characters in **string**.

StuffTrashBin: PROC [window: Window.Handle] RETURNS [BOOLEAN]

StuffTrashBin is currently not implemented.

46.2.14 Errors

InvalidTable: SIGNAL [type: TableError, message: XString.Reader];

TableError: TYPE = {fileNotFound, badSyntax};.

InvalidTable is only raised by **CreateTable**. The type is **fileNotFound** if the file could not be found and the **message** string was empty. **fileNotFound** is raised as an ERROR . The type is **badSyntax** if the current file is syntactically incorrect. If **badSyntax** is RESUMEd, and **message** is not empty, the **message** is written into **file**, and it is reparsed. If the file has been overwritten, or **message** is empty, and there is a syntax error, the error will be **badSyntax**. In this case if the signal is resumed, **CreateTable** simply returns NIL.

Error: ERROR [code: ErrorCode];

ErrorCode: TYPE = {noSuchPeriodicNotifier, other};

ReturnToNotifier: ERROR [string: XString.Reader];

Sometimes a client is deep in the call stack of some Notifier-invoked operation from which it wishes to unwind. The ERROR **ReturnToNotifier** can be raised and will be caught at the top level of the Notifier process. Clients can catch this error, post a message with **string** in it, and let the error propagate up.

46.2.15 Miscellaneous Items

GetPlace: PROCEDURE [window: Window.Handle] RETURNS [Window.Place];

GetPlace returns the **window** relative coordinate of the last user action that was matched. **GetPlace** should only be invoked while in the notifier process.

actionToWindow: PACKED ARRAY KeyName OF BOOLEAN;

actionToWindow determines if a user action should be sent to the window containing the cursor (TRUE) or to the window containing the current input focus (FALSE). This array is global to the entire environment. It is initialized to have all actions go to the input focus, except those associated with the **Adjust**, **Menu**, and **Point** mouse buttons and the STOP key.

caretRate: Process.Ticks;

clickTimeout: System.Pulses;

clickTimeout and **caretRate** are values that are set by user profile. Clients who implement blinking carets may use **caretRate** to determing the rate of caret blinking. Clients who implement click timeout without using the timing facilities in tables may use **clickTimeout** to determine the maximum time allowed between two clicks of a multi-click.

FlushUserInput: PROCEDURE;

FlushUserInput empties the queue of pending user actions (type- ahead and button-ahead).

46.3 Usage/Examples

46.3.1 Periodic Notification

The following example shows the use of a periodic notifier for updating a display of the volume page count. The page count will be updated every 20 seconds, provided that the Notifier is not otherwise occupied.

```
window: Window.Handle ← ...;
updateCount: Atom.ATOM ← Atom.MakeAtom["UpdateCount"L];
results: ResultsObject ← [next: NIL, body: atom[a: updateCount]];
pageNotifier: PeriodicNotify ←
  CreatePeriodicNotifty[window: window, results: @results, milliSeconds: 20000];

MyNotifyProc: NotifyProc = {
  input: Results;
  FOR input ← results, results.next DO
    WITH z: input SELECT FROM
      atom = >
        IF z.a = updateCount THEN {
          -- code to update page count on screen;}
        ELSE {
          -- code to handle other atoms};
      ENDCASE;
    ENDLOOP};
```

46.3.2 Syntax of TIP tables

Following is the BNF description for the syntax of tables. Non-terminals are boldface, terminals are non-bold Titan (e.g., `FastMouse`). The characters "`"`", "`.`", "`;`", "`,`", "=>", "{", and "}" in the BNF below are terminal symbols. The semantics are described in the next section.

```
TIPTable             :: = Options TriggerStmt .
                     Note: tables terminate with a period.

Options              :: = empty | OPTIONS OptionList ;
OptionList           :: = Option | Option , OptionList
Option               :: = SmallOrFast | FastOrSlowMouse
SmallOrFast          :: = Small | Fast
FastOrSlowMouse      :: = FastMouse | SlowMouse

Expression           :: = AND TriggerChoice | WHILE EnableChoice | => Statement
Statement            :: = TriggerStmt | EnableStmt | Results

TriggerStmt          :: = SELECT TRIGGER FROM TriggerChoiceSeries
EnableStmt           :: = SELECT ENABLE FROM EnableChoiceSeries

TriggerChoiceSeries  :: = TriggerChoice ; TriggerChoiceSeries
                        | TriggerChoice ENDCASE FinalChoice
                        | ENDCASE FinalChoice
```

```
EnableChoiceSeries    :: = EnableChoice ; EnableChoiceSeries
                           | EnableChoice ENDCASE FinalChoice
                           | ENDCASE FinalChoice

TriggerChoice         :: = TriggerTerm Expression
EnableChoice          :: = EnableTerm Expression
FinalChoice           :: = empty | => Statement

TriggerTerm           :: = ( Key | MOUSE | ENTER | EXIT ) TimeOut
EnableTerm            :: = KeyEnableList | PredicateIdent

TimeOut               :: = empty | BEFORE Number | AFTER Number

KeyEnableList         :: = Key | Key  |  KeyEnableList
                         Note: the  |  between Key and  KeyEnableList is  a
                         terminal and must be entered.
Key                   :: = KeyIdent UP | KeyIdent DOWN

Results               :: = ResultItem | ResultItem  , Results | ResultItem Expression
                           | { ResultItems }
ResultItems           :: = ResultItem | ResultItem ResultItems
ResultItem            :: = COORDS | BUFFEREDCHAR | CHAR | KEY | TIME
                           | Number| String | ResultIdent

String                :: =  "any sequence of characters not containing a " "

ResultIdent           :: = Ident
KeyIdent              :: = Ident
PredicateIdent        :: = Ident
```

46.3.3 Semantics of Tables

The whole match process can be viewed as a **SELECT** statement, that is continuously reading key transitions, mouse movements, or key states from the input queue. A trigger statement has the effect of looking at the next action recorded in the input queue and branching to the appropriate choice. An enable statement implies selection between the different choices according to the current state of the keyboard or the mouse keys. Trigger terms may appear in sequence, separated by **AND**. They might be mixed with enable terms, which in turn are characterized by the keyword **WHILE**. A timeout following a trigger indicates a timing condition that has to hold between this trigger and its predecessor. The number associated with the timeout expresses a time interval in milliseconds. Events starting with the same sequence of trigger and/or enable terms are expressed as nested statements. Result items may be identifiers, numbers, strings, or the keywords COORDS, BUFFEREDCHAR, CHAR, KEYS, or TIME. The results of a successfully parsed event are passed to the client. Numbers are passed as **LONG INTEGER**s, and strings as **XString.ReaderBody**s. BUFFEREDCHAR and CHAR come as **XString.ReaderBody**s containing the character interpretation of the key involved with the event as defined by the **CharTranslator**. COORDS results in a **Window.Place** containing the mouse coordinates of the event.

```
Option                :: = SmallOrFast | FastOrSlowMouse
```

SmallOrFast	:: = `Small|Fast` TIP can produce its internal table in two formats: one designed for compactness (default) and one for speedy execution. This option indicates which format should be used.
FastOrSlowMouse	:: = `FastMouse|SlowMouse`
`FastMouse`	The TriggerTerm MOUSE means *all* mouse movement.
`SlowMouse`	The TriggerTerm MOUSE means only the most recent mouse motion (default).
Expression	:: = AND **TriggerChoice** | WHILE **EnableChoice** | => **Statement**
AND **TriggerChoice**	match if and only if **TriggerChoice** is the next input event *after* the preceding choice. For example, A `Down AND B Down` means A goes down and then B goes down (with no intervening actions like A Up or mouse motion).
`WHILE` **EnableChoice**	match if **EnableChoice** is also true at this point. For example, A `Down WHILE B Down` matches if A goes down while B is down.
=> **Statement**	continue processing at **Statement** (it is used for results and common prefixes).
Statement	:: = **TriggerStmt** | **EnableStmt** | **Results**
TriggerStmt	:: = `SELECT TRIGGER FROM` **TriggerChoiceSeries**
EnableStmt	:: = `SELECT ENABLE FROM` **EnableChoiceSeries**
EnableStmt	matches if any of the **EnableChoiceSeries** *have already happened.*
TriggerStmt	matches if any of the **TriggerChoiceSeries** *have just happened.*
TriggerTerm	:: = **(** **Key** | MOUSE | ENTER | EXIT **)** **TimeOut**
Key	matches if the appropriate key transition occurs.
MOUSE	matches if there is mouse motion (useful for tracking the mouse).
ENTER	matches if the mouse enters the window.
EXIT	matches if the mouse leaves the window.
TimeOut	:: = **empty** | BEFORE **Number** | AFTER **Number**
BEFORE **Number**	matches if the associated **TriggerTerm** happens within a number ofmilliseconds of the preceding (matched) user action. For example, A `Down AND B Down BEFORE 200` would match if A went down and then B went down within 1/5 second (and there were no intervening actions).
AFTER **Number**	matches if the associated **TriggerTerm** happens a number of milliseconds or more after the preceding user action. For

example, `A Down AND B Down AFTER 200` would match if A went down and then B went down more than 1/5 second later (and there were no intervening actions).

EnableTerm	:: = **KeyEnableList | PredicateIdent**
KeyEnableList	is true if any of the **Key**s are true.
Key	:: = **KeyIdent** UP | **KeyIdent** DOWN
Key	is true if the appropriate transition has happened (if this is part of a trigger term, is the current user action; if this is an enable term, it has already happened).
KeyIdent	identifies the keyboard key. The identifiers should be one of: A ... Z, One, Two, Three, ... Zero, Adjust, AGAIN, OpenQuote, DEFAULTS, BackSlash, BS, SUBSCRIPT, SMALLER, Comma, KEYBOARD, TAB, PROPS, COPY, Minus, DELETE, MARGINS, Equal, EXPAND, FIND, HELP, ITALICS, UNDERLINE, Keyset1, Keyset2, Keyset3, Keyset4, Keyset5, LeftBracket, LeftShift, LOCK, MouseMiddle, CENTER, MOVE, NEXT, SAME, Period, Point, CloseQuote, SUPERSCRIPT, RETURN, RightBracket, RightShift, BOLD, SemiColon, Slash, Space, OPEN, PARATAB, UNDO, STOP, A8, A9, A10, A11, A12, L1, L4, L7, L10, Key47, R3, R4, R9, R10 **Note:** There are no names for shifted characters like left or right paren. Instead, specify one or both shift keys plus the unshifted key name. For example, `Nine Down WHILE LeftShift Down` instead of `LeftParen Down`. See **LevelIVKeys** and the *Pilot Programmer's Manual* for (610E00160) more information on the keyboard.
ResultItem	:: = COORDS | BUFFEREDCHAR | CHAR | KEY | TIME | **String | Number | ResultIdent**
String	:: = **"any sequence of characters not containing a ""**
ResultIdent	:: = **Ident**
COORDS	return a coord **ResultElement** with the coords of the last user action.
BUFFEREDCHAR	return a string **ResultElement** containing the character representations of the last user actions that were also buffered characters.
CHAR	same as BUFFEREDCHAR
KEY	return a key **ResultElement** with the current state of the key (not recommended in normal usage. Usually a more complex TIP table is indicated if you are using this result).
TIME	return a time **ResultElement** with the time of the last (matched) user action.
String	return a string **ResultElement.**
Number	return an integer **ResultElement.**

ResultIdent	return an atom **ResultElement**.
PredicateIdent	:: = **Ident**
PredicateIdent	is not currently implemented.

46.3.4 Example Table

```
SELECT TRIGGER FROM
  Point Down =>
    SELECT TRIGGER FROM
      Point Up BEFORE 200 AND Point Down BEFORE 200 =>
        SELECT ENABLE FROM
          LeftShift Down => COORDS, ShiftedDoubleClick
          ENDCASE        => COORDS, NormalDoubleClick;
  Adjust Down BEFORE 300 => PointAndAdjust;
  ENDCASE => COORDS, SimpleClick;
  ...
```

This table produces the result element (atom) `NormalDoubleClick` along with the mouse coordinates if the left mouse button goes down, remains there not longer than 200 ms, and goes down again before another 200-ms elapse. The result is `ShiftedDoubleClick` if the same actions occur but also the left shift key is down. If the right mouse button also goes down less than 300 ms after the initial `Point Down` and the left mouse button also goes down, `PointAndAdjust` results.. Finally, the table specifies the result `SimpleClick` (with coordinates) if `Point` goes down but none of the above-described succeeding actions occurs.

46.3.5 Simple TIP Client Example

This example shows a simple **TIP** client. The window acts in the following manner. If the left (`Point`) mouse button is depressed the window becomes the input focus and the cursor changes to its special shape. As long as the window is the input focus and the cursor is in the window, it remains the special shape but returns to the original shape when the mouse leaves the window. The place in the window where the depressed left (`Point`) mouse button is released is the place where text is displayed.

The procedure **InitAtoms** is part of the initialization code and creates the four atoms that the notify procedure understands. It is put in a separate procedure so the string literals will not be allocated in the global frame. The procedure **InitWindow** initializes the window by attaching the context data and setting the table and notify procedure.

This example uses the system's table from **TIPStar**. The fragments of the **NormalMouse.tip** portion of **TIPStar**'s normal table that are used to generate the atom results in this example are

```
Point Down => SELECT ENABLE FROM
  [SHIFT]=> TIME, COORDS, Shift, PointDown;
  ENDCASE => TIME, COORDS, PointDown;

Point Up => SELECT ENABLE FROM
  [SHIFT]=> TIME, COORDS, Shift, PointUp;
  ENDCASE => TIME, COORDS, PointUp;
```

```
ENTER => Enter;
EXIT => Exit;
```

The notify procedure **TIPMe** looks at the results and understands four atoms and string input. For the atom **pointDown**, if the window is not already the input focus, it sets the window as the input focus and sets the cursor to its special shape. For the atom **pointUp**, it saves the place the event occurred as the location to display text. The **enter** atom just fiddles with the cursor if the window is the input focus. The **exit** atom restores the cursor. If the window is the input focus and the user types intô the window, a string result is sent to the notify procedure containing the characters typed. The **NormalKeyboard.tip** portion of **TIPStar**'s normal table contains the BUFFEREDCHAR results for the keyboard–keys–going down events.

```
Handle: TYPE = LONG POINTER TO Object;
Object: TYPE = ...;
contextType: Context.Type = Context.UniqueType[];
pointDown, pointUp, enter, exit: Atom.ATOM;

InitAtoms: PROCEDURE = {
  pointDown ← Atom.MakeAtom["PointDown"L];
  pointUp ← Atom.MakeAtom["PointUp"L];
  enter ← Atom.MakeAtom["Enter"L];
  exit ← Atom.MakeAtom["Exit"L]};

InitWindow: PROCEDURE [window: Window.Handle] = {
  h: Handle = zone.NEW[Object ← []];
  Context.Create[type: contextType, data: h, proc: DestroyContext, window: window];
  TIP.SetTableAndNotifyProc[
    window: window, table: TIPStar.NormalTable[], notify: TIPMe]};

TIPMe: TIP.NotifyProc = {
  h: Handle = Context.Find[type: contextType, window: window];
  place: Window.Place;
  FOR input: TIP.Results ← results, input.next UNTIL input = NIL DO
    WITH z: input SELECT FROM
      coords => place ← z.place;
      atom => SELECT z.a FROM
        pointDown =>
          IF ~h.hasInputFocus THEN {
            TIP.SetInputFocus[
              window: window, takesInput: TRUE,
              newInputFocus: MyLosingFocusProc, clientData: h];
            SaveCursorAndSetMine[h]}
        pointUp => h.textPlace ← place;
        enter => IF h.hasInputFocus THEN SaveCursorAndSetMine[h];
        exit => RestoreCursor[h];
        ENDCASE;
      string =>
        h.textPlace ← DisplayTextAtPlace[h: h, reader: @z.rb, place: h.textPlace];
      ENDCASE;
    ENDLOOP};
```

```
MyLosingFocusProc: TIP.LosingFocusProc = {
  OPEN h: NARROW[clientData, Handle];
  h.hasInputFocus ← FALSE};
```

46.3.6 Modifying an Existing TIP Client

This example shows how an existing **TIP** client may be modified. Assuming the existence of a TextWindow package similiar to that in Tajo, this example builds a TTY-like window on top of it. It modifies the text window's behavior in two ways. First, it changes the table that the text window uses by linking its own table on the front of the normal table that the text window package uses. It also has its own notify procedure that just looks for the STOP key going down but passes all other notifications to the text window's notify procedure that it saves.

This example writes its own table. The table maps shift backspace to the character Control-W, backspace to the character Control-H, the DELETE key to the DEL character and the TAB key to the ESCAPE character. This table handles only a few of the functions and is linked onto **TIPStar**'s normal table to provide the bulk of the funtion.

```
-- File: TTY.tip

[DEF SHIFT, (LeftShift Down | RightShift Down | Key47 Down | A12 Down)]

SELECT TRIGGER FROM
  BS Down => SELECT ENABLE FROM
    [SHIFT]=> "\027";
    ENDCASE => "\010";

  DELETE Down => "\177";

  TAB Down => "\033";

  ENDCASE.
```

```
Handle: TYPE = LONG POINTER TO Object;
Object: TYPE = ...;
contextType: Context.Type = Context.UniqueType[];
stop: Atom.ATOM;

Init: PROCEDURE = {
  rb: XString.ReaderBody ← XString.FromSTRING["TTY.tip"L];
  stop← Atom.MakeAtom["Stop"L];
  myTable ← TIP.CreateTable[file: @rb];
  [] ← TIP.SetTableLink[from: myTable, to: TIPStar.NormalTable[]};

Create: PROCEDURE [window: Window.Handle, ...] = {
  h: Handle = zone.NEW[Object ← []];
  TextWindow.Create[window, ...];
  h.oldNotify ← TIP.SetNotifyProc[window: window, notify: TIPMe]};

TIPMe: TIP.NotifyProc = {
  h: Handle = Context.Find[type: contextType, window: window];
  WITH z: results SELECT FROM
    atom => SELECT z.a FROM
```

```
        stop => {
          TIP.FlushUserInput[];
          SendHaltNotification[h];
          RETURN};
        ENDCASE;
  h.oldNotify[window, results]}; -- normally pass results to text window's notify
```

46.3.7 Macro Package

The macro package used in **TIP** is based on the general-purpose macrogenerator described by Strachey in *Computer Journal* (October 1965). The following summary is based on that article; see the article itself for more details.

A macro call consists of a macro name and a list of actual parameters, each separated by a comma. The name is preceded by a left square bracket ([), and the last parameter is followed by a right square bracket. A macro is defined by the special macro DEF, which takes two arguments: the name of the macro to be defined and the defining string. The defining string may contain the special symbols ~1, ~2, etc., which stand for the first, second, etc., formal parameters. Enclosing any string in parentheses prevents evaluation of any macro calls inside; in place of evaluation, one layer of string quotes is removed. It is usual to enclose the defining string of a macro definition in string quotes to prevent any macro calls or uses of formal parameters from being effective during the process of definition.

Here are some sample macros and an example:

```
-- macro definitions
[DEF,LSHIFT,(LeftShift Down)]
[DEF,RSHIFT,(RightShift Down)]
[DEF,EitherShift,(
  [LSHIFT] => ~1;
  [RSHIFT] => ~1)]

-- trigger cases
SELECT TRIGGER FROM
BS Down => SELECT ENABLE FROM
  [EitherShift,{BackWord}];
  ENDCASE => {BackSpace};
-- more cases ...
ENDCASE...
```

The above example expands to:

```
BS Down => SELECT ENABLE FROM
  LeftShift Down => BackWord;
  RightShift Down => BackWord;
  ENDCASE => {BackSpace};
```

46.4 Index of Interface Items

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TIPStar

47.1 Overview

The **TIP** facility provides a mechanism that links a list of **TIP.Tables**. These **TIP.Tables** contain productions that translate user actions into terms a client is prepared to deal with. **TIPStar** creates a structure for the list of ViewPoint **TIP** tables to be built on. This structure divides all possible input actions into logical groups (mouse actions, special keys like UNDO and STOP, utility keys like MOVE and COPY, etc.) and provides a means for accessing these groups of tables.

47.2 Interface Items

47.2.1 The TIPStar Structure

The basis for the **TIPStar** structure is the placeholder.

Placeholder: TYPE = {mouseActions, keyOverrides, softKeys, keyboardSpecific, blackKeys, sideKeys, backstopSpecialFocus};

A placeholder table is created for each of the enumerateds in **Placeholder**. Placeholder tables are *empty* **TIP** tables linked to form a list. This list divides all possible input actions into logical groupings as discussed in the Overview above. This defines a series of segments for the list of **TIP.Tables** to be built upon. Segments (mini-stacks) are delineated by the placeholder tables. This initial list of **TIP.Tables** then, contains only empty tables. **Note:** Placeholder tables will always be empty. They are as their name implies, placeholders--each providing a position in the list of tables for adding or removing real tables of a particular kind (those relating to mouse actions, those mentioning the soft keys, etc.). See Examples in the next section.

Fine Point: A set of normal tables that contain all the basic key productions is installed at boot time. See the **System TIP Tables Appendix** for listings of those tables and a view of the **TIP** Table list at the completion of booting. These normal tables are referred to as *generic* in the description of **TIPStar.GetTable** to prevent confusion with the procedure **TIPStar.NormalTable**.

The list of ViewPoint placeholder tables is initialized as in Figure 47.1 (the arrows represent the links of the list).

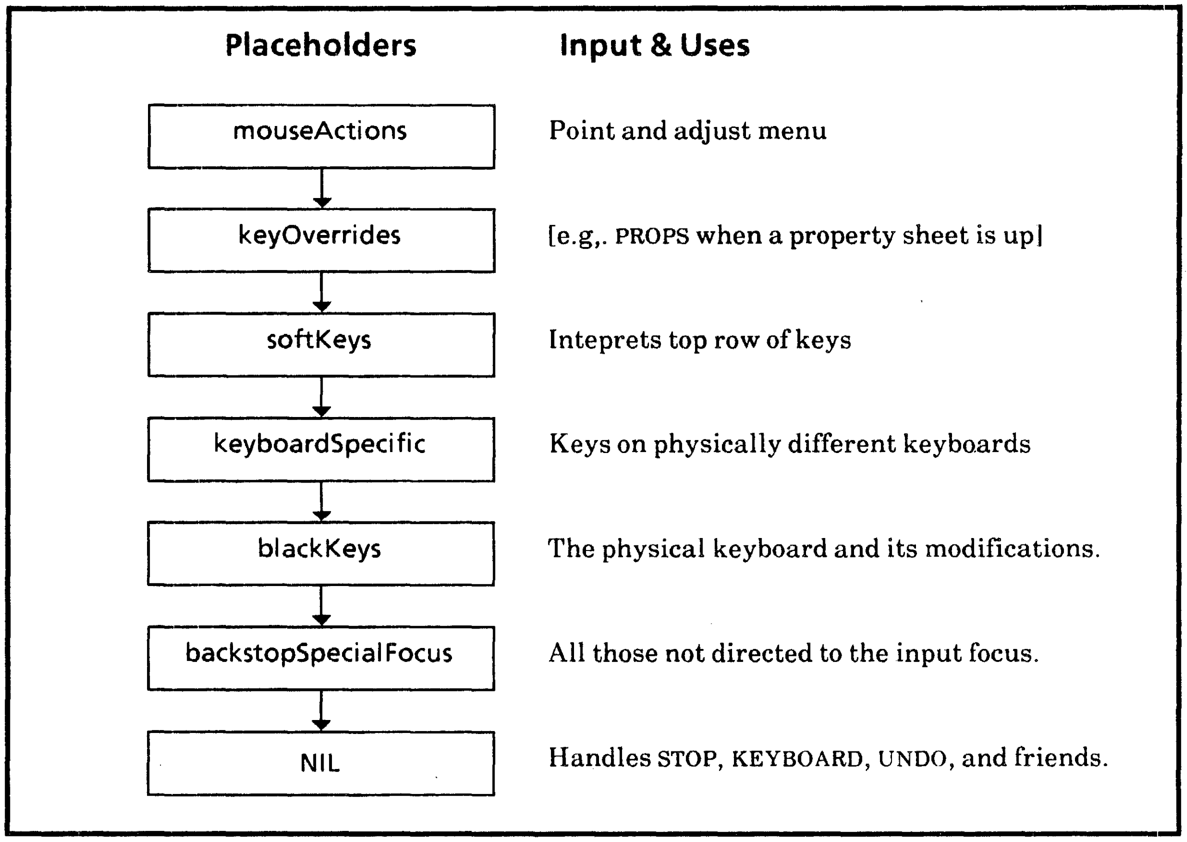
Placeholders
Input & Uses
mouseActions
Point and adjust menu
keyOverrides
[e.g,. PROPS when a property sheet is up]
softKeys
Inteprets top row of keys
keyboardSpecific
Keys on physically different keyboards
blackKeys
The physical keyboard and its modifications.
backstopSpecialFocus
All those not directed to the input focus.
NIL
Handles STOP, KEYBOARD, UNDO, and friends.

Figure 47.1 ViewPoint Placeholder Tables

47.2.2 Installing and Removing Tables

A client may alter the table arrangement by *pushing* or *storing* a TIP table into any point on the tree, or by *popping* back to a previous table.

PushTable: PROCEDURE [Placeholder, TIP.Table] ;

PushTable leaves old tables in the watershed, but places the new table (or chain of tables) directly after the specified placeholder. This places the new table in front of any others within that segment. Thus if the new table mentions the same key actions as the old table, the old one is effectively ignored until the new one is popped. If the new table only mentions a few key actions, however, previously pushed tables will be used for the others.

For an example of **PushTable** and the resulting **TIP.Table** list, see §47.3.1.

PopTable: PROCEDURE [Placeholder, TIP.Table] ;

PopTable takes the single **TIP** table to be popped. It is not required that the table to be popped be at the top of the placeholder's list. A strict stack discipline is relaxed.

StoreTable: PROCEDURE [Placeholder, TIP.Table] RETURNS [TIP.Table] ;

StoreTable replaces the table (or chain of tables) with the client's table (or chain of tables) and returns the previous table. The client can restore the old value later, if it wishes. (In using **StoreTable**, and especially remembering/restoring the old value, the client probably needs to be cognizant of the other clients that may manipulate the same placeholder.) See examples in §47.3.3.

47.2.3 Retrieving Pointers to Installed Tables

NormalTable: PROCEDURE [TIP.Table];

NormalTable returns the table at the head of the list (**mouseActions** placeholder). This is the appropriate table to use for a normal TIP.**SetTableAndNotifyProc**.

GetTable: PROCEDURE [Placeholder] RETURNS [TIP.Table];

GetTable returns the generic table at the specified placeholder, if one exists. (See the Fine Point in §47.2.1.)

47.2.4 Mouse Modes

Mode: TYPE = {normal, copy, move, sameAs};

The TIPStar.**Modes** refer to the various modes attributable to mouse actions. These modes can be programmatically checked and changed using the **GetMode** and **SetMode** procedures outlined below.

GetMode:PROCEDURE RETURNS [mode: Mode];

GetMode returns the current mode.

SetMode:PROCEDURE [mode: Mode] RETURNS [old: Mode];

Calling **SetMode** causes the appropriate TIP.**Table** to be stored in the TIPStar chain.

For example, when the COPY key goes down, the call to TIPStar.**SetMode[copy]** causes NormalMouse.**TIP** to be relaced by CopyModeMouse.**TIP**. Clients receiving mouse notifications receive **CopyModeDown** instead of **PointDown**. If the world was in **move** mode (causing MoveModeMouse.**TIP** to be stored) the client would receive the **MoveModeDown** when mouse point was pressed. See the **TIP Table** Appendix for information on the other productions in the four mouse tables (NormalMouse.**TIP**, CopyModeMouse.**TIP**, MoveModeMouse.**TIP** and SameAsModeMouse.**TIP**).

47.3 Usage/Examples

47.3.1 When PushTable Is Called

```
InitializeMyTIPTables: PROCEDURE =
BEGIN
rbClientAMouse: XString.ReaderBody ← XString.FromSTRING["ClientAMouse.TIP"L];
 tipClientAMouse: TIP.Table ← TIP.CreateTable[file: @rbClientAMouse];
 -- install my tip table (tie it to my notify proc)
[]←TIP.SetNotifyProcForTable[ tipClientAMouse, ClientAMouseNotifyProc];
PushTable[mouseActions, tipClientAMouse];

rbClientAKeys: XString.ReaderBody ←XString.FromSTRING["ClientAKeys.TIP"L];
 tipClientAKeys: TIP.Table ← TIP.CreateTable[file: @rbClientAKeys];
 -- install my tip table (tie it to my notify proc)
[]←TIP.SetNotifyProcForTable[ tipClientAKeys, ClientAKeysNotifyProc];
PushTable[sideKeys, tipClientAKeys];
END; -- InitializeMyTIPTables
```

Assume initially the list appears as in Figure 47.1. If Client A then pushes two tables onto that list, as in the code above, the new links result in the list shown in Figure 47.2..

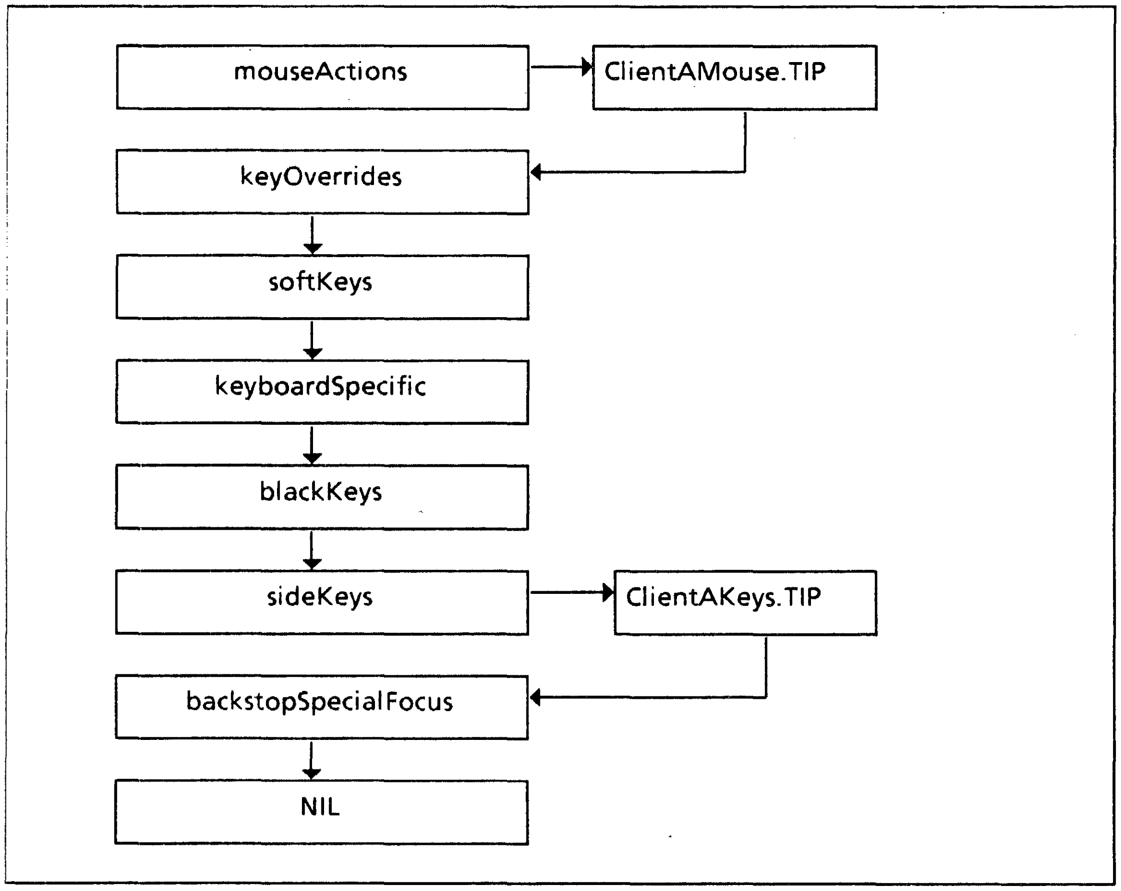

Figure 47.2 When **PushTable** Is Called

If client B then pushes another table to the **mouseActions** placeholder

```
PushTable[mouseActions, tipClientBMouse];
```

the resulting list appears as in Figure 47.3.

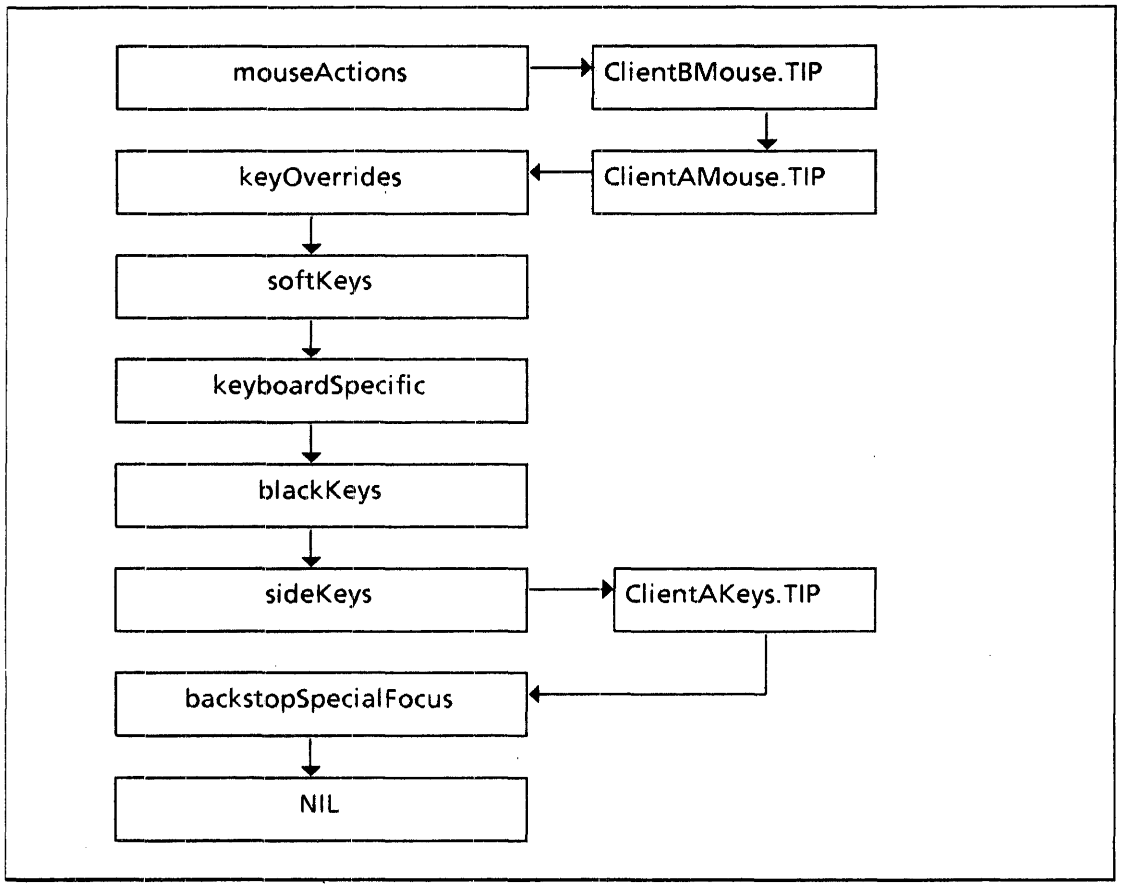

Figure 47.3 Pushing Another Table

47.3.2 When StoreTable Is Called

```
rbClientCMouse: XString.ReaderBody ← XString.FromSTRING["ClientCMouse.TIP"L];
tipClientCMouse: TIP.Table ← TIP.CreateTable[file: @rbClientCMouse];
-- install my tip table (tie it to my notify proc)
[]←TIP.SetNotifyProcForTable[ tipClientCMouse, ClientCMouseNotifyProc];
savedTable ← StoreTable[mouseActions, tipClientCMouse];
```

Assume initially the list appears as in Figure 47.3. If client C then calls **StoreTable** with another table directed at the **mouseActions** placeholder, the resulting list appears as in Figure 47.4.

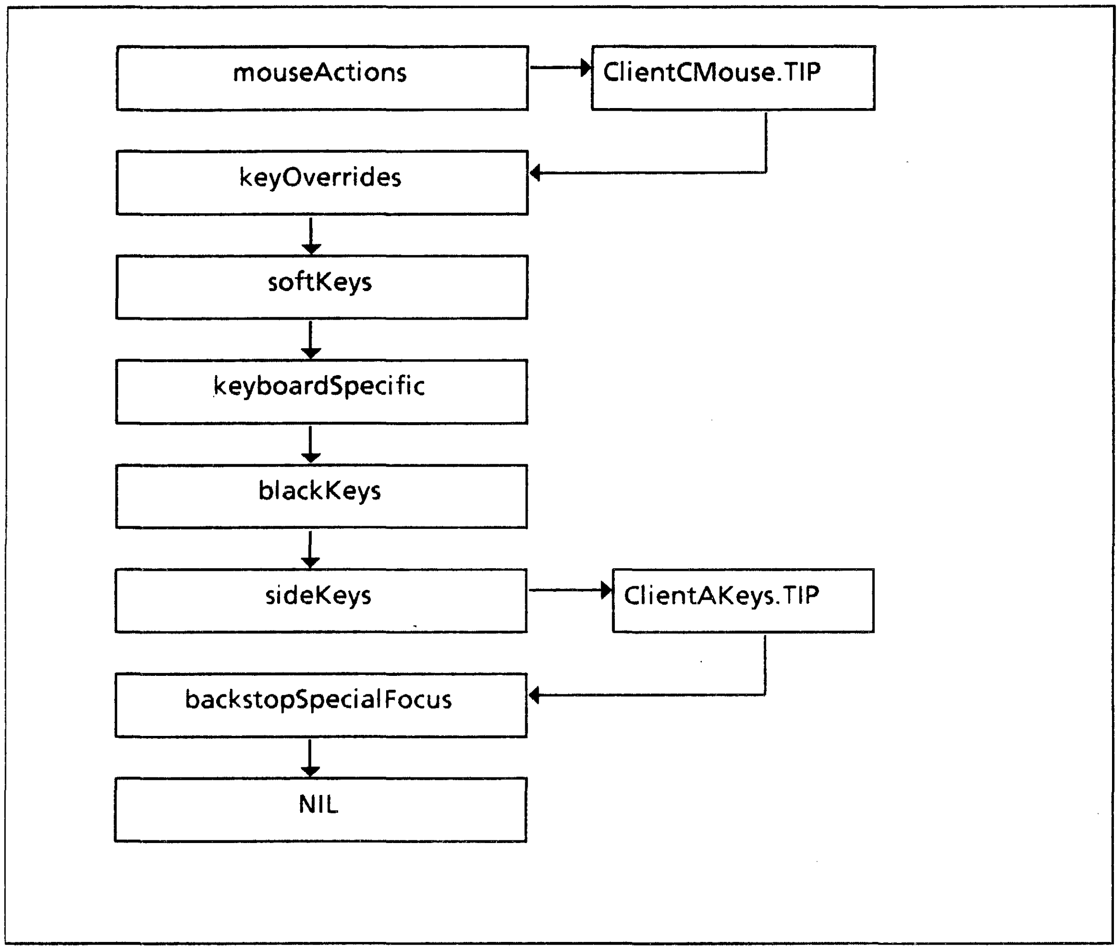

Figure 47.4 Pushing Another Table

Client C will now have the handle to the segment removed from **mouseActions** when the **StoreTable** was done (**savedTable**, see Figure 47.5). This table (or in this case, chain of tables) should be replaced when the client is through with its own mouse tip (**tipClientCMouse**) by a call to:

StoreTable[mouseActions, savedTable]; or
PopTable[mouseActions, tipClientCMouse];
PushTable[mouseActions, savedTable];

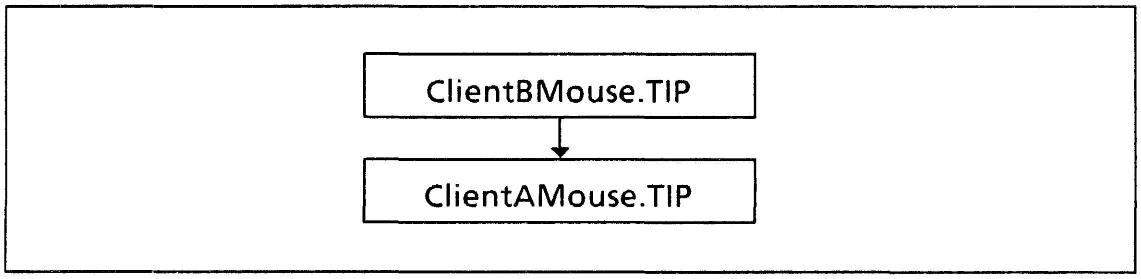

Figure 47.5 Saved Table

47.3.3 When PopTable Is Called

Assume initially the list appears as in Figure 47.3. If client A then pops its table at the **mouseActions** placeholder, the resulting list appears as in Figure 47.6. **Note**: It is not necessary for the table being popped to be at the top of the stack (where the top of a stack is here defined to be the position immediately following any placeholder table--thus there are several stacks within the watershed list of tables).

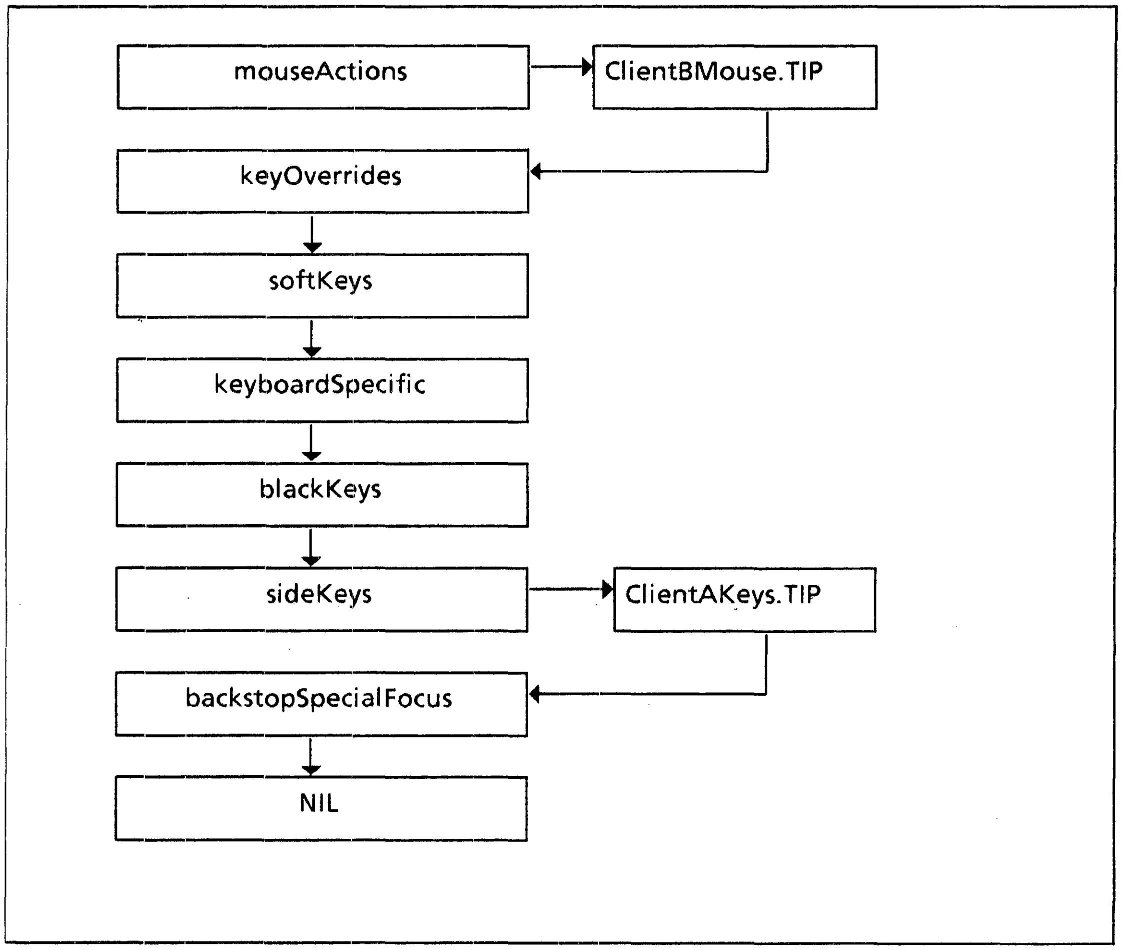

Figure 47.6 Pop Table

47.4 Index of Interface Items

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Undo

48.1 Overview

The **Undo** interface provides a set of procedures that allow applications to add **Undo** opportunities to the current **Undo** stack. An implementation of **Undo** can then call applications when the UNDO key is depressed.

48.2 Interface Items

48.2.1 Application's Procedures

```
Opportunity: Undo.Proc;

Proc: TYPE = PROCEDURE [
   undoProc: PROCEDURE [LONG POINTER],
   destroyProc: PROCEDURE [LONG POINTER],
   data: LONG POINTER,
   size: CARDINAL ← 0 ];
```

The **Opportunity** procedure is called by an application when it does something that can be undone. The client's **undoProc** is called to perform an undo. The **destroyProc** is called when the undo opportunity no longer exists. The client can destroy any data at that time. The **undoProc** or the **destroyProc** will always be called. The client's context for the undoing is passed in via the **data** item: a non-zero **size** indicates that the **Undo** implementation should copy the words from **data↑** through **(data + size-1)↑** into its zone. If **size** = 0, the caller's long pointer is simply remembered.

```
Roadblock: PROCEDURE [XString.Reader];
```

The **Roadblock** procedure is called by an application when it does something that cannot be undone. The immutable string passed in is a message that the **Undo** implementation can issue if the user attempts to undo past this point. The string is copied.

```
DoAnUndo: PROCEDURE;
```

The **DoAnUndo** procedure is called when an undo action should be forced. Typically this will be when the keyboard modules notice that UNDO has been pressed.

```
DoAnUnundo: PROCEDURE;
```

The **DoAnUnundo** procedure is called when an un-undo action should be forced. Typically this will be when the keyboard modules notice that shift-UNDO has been pressed.

```
DeleteAll: PROCEDURE;
```

The **DeleteAll** procedure is called to tell the **Undo** implementation to empty its stack of opportunities. Typically this procedure will be called upon logoff.

48.2.2 Implementation's Procedures

```
SetImplementation: PROCEDURE [
    Undo.Implementation] RETURNS [Implementation];

GetImplementation: PROCEDURE RETURNS [Implementation];

Implementation: TYPE = RECORD [
   opportunity: Undo.Proc,
   roadblock: PROCEDURE [XString.Reader],
   doAnUndo: PROCEDURE,
   doAnUnundo: PROCEDURE,
   deleteAll: PROCEDURE ];
```

These procedures allow an implementation to plug itself in to the **Undo** mechanism. An implementation can supply its set of procedures, and can ascertain the current procedures. **SetImplementation** returns the procedures of the previous implementation.

An initial set of dummy procedures are provided. They are basically no-ops; the dummy **Opportunity** procedure immediately calls the application's **opportunity.destroyProc**.

```
Zone: PROCEDURE RETURNS [UNCOUNTED ZONE]
```

Returns the implementation's zone.

48.3 Usage/Examples

The application calls **Opportunity** with some context. The **Undo** implementation will eventually call the application either at its **undoProc** or its **destroyProc**. The former is called upon a real undo request. The latter is called when the opportunity is about to be forgotten: it allows the application to garbage-collect context. The **destroyProc** is typically called to prune the undo stack of very old elements or to prune opportunities that are trapped behind a roadblock.

At the application's **undoProc** or **destroyProc**, the argument is either (1) the original pointer passed in to **Opportunity**, if size was zero or (2) a pointer into the **Undo** implementation's zone that points to a copy of the application's data. In the latter case, the data will be freed by the **Undo** implementation right after the call. Exception: if the help implementation is a no-op implementation, it can call the application's **destroyProc** from inside the **Opportunity** call. In this case, the help implementation can present the original pointer to the **destroyProc** even if size is non-zero.

48.3.1 Example

```
MyUndoDataObject: TYPE = RECORD [...];
MyUndoData: TYPE = LONG POINTER TO MyUndoDataObject;
complaint: XString.ReaderBody ← XString.FromSTRING ["Can't do that"L];

UndoProc: PROCEDURE [myUndoData: MyUndoData] = {
   --- does something appropriate, like a partial cleanup of data structures.message
   -- might post a about current state for the user.
   Undo.Zone [].FREE [@myUndoData];
   };

DestroyProc: PROCEDURE [myUndoData: MyUndoData] = {
   Undo.Zone [].FREE [@myUndoData];
   };

-- Mainline code
-- Code that cannot be undone
...
Undo.Roadblock [@complaint];
-- Code that can be undone
...
Undo.Zone[].NEW[MyUndoDataObject ← [...] ];
Undo.Opportunity [undoProc: UndoProc, destroyProc: DestroyProc, data: myData];
...
```

48.4 Index of Interface Items

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UnitConversion

49.1 Overview

UnitConversion provides for converting numbers between various units of measure.

49.2 Interface Items

```
Units: TYPE = {inch, mm, cm, mica, point, pixel, pica, didotPoint, cicero};
```

Units defines all the units that may be converted. point is printer point. pixel is screen dot. pica = 12 points.

```
ConvertReal: PROCEDURE [n: XLReal.Number, inputUnits, outputUnits: Units]
   RETURNS [XLReal.Number];
```

ConvertReal converts n from inputUnits to outputUnits, using XLReal. May raise XLReal.Error.

```
ConvertInteger: PROCEDURE [n: LONG INTEGER, inputUnits, outputUnits: Units]
   RETURNS [LONG INTEGER];
```

ConvertInteger converts n from inputUnits to outputUnits. May raise XLReal.Error.

49.3 Usage/Examples

49.3.1 Converting Font Values

The following example implements a real number conversion utility:

```
Unit: TYPE = MACHINE DEPENDENT {inch(0), mm(1), mica(2), point(3), space(4), cm(5), (15)};

Convert: PUBLIC PROC [n: XLReal.Number, inputUnits, outputUnits: Unit.Units]
  RETURNS [XLReal.Number] = {
  IF inputUnits = outputUnits THEN RETURN [n];
  IF inputUnits = space THEN
    RETURN
      UnitConversion.ConvertReal[
            XLReal.Multiply[n, pointPerSpace],seventySecondOfAnInch,
                ConvertUnits[outputUnits]];
    IF outputUnits = space THEN
        RETURN
            XLReal.Divide[UnitConversion.ConvertReal[n, ConvertUnits[inputUnits],
                seventySecondOfAnInch], pointPerSpace];
    RETURN
        UnitConversion.ConvertReal[
            n, ConvertUnits[inputUnits], ConvertUnits[outputUnits]]};

ConvertUnits: PROC [u: Units] RETURNS [UnitConversion.Units] = {
    IF u < mica THEN RETURN [VAL[u.ORD]];
    IF u = mica THEN RETURN [VAL[u.ORD + 1]];
    IF u = point THEN RETURN [VAL[u.ORD + 6]];
    RETURN [cm]
    };
```

49.4 Index of Interface Items

50

Window

50.1 Overview

The **Window** interface supplies facilities for managing windows on the display screen. A *window* is a rectangular region of the display screen in which a client can display information to the user. A window may overlap another window or even completely cover it. A window may extend past the edges of the physical display screen or even be completely outside it, and thus not visible. Windows may be moved around horizontally and vertically, have their size changed, and have their depth changed in the stack of windows visible on the screen. **Window** shields the client from these considerations–from the client's point of view, each window is unaffected by other windows or by the edges of the display screen. **Window** automatically handles client requests to paint into window regions that are not currently visible on the screen.

The **Display** interface supplies routines for painting into windows.

50.1.1 Window Creation

Window supplies operations to allocate and free a window (a **Window.Object**). However, windows are usually not allocated directly by clients, but rather are obtained from various other facilities, such as **StarWindowShell** or **FormWindow**. Once allocated, a window is referred to and manipulated by reference, using a **Window.Handle**.

50.1.2 Child Windows and the Window Tree

Window manipulates a *tree* of windows. A window may have *child windows*. Child windows obscure their parent; that is, they are above their parent in the apparent stack of windows visible on the screen. A child window may be entirely contained within its parent's screen area, may project beyond its parent's edges, or even be completely outside its parent. **Window** automatically clips the display of a child window at its parent's edges. Thus a child window that is completely outside of its parent will not be visible on the screen at all.

Each window has an ordered list or *stack* of its child windows. Sibling windows may overlap: if they do, one that appears earlier in the stack is on top of or obscures one that appears later. The first window in the stack is the *top sibling*, and the last is the *bottom* *sibling.* Each window has a pointer to its parent, a pointer to the next sibling of its parent, and a pointer to the window's topmost child.

When a window is created, it is not in the window tree, and is called a *private window.* A private window is unknown to **Window** and is not displayed on the screen. **Window** provides facilities for inserting private windows into the tree, moving them within the tree, and removing them from it. A window that is in the tree will be wholly or partially visible on the screen unless it is entirely outside its parent's area or its children completely cover the portion that is within its parent. Private windows may also be built into *private trees,* which can be inserted into and removed from the window tree as a unit.

Display supplies the *root window,* which is the root of the window tree and corresponds to the entire display screen. The root window typically supplies the background pattern.

Each window has its own *coordinate system*: the upper-left corner is the origin [x: 0, y: 0], with x increasing to the right and y increasing downward. A window's location is defined in terms of its parent's window's coordinate system. Coordinates may be positive or negative, and thus a window can have any location relative to its parent.

50.1.3 Painting into a Window

Every window contains a client-supplied *display procedure* that will, on demand, paint all or part of the window. Note that windows can be much larger than the display screen; any paint directed to non-visible portions of a window–or outside the window entirely–is discarded. Thus a client never needs to be concerned about what parts of its window are covered by other windows or what parts are off the screen. As a convenience to clients, requests to paint into a window that is not currently in the window tree are also ignored.

The **Display** and **SimpleTextDisplay** interfaces provide a variety of procedures for painting various things into a window, including character strings, black, white, or gray boxes, and various graphics, such as curves and lines.

The display background color, which is represented by a pixel value of zero, is commonly called *white* and a value of one is called *black.* **Note:** The display hardware also can render the picture using zero for black and one for white. *Clearing* or *erasing* an area of the screen means setting all of its pixels to zero, or white.

It is common that a display procedure wants to start with an erased (zero) area and logically **OR** the black pixels into the area. **Window** supplies an accelerator **clearingRequired** to minimize unnecessary erasures. If **clearingRequired** = **TRUE**, **Window** guarantees that when the display procedure is called to paint the window, all of the window's pixels that should be white indeed are white. In that situation, the window might contain any combination of its previous contents and erased areas. On the other hand, some display procedures will want to set all pixel values, completely overwriting the previous contents. These windows should specify **clearingRequired** = **FALSE**.

Areas displayed on the screen may become incorrect or *invalid* for many reasons, such as when a window that was visible is deleted. A client can also mark an area invalid. **Window** accumulates these *invalid areas* and then, in response to a client call to **Validate** or **ValidateTree**, calls the various windows' display procedures to paint the necessary areas. ***Validate** and **ValidateTree** are the only **Window** operations that cause immediate* *screen painting.* All other operations merely enqueue work to be performed by a later **Validate** operation. Fine Point: The few special cases that do not follow this rule are noted in the text.

The standard way for a client to paint into its window is to update its data structures, invalidate the portion of its window that needs to be painted, and then call a **Validate** routine. **Window** responds by calling back into the client's display procedure to do the painting.

When a window's display procedure is called, it has access to a list of the invalid areas of the window. It may choose to paint the entire window or, alternatively, to enumerate the invalid areas and just paint those areas. In any case, **Window** clips all of the display routine's paint requests to the boundaries of the invalid areas–paint directed to other areas is discarded. In special circumstances, the client may wish to paint into valid visible areas. The operation **FreeBadPhosphorList** deletes the display routine's invalid area list; for the lifetime of that invocation of that display procedure, paint requests will be clipped only to the boundaries of the visible parts of the window.

If display routines are called from outside the invocation of a window's display procedure, the paint requests will be clipped to the boundaries of the visible parts of the window.

50.1.4 Bitmap-under

The window package allows clients to associate a window with a *bitmap-under*. This is a block of memory that is used to hold the pixels that are covered up by the window. This facility allows **Window** to move or delete such a window quickly, since it can repaint the display directly using the contents of the bitmap-under instead of calling client display procedures. A bitmap-under is commonly used for menu windows.

50.1.5 Window Panes

The window package normally maintains a detailed list of invalid regions and allows arbitrary overlapping of windows without requiring the client to worry about other windows. Some clients would prefer to have greater control over their windows at the expense of more restrictions over their use. Window panes are such a mechanism. If a window is a window pane, the client must assure that it doesn't overlap any of its siblings and that the parent doesn't paint underneath the pane. A further restriction is that only window panes may be children of panes. In return, the window package can do much less calculation to determine invalid regions. The window package does not enforce these restrictions. It is up to the client to follow them, or inconsistent screen appearance may result. The client must specify whether a window is a window pane when it is initialized.

50.2 Interface Items

50.2.1 Basic Data Types and Utility Operations

This section describes basic **Window** data types and utility procedures.

Handle: TYPE = LONG POINTER TO Object;

Object: TYPE [19];

Object is the storage that represents a window. A **Handle** is used to refer to the window. Clients should not allocate objects directly but must use operations described in §50.2.2.

rootWindow: READONLY Handle;

Root: PROCEDURE RETURNS [Handle] = INLINE {RETURN[rootWindow]};

rootWindow is the window that is the root of the window tree. The procedure **Root** is provided for compatibility with previous versions; new applications should use **rootWindow** instead.

MinusLandBitmapUnder: TYPE [6];

MinusLandBitmapUnder is additional storage for windows that may have bitmap-unders.

MinusLandColor: TYPE [1];

MinusLandColor is not used in the current release.

MinusLandCookieCutter: TYPE [2];

MinusLandCookieCutter is not used in the current release.

Place: TYPE = UserTerminal.Coordinate; -- *[x, y: INTEGER];*

Place is a position in a window. It is measured relative to the window's upper-left corner, which is defined to be at **[x: 0, y: 0]**. **x** increases to the right, **y** increases downward. Note that the coordinates may be negative.

Dims: TYPE = RECORD [w, h: INTEGER];

Dims is the size of a rectangular box. The rectangle is **w** pixels wide and **h** pixels high.

Box: TYPE = RECORD [place: Place, dims: Dims];

BoxHandle: TYPE = LONG POINTER TO Box;

nullBox: Box = [place: [0, 0], dims: [0, 0]];

Box describes completely a rectangular box. **place** describes the upper-leftmost pixel of the box, and **dims** describes the size of the box. The box extends to the right and downward from **place**. As always, **place** is expressed in its containing window's coordinate system.

BoxesAreDisjoint: PROCEDURE [a, b: Box] RETURNS [BOOLEAN];

BoxesAreDisjoint returns **TRUE** if **a** and **b** do not intersect.

IntersectBoxes: PROCEDURE [b1, b2: Box] RETURNS [box: Box];

IntersectBoxes returns a **Box** that is the intersection of **b1** and **b2**. If their intersection is empty, this operation returns **box.dims = [0, 0]**.

IsPlaceInBox: PROCEDURE [place: Place, box: Box] RETURNS [BOOLEAN];

IsPlaceInBox returns TRUE if **place** is a pixel of **box**.

BitmapPlace: PROCEDURE [window: Handle, place: Place ← [0,0]] RETURNS [Place];

BitmapPlace returns the coordinates in the root window that correspond to **place** in **window**.

```
BitmapPlaceToWindowAndPlace: PROCEDURE [bitmapPlace: Place]
  RETURNS [window: Handle, place: Place];
```

BitmapPlaceToWindowAndPlace returns the topmost visible window and the coordinates within it that correspond to **bitmapPlace** in the root window.

50.2.2 Window Creation and Initialization

A window is created by the client allocating and initializing a **Window.Object**. Many times windows are not created directly by clients, but rather are obtained from various other facilities, such as **StarWindowShell** or **FormWindow**.

To create a window, the client allocates a **Window.Object** using **New**, initializes it using **Initialize**, and presents it to **Window** for use using **InsertIntoTree**. When the window is of no further use, it is withdrawn from **Window** using **RemoveFromTree**, and the storage is freed using **Free** or **FreeTree**.

```
New: PROCEDURE [
  under, cookie, color: BOOLEAN ← FALSE, zone: UNCOUNTED ZONE ← NIL] RETURNS [Handle];
```

New allocates a window object. If **zone** is NIL, a cache of objects is used. A client should never call **zone.NEW[Window.Object]** because the window object will not be properly initialized.

```
Initialize, InitializeWindow: PROCEDURE [
  window: Handle, display: DisplayProc, box: Box,
  parent: Handle ← rootWindow, sibling, child: Handle ← NIL,
  clearingRequired: BOOLEAN ← TRUE, windowPane: BOOLEAN ← FALSE,
  under, cookie, color: BOOLEAN ← FALSE];
```

DisplayProc: TYPE = PROCEDURE [window: Handle];

Initialize and **InitializeWindow** initialize the window object at **window↑**. This must be done before the window is inserted into the window tree. The window is initially not a part of the window tree. The window may be created as an isolated window or may be linked to other private windows to form a private tree. **display** is the client procedure for repainting the window. **box** is the window's size and parent-relative location. **parent** is the window's parent. **sibling** is the sibling immediately below the window in the sibling stack of **parent** and **child** is the top child of the window. **parent**, **sibling**, and **child** may be NIL. **clearingRequired** is described in §50.1.3. **windowPane** is described in §50.1.4. **under** indicates that the window can be associated with a bitmap-under. **cookie** and **color** are not supported in the current release; clients should default this parameter for compatibility with future versions.

```
Create: PROCEDURE [
   display: DisplayProc, box: Box,
   parent: Handle ← rootWindow, sibling, child: Handle ← NIL,
   clearingRequired: BOOLEAN ← TRUE, windowPane: BOOLEAN ← FALSE,
   under, cookie, color: BOOLEAN ← FALSE, zone: UNCOUNTED ZONE ← NIL]
   RETURNS [Handle] = INLINE ...;
```

Create is an inline that follows a call to **New** with a call to **Initialize**.

```
Free: PROCEDURE [window: Handle, zone: UNCOUNTED ZONE ← NIL];
```

Free frees a window object. If **zone** is NIL, the window is returned to the cache of objects maintained by **Window**; otherwise it is freed to the zone. Any contexts associated with the window, via the **Context** interface, are not freed. **Free** may raise **Error[invalidParameters]** if the window had already been freed, if the window is still in the window tree, if the zone is NIL but was not NIL on the call to **New**, or the if zone is non-NIL but was NIL on the call to **New**.

```
FreeTree: PROCEDURE [window: Handle, zone: UNCOUNTED ZONE ← NIL];
```

FreeTree frees the window and all its children, children first, and frees all contexts on windows in the subtree whose root is **window**.. Clients should almost always call **FreeTree** rather than **Free**. **FreeTree** may raise **Error[invalidParameters]** if the windows had already been freed, if the windows are still in the window tree, if the zone is NIL but was not NIL when the windows were allocated, or if the zone is non-NIL but was NIL when the windows were allocated. **FreeTree** assume all the windows were allocated with the same zone if it is non-NIL.

Caution: In the current version of ViewPoint, a window may be referred to for a few seconds *after* it is removed from the tree (due to another process simultaneously doing a **Validate**). Thus storage for **Objects** should not be freed immediately.

50.2.3 Access to and Modification of a Window's Properties

The **Get** procedures below return properties of a window. The **Set** procedures change properties and return the previous value. These properties of a window are described in this chapter's overview.

```
GetDisplayProc: PROCEDURE [Handle] RETURNS [DisplayProc];

SetDisplayProc: PROCEDURE [Handle, DisplayProc] RETURNS [DisplayProc];

GetClearingRequired: PROCEDURE [Handle] RETURNS [BOOLEAN];

SetClearingRequired: PROCEDURE [window: Handle, required: BOOLEAN]
   RETURNS [old: BOOLEAN];

GetParent: PROCEDURE [Handle] RETURNS [Handle];
```

GetSibling: PROCEDURE [Handle] RETURNS [Handle];

GetSibling returns the next lower sibling of the argument window.

GetChild: PROCEDURE [Handle] RETURNS [Handle];

GetChild returns the topmost child of the argument window.

See also §50.2.4 for **Set** procedures that change a window's links to its parent, siblings, and child.

EntireBox: PROCEDURE [Handle] RETURNS [Box];

EntireBox returns the box [[0, 0], window.dims]. It is handy for invalidating the entire window.

GetBox: PROCEDURE [Handle] RETURNS [Box];

Note that there is no **SetBox**; **SlideAndSize** should be used instead.

GetPane: PROCEDURE [Handle] RETURNS [BOOLEAN];

GetPane returns whether or not the window is a window pane. The window pane property can only be set when the window is initialized.

IsCookieVariant: PROCEDURE [Handle] RETURNS [BOOLEAN];

Cookie cutters are not supported by the current release. **IsCookieVariant** should always return FALSE.

IsColorVariant: PROCEDURE [Handle] RETURNS [BOOLEAN];

Color is not supported by the current release. **IsColorVariant** should always return FALSE.

50.2.4 Window Tree and Window Box Manipulation

Basic operations are provided for constructing private trees from private windows and for inserting them into and removing them from the window tree. Other operations allow moving a window within a window tree and changing a window's location and size. Special operations are provided to perform common combinations of these operations.

Most clients obtain windows from some higher-level facilitiy like **FormWindow**; in such cases, the window will typically have been already inserted into the window tree. Thus most clients will only use the following operations: **Stack**, **Slide**, **SlideAndStack**, **SlideAndSize**, **SlideAndSizeAndStack**.

Unless otherwise noted, all of these operations may be applied either to windows in the window tree or to windows in a private tree. Operations performed on windows in private trees change tree links and the window's box, but naturally create no invalid regions on the display.

As described in the overview, none of the operations in this section perform screen painting. They merely enqueue painting work to be performed by a later **Validate** operation.

IsDescendantOfRoot: PROCEDURE [Handle] RETURNS [BOOLEAN];

IsDescendantOfRoot returns TRUE if window is currently a part of the window tree.

ObscuredBySibling: PROCEDURE [Handle] RETURNS [BOOLEAN];

ObscuredBySibling returns TRUE if the box of any higher sibling intersects **window**'s box.

EnumerateTree: PROCEDURE [root: Handle, proc: PROCEDURE [window: Handle]];

EnumerateTree calls **proc** for every window in the tree rooted at **root**. The order of enumeration is not specified. Altering the tree while an enumeration is in progress will cause unpredictable operation.

The following three operations allow constructing private trees from private windows.

SetParent: PROCEDURE [window, newParent: Handle] RETURNS [oldParent: Handle];

SetSibling: PROCEDURE [window, newSibling: Handle] RETURNS [oldSibling: Handle];

SetChild: PROCEDURE [window, newChild: Handle] RETURNS [oldChild: Handle];

These **Set** procedures set the parent, next lower sibling, or topmost child of **window**. No list manipulation nor consistency checking is done–these operations merely store their argument into the window object. If **window** is in the window tree, **Error[windowInTree]** is raised (**Stack**, et al. can be used in that case). If inconsistent calls to the **Set** procedures are made, **Error[windowNotChildOfParent]** will be raised when some subsequent operation detects the inconsistency.

InsertIntoTree: PROCEDURE [window: Handle];

InsertIntoTree inserts a private window or subtree into any window tree. **window** will be inserted as a child of **window.parent**. **window** will be immediately above **window.sibling** in the sibling stack of the new parent; **window.sibling = NIL** makes it be the bottommost sibling. **window.child** is the topmost child of a private tree that descends from the window–NIL if none. All of these fields of **window** may be set using the **Set** procedures described above. The client can force painting of the windows just inserted by doing **window.GetParent[].ValidateTree[]**. **Error[noSuchSibling]** may be raised. Fine Point: **InsertIntoTree** does not normally cause any painting activity. However, if a window that has a bitmap-under is inserted into the tree *and* the content of the bitmap is not available on the display, **ValidateTree** will be done on that window's parent to obtain the content of the bitmap.

RemoveFromTree: PROCEDURE [Handle];

RemoveFromTree removes the window and all of its descendents from its containing tree. The window becomes the property of the client. The descendents of the window remain attached to it. The entire subtree may be later inserted back into a tree using

InsertIntoTree. The client can force painting of now-incorrect areas of the display by by applying **ValidateTree** to any parent of the removed window.

Stack: PROCEDURE [window: Handle, newSibling: Handle, newParent: Handle ← NIL];

Stack changes **window**'s location in its window tree, thus changing the window's depth in the apparent stack of windows on the screen. If **newParent** is not **NIL**, then **window** is moved to be a child of **newParent**; otherwise, its parent is unchanged. Next, the sibling stack then containing **window** is modified so that **window** is now immediately above **newSibling**, thus potentially obscuring siblings lower on its sibling stack. Supplying **newSibling = NIL** puts **window** on the bottom of the sibling stack. Unless **window** is already the top sibling, supplying **newSibling = window.GetParent.GetChild[]** puts **window** on the top of the stack. **Caution:** If **window** is the top sibling, the previous expression is a client error that is not guarded against. If one of **window** or **newParent** is in the window tree but the other is not, **Error[illegalStack]** is raised. **Error[noSuchSibling]** may also be raised.

Slide: PROCEDURE [window: Handle, newPlace: Place];

Slide changes **window**'s position relative to its parent. This procedure may be used to implement scrolling. **Error[whosSlidingRoot]** may be raised.

SlideAndStack: PROCEDURE [
window: Handle, newPlace: Place, newSibling: Handle, newParent: Handle ← NIL];

SlideAndStack performs a **Stack** and then a **Slide**, thus changing **window**'s location in its tree and its position within its new parent. **Error[illegalStack]**, **Error[noSuchSibling]**, and **Error[whosSlidingRoot]** may be raised.

Gravity: TYPE = {nil, nw, n, ne, e, se, s, sw, w, c, xxx};

Gravity indicates where the old pixel content of a window should go when it changes size. This allows **Window** to reuse any current window content that will be visible in its new configuration.

nil	the contents remain at their current *screen* position (not their window-relative position).
nw, n, ne, e, se, s, sw, w	the contents stay attached to the indicated compass point of the window, which is either a corner or the middle of a side; for example, nw means the contents stay in the upper-left corner.
c	the contents go in the middle of the new window–trimming or expansion occurs equally at opposite edges.
xxx	the contents are discarded.

SlideAndSize: PROCEDURE [window: Handle, newBox: Box, gravity: Gravity ← nw];

SlideAndSize changes both the location and size of **window**. **gravity** indicates what to do with the current contents of the window. **Error[sizingWithBitmapUnder]** and **Error[whosSlidingRoot]** may be raised.

SlideAndSizeAndStack: PROCEDURE [
window: Handle, newBox: Box, newSibling: Handle, newParent: Handle ← NIL, gravity: Gravity ← nw];

SlideAndSizeAndStack performs a **Stack** and then a **SlideAndSize**, thus changing **window's** location in its window tree and its position and size within its new parent. **Error[illegalStack]**, **Error[noSuchSibling]**, **Error[sizingWithBitmapUnder]**, and **Error[whosSlidingRoot]** may be raised.

SlideIconically: PROCEDURE [window: Handle, newPlace: Place];

SlideIconically is not implemented in the current release.

50.2.5 Causing Painting

A general description of painting is given in §50.1.3. The procedures below are used to cause areas of the screen to be painted, and in actually doing the painting.

InvalidateBox: PROCEDURE [window: Handle, box: Box, clarity: Clarity ← isDirty];

Clarity: TYPE = {isClean, isDirty};

InvalidateBox declares that the current screen content of **box** in **window** is incorrect. **Window** adds **box** to the list of invalid regions of the window. **clarity** indicates the current state of the box. **clarity = isClean** means the region is already erased (all white); **isDirty**, that it contains some black. **Window** uses this information to avoid unnecessary clearing. **InvalidateBox** does not cause immediate display painting; only the **Validate** procedures do that. Note that a call on **InvalidateBox** followed by a call on **Validate** may result in no call to the display procedure–for example, if the invalidated area is not visible. If the window is not in the window tree, this operation does nothing.

Validate: PROCEDURE [window: Handle];

ValidateTree: PROCEDURE [window: Handle ← rootWindow];

Validate and **ValidateTree** are the only **Window** procedures that cause immediate display painting. Fine Point: The few special cases that do not follow this rule are noted in the text. **Validate** acts only on **window**; **ValidateTree** acts on the tree whose root is **window**. Typically, a client will update its data structures and invalidate various regions. When the client is ready to have the display updated, one of the **Validate** procedures is called. If **window** is not in the window tree, this operation does nothing.

EnumerateInvalidBoxes: PROCEDURE [window: Handle, proc: PROCEDURE [Handle, Box]];

EnumerateInvalidBoxes is used within a window's display procedure to obtain the list of invalid regions of the window. **EnumerateInvalidBoxes** calls **proc** for each of the invalid boxes of **window**; **window** is passed to **proc** as its first argument. The second argument of **proc** describes the region that is invalid. **Note:** A display procedure need not worry about redundant painting outside the invalid regions; **Window** automatically discards the display procedure's paint that falls outside the invalid regions. This operation must only be called from within a display procedure, and **window** must be the window argument of the display procedure.

FreeBadPhosphorList: PROCEDURE [window: Handle];

In special circumstances, a display procedure may wish to paint into valid visible areas. **FreeBadPhosphorList** deletes the display procedure's invalid area list; for the lifetime of that invocation of that display procedure, paint requests will be clipped only to the visible parts of the window. This operation must only be called from within a display procedure, and **window** must be the window argument of the display procedure.

TrimBoxStickouts: PROCEDURE [window: Handle, box: Box] RETURNS [Box];

TrimBoxStickouts returns a box which is the result of excluding any portion of **box** that sticks out of **window** or its ancestors. Display procedures may find it useful.

50.2.6 Errors

```
Error: ERROR [code: ErrorCode];

ErrorCode: TYPE = {
    illegalBitmap, illegalFloat, windowNotChildOfParent, whosSlidingRoot,
    noSuchSibling, noUnderVariant, windowInTree, sizingWithBitmapUnder,
    illegalStack, invalidParameter};
```

illegalBitmap	A window passed to **SetBitmapUnder** is not totally visible.
illegalFloat	See **Float**.
windowNotChildOfParent	A window is not in the list of its parent's children. This usually means that inconsistent calls to **SetParent**, **SetChild**, or **SetSibling** were made.
whosSlidingRoot	The client has attempted to move the root window.
noSuchSibling	An operation moving a window in the window tree specifies a new sibling that is not a child of the new parent.
noUnderVariant	A bitmap-under operation was applied to a window that may not have a bitmap-under associated with it.
windowInTree	**SetParent**, **SetSibling**, or **SetChild** was applied to a window in the window tree. **Stack**, et al., can be used instead.
sizingWithBitmapUnder	A client has tried to change the size of a window that currently has a bitmap-under.
illegalStack	The client is attempting to move a window between parents, one of which is in the window tree and the other is not.

invalidParameter	The client has invoked an operation with invalid parameters.

50.2.7 Special Topic: Bitmap-Under

Bitmap-unders are described in §50.1.4. Most clients have no need for bitmap-unders.

IsBitmapUnderVariant: PROCEDURE [Handle] RETURNS [BOOLEAN];

IsBitmapUnderVariant returns **TRUE** if the window can be associated with a bitmap-under (i.e., **InitializeWindow[. . . , under: TRUE]**.

WordsForBitmapUnder: PROCEDURE [window: Handle] RETURNS [CARDINAL];

WordsForBitmapUnder returns the number of words of storage needed for a bitmap-under corresponding to the current size of **window**.

```
SetBitmapUnder: PROCEDURE [
    window: Handle, pointer: LONG POINTER ← NIL,
    underChanged: UnderChangedProc ← NIL,
    mouseTransformer: MouseTransformerProc ← NIL] RETURNS [LONG POINTER];
```

UnderChangedProc: TYPE = PROCEDURE [Handle, Box];

MouseTransformerProc: TYPE = PROCEDURE [Handle, Place] RETURNS [Handle, Place];

SetBitmapUnder associates a bitmap-under with **window**. **pointer** describes a scratch storage area for the bitmap-under; its length must be as given by **WordsForBitmapUnder**. If **pointer = NIL**, the window ceases to have a bitmap-under. The pointer to any previous bitmap-under is returned; the client becomes the owner of that storage. The **underChanged** and **mouseTransformer** parameters are ignored in the current release. If the window cannot be associated with a bitmap-under, **Error[noUnderVariant]** is raised. If the window is in the window tree but is obscured by another window, **Error[illegalBitmap]** is raised. While the bitmap-under is in effect, the window's size cannot be changed; an attempt to do so will raise **Error[sizingWithBitmapUnder]**.

GetBitmapUnder: PROCEDURE [window: Handle] RETURNS [LONG POINTER];

GetBitmapUnder returns the pointer to the current bitmap-under for **window**–returns **NIL** if none. If the window cannot be associated with a bitmap-under, **Error[noUnderVariant]** is raised.

Float: PROCEDURE [window, temp: Handle, proc: FloatProc];

FloatProc: TYPE = PROCEDURE [window: Handle] RETURNS [place: Place, done: BOOLEAN];

Float is used to move a window continuously on the screen. **Float** first forces **window** to the top of its sibling stack, next does **ValidateTree[rootWindow]**, and then enters a loop for changing the window's position. In the loop, **Float** calls **proc**, passing **window** to it. If **proc** returns **done = TRUE**, the operation terminates and **Float** returns to the client. Otherwise, **Float** moves the window to **place** and repaints the display–and does so without calling any client display procedure; control returns to the top of the loop. The client must ensure that the window is wholly visible when moved to **place**. **temp** is used for temporary storage for the duration of the float operation. **temp** must be the same size as **window**, have a bitmap-under, and not be in the window tree. If **window** is not in the window tree, if **temp** *is* in the window tree, if either window lacks a bitmap-under, or if the windows have different sizes, **Error[illegalFloat]** is raised.

50.3 Usage/Examples

A scrollbar is an example of a simple window. An entire **StarWindowShell** window is an example of a window that has many descendant windows—the window header, the scrollbars, and the main interior window used to display the content.

Window shields the client from interference between windows and from the presence of the edges of the display screen. A client can freely move a window around on or off the screen and alter its position in the stack of windows; **Window** automatically handles the overlapping.

Window automatically clips painting into windows to the visible interior of its parent window. A client can freely paint anywhere inside or even outside of its window as convenient.

It is always correct to paint more of a window than the minimum required. Simple clients may adopt a simple repaint strategy, invalidating and/or repainting a large part or even all of a window. Sophisticated clients may invalidate only the necessary parts of a window, thus allowing only small amounts of repainting and minimizing references to the window's backing data. This may result in improved performance.

A display procedure has available to it a list of invalid areas that need to be repainted. However, it may adopt the simple approach of ignoring this data and repainting the entire window. In any case, **Window** clips a display procedure's paint to the boundaries of the invalid regions.

Areas that project outside of a window's parent are trimmed for display purposes. Vertical scrolling can be implemented quite simply by embedding a tall *content window* in a short *clipping window* and then just **Slide**ing the position of the content window within the clipping window. Horizontal scrolling can be done in a similar way. The **StarWindowShell** interface supports this method of scrolling. This approach is limited by the domain of the coordinates, which are **INTEGERs**. Scrolling in this manner is limited to +-2↑15 pixels offset from the frame window. If more scrolling than this is required, the client cannot use this technique, but must itself perform the transformation from data coordinates to window coordinates.

Since a window's location is defined in its parent window's coordinate system, moving a window automatically moves all of its descendant windows along with it.

Window itself has nothing to do with the keyboard and mouse. However, the **TIP** interface provides the facility for associating mouse and keyboard actions with a window.

50.3.1 Display Procedures and MONITORS

Any process may manipulate windows, and thus cause screen painting activity. Even if one client always runs in the Notifier process, its window's display procedure may be called at any instant because of asynchronous activities by some other process. *If a window's display procedure uses any nonlocal variables in its painting activity (the usual case), those variables must be protected by a* **MONITOR**. Most display procedures are monitor entry procedures. Of course, if the display procedure only refers to immutable data, its operation need not be monitored.

Since a display procedure is usually a monitor entry, the client must avoid deadlocks by not invoking the display procedure from within other monitor procedures. This is the standard rule for monitors. Because calling **Validate** may cause **Window** to call the client's display procedure, calls to **Validate** must be done outside the client's monitor. The normal arrangement is (1) enter monitor, (2) update monitor data and **Invalidate** regions, (3) exit monitor, (4) **Validate** (which causes the display to be repainted).

50.3.2 Example

```
-- These excerpts are taken from <BWSHacks>1.0>Source>Puzzle15Impl.mesa

boxSize: CARDINAL = 32;
boxDims: Window.Dims = [boxSize, boxSize];

bodyWindowDims: Window.Dims = [boxSize*grid + 2, boxSize*grid + 2];
boxes: ARRAY [0..max) OF Window.Box;

MenuProc: MenuData.MenuProc = {
    another: XString.ReaderBody ← XString.FromSTRING["Another"L];
    rb: XString.ReaderBody ← XString.FromSTRING["15 Puzzle"L];
    shell: StarWindowShell.Handle = StarWindowShell.Create [name: @rb];
    -- Window.Initialize[] is called by StarWindowShell Impls.
    body: Window.Handle = StarWindowShell.CreateBody [
        sws: shell,
        box: [[0,0],bodyWindowDims],
        repaintProc: Redisplay,
        bodyNotifyProc: NotifyProc ];
    .
    .
    .
    StarWindowShell.SetRegularCommands [shell, myMenu];
    StarWindowShell.SetPreferredDims [shell, bodyWindowDims];
    StarWindowShell.SetPreferredPlace [shell, [200, 200]];
    StarWindowShell.Push [shell];
    };

NotifyProc: TIP.NotifyProc = {
    data: Data ← LocalFind[window];
    place: Window.Place;
    FOR input: TIP.Results ← results, input.next UNTIL input = NIL DO
        WITH z: input SELECT FROM
        coords => place ← z.place;
        atom => SELECT z.a FROM
            pointUp => {
            box: CARDINAL ← ResolveToBox [place];
            IF Adjacent [data.empty, box] THEN {
                Window.InvalidateBox [window, boxes[data.empty]];
                Window.InvalidateBox [window, boxes[box]];
                SwapBoxWithEmpty [data, box];
                Window.Validate[window];
                };
            };
            ENDCASE;
        ENDCASE;
.
.
.

Redisplay: PROC [window: Window.Handle] = {
    -- This is the body window's display procedure.
    data: Data ← LocalFind[window];
    vertical: Window.Dims ← [2, boxSize*grid];
    horizontal: Window.Dims ← [boxSize*grid, 2];
    place: Window.Place ← [0,0];
    -- Display the 15 numbers
    FOR i: CARDINAL IN [0..max) DO
        value: CARDINAL ← data.values[i];
        Display.Bitmap [window, boxes[i], [@bitmaps[value],0,0], boxSize];
        ENDLOOP;
    -- Display the vertical lines
    FOR i: CARDINAL IN [0..grid + 2) DO
        Display.Black [window, [place,vertical]];
        place.x ← place.x + boxSize;
        ENDLOOP;
    -- Display the horizontal lines
    place ← [0,0];
    FOR i: CARDINAL IN [0..grid + 2) DO
        Display.Black [window, [place,horizontal]];
        place.y ← place.y + boxSize;
        ENDLOOP;
};

Init: PROC = {
    rb: XString.ReaderBody ← XString.FromSTRING["15 Puzzle"L];
    StarDesktop.AddItemToAttentionWindowMenu [
        MenuData.CreateItem [
            zone: Heap.systemZone,
            name: @rb,
            proc: MenuProc] ];
    .
    .
    .
    };
```

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51

XChar

51.1 Overview

The **XChar** interface is part of a string package that supports the *Xerox Character Code Standard,* referred to in this document as the "standard." **XChar** defines the basic character type and some operations on it.

The standard defines 16-bit characters, which would permit up to 65,536 distinct characters. Reserving control character space reduces them to 35,532. It is convenient to partition the character code range into 256 blocks of 256 codes each. Each block is called a character set. This approach allows a convenient run-encoding scheme.

All of the character sets currently defined are enumerated in **XCharSets**.

51.2 Interface Items

51.2.1 Character Representation

Character: TYPE = WORD;

Character is a 16-bit character.

Fine Point: Currently only 16-bit characters are defined by the standard, but larger characters are not precluded. If the standard is extended to include more bits per character, the type **Character** will have to be redefined.

CharRep: TYPE = MACHINE DEPENDENT RECORD [set, code: Environment.Byte];

CharRep is a type that defines the representation of a character as character set and code. The operations **Code, Make,** and **Set** should be used instead of this type.

Code: PROCEDURE [c: Character] RETURNS [code: Environment.Byte] ;

Code returns the code within a character set of the character parameter.

Make: PROCEDURE [set, code: Environment.Byte] RETURNS [Character];

Make constructs a character, given a character set and a code within the character set.

Set: PROCEDURE [c: Character] RETURNS [set: Environment.Byte] ;

Set returns the character set of the character parameter.

null: Character = 0;
not: Character = 177777B;

not is a value that may be used by operations that return a character to signify that no characters remain.

51.2.2 JoinDirection and StreakNature

JoinDirection: TYPE = {nextCharToLeft, nextCharToRight};

JoinDirection specifies whether a character goes left to right or right to left.

GetJoinDirection: PROCEDURE [Character] RETURNS [JoinDirection];

GetJoinDirection returns the join direction for a character, given its set and code within its set.

ArabicFirstRightToLeftCharCode: Environment.Byte = 60B;

ArabicFirstRightToLeftCharCode is used by **GetJoinDirection**.

StreakNature: TYPE = {leftToRight, rightToLeft};

GetStreakNature: PROCEDURE [Character] RETURNS [StreakNature];

Returns a characters **StreakNature** (see **SimpleTextDisplay.StreakSuccession**).

51.2.3 Case

Decase: PROCEDURE [c: Character] RETURNS [Character];

Decase is a case-stripping operation. It returns **c** with all case information removed. This is useful when comparing characters with case ignored. Only characters in character sets zero (Latin), 46(Greek), and 47(Cyrillic) are affected.

LowerCase: PROCEDURE [c: Character] RETURNS [Character];

LowerCase returns the lowercase representation of character **c**. Only characters in character set zero (Latin), 46 (Greek), and 47 (Cyrillic) are affected.

UpperCase: PROCEDURE [c: Character] RETURNS [Character];

UpperCase returns the uppercase representation of character **c**. Only characters in character set zero (Latin), 46 (Greek), and 47 (Cyrillic) are affected.

51.3 Usage/Examples

The following two examples create specific characters. XChar.Make is also useful if the character set and code are not known at compile time, but are known at run time.

51.3.1 Creating an ASCII Character

The following example creates an ASCII CR character.

```
c: XChar.Character ← XChar.Make[set: XCharSets.Sets.latin.ORD, code:LOOPHOLE[Ascii.CR]];
```

51.3.2 Creating a Greek Character

The following example creates a α from the Greek character set.

```
c: XChar.Character ← XChar.Make[set:XCharSets.Sets.greek.ORD, code:
XCharSet46.Codes46.lowerAlpha.ORD];
```

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GetStreakNature: PROCEDURE	2
JoinDirection: TYPE	2
LowerCase: PROCEDURE	2
Make: PROCEDURE	1
null: TYPE	2
not: TYPE	2
Set: PROCEDURE	2
StreakNature: TYPE	2
UpperCase: PROCEDURE	2

52

XCharSets

52.1 Overview

XCharSets enumerates the character sets defined in the *Xerox Character Code Standard.* This chapter also describes a collection of interfaces that enumerate the character codes of several common character sets. This collection of interfaces is **XCharSetNNN**.

52.2 Interface Items

52.2.1 Sets

```
Sets: TYPE = MACHINE DEPENDENT {
   latin(0), firstUnused1(1), lastUnused1(40B), jisSymbol1(41B), jisSymbol2(42B),
   extendedLatin(43B), hiragana(44B), katakana(45B), greek(46B), cyrillic(47B),
   firstUserKanji1(50B), lastUserKanji1(57B), firstLevel1Kanji(60B),
   lastLevel1Kanji(117B), firstLevel2Kanji(120B), lastLevel2Kanji(163B), jSymbol3(164B),
   firstUserKanji2(165B), lastUserKanji2(176B), firstUnused2(177B), lastUnused2(240B),
   firstReserved1(241B), lastReserved1(337B), arabic(340B), hebrew(341B),
   firstReserved2(342B), lastReserved2(355B), generalSymbols2(356B),
   generalSymbols1(357B), firstRendering(360B), lastRendering(375B),
   userDefined(376B), selectCode(377B)};
```

Sets enumerates the character sets. Specific character sets have values defined, such as **Latin** and **Hiragana**. Character set families such as **Kanji** and unused or reserved portions of the character set enumeration are specified by first and last values; for example, **firstUserKanji1** and **lastUserKanji1**.

For those eleven character sets whose codes are specified in the standard, an interface has been defined that contains an enumerated type enumerating the codes within the character set and a Make procedure that will make a character given a code literal.

For example, the interface **XCharSet356** has the following definitions:

```
Make: PROCEDURE [code: Codes356] RETURNS [Character];
```

```
Codes356: TYPE = MACHINE DEPENDENT {
  thickSpace(41B), fourEmSpace(42B), hairSpace(43B), punctuationSpace(44B),
  decimalPoint(56B), absoluteValue(174B), similarTo(176B), escape(377B)};
```

52.2.2 Enumeration of Character Sets

Table 52.1 enumerates the eleven character sets whose codes are specified in the standard, the interface in which they are contained, and the enumerated type name for that interface.

Character Set	Interface	Enumerated Type
Latin	XCharSet0	Codes0
jisSymbol1	XCharSet41	Codes41
jisSymbol2	XCharSet42	Codes42
extendedLatin	XCharSet43	Codes43
Hiragana	XCharSet44	Codes44
Katakana	XCharSet45	Codes45
Greek	XCharSet46	Codes46
Cyrillic	XCharSet47	Codes47
jSymbol3	XCharSet164	Codes164
generalSymbols2	XCharSet356	Codes356
generalSymbols1	XCharSet357	Codes357

Table 52.1: Standard Character Sets

52.3 Usage/Examples

52.3.1 Creating a Greek Character

The following example shows two ways to create an α from the Greek character set.

```
c: XChar.Character ← XChar.Make[set: XCharSets.Sets.greek.ORD, code:
XCharSet46.Codes46.lowerAlpha.ORD];

c: XChar.Character ← XCharSet46.Make[code: XCharSet46.Codes46.lowerAlpha.ORD];
```

52.4 Index of Interface Items

53

XComSoftMessage

53.1 Overview

This interface assigns the *global handle* and message keys for all the messages the system requires for system templates (such as time and date formatting, numbers, etc.). The **XMessage** interface deals with system messages; it must be understood before using this interface.

53.2 Interface Items

53.2.1 Obtaining Message Handle

GetHandle: PROCEDURE RETURNS [h: XMessage.Handle];

This procedure returns a handle for system-required messages that have already been initialized and allocated, and registered by the **XComSoftMessage** implementation.

53.2.2 Message Keys

```
Keys: TYPE = MACHINE DEPENDENT {
  time(0), date(1), dateAndTime(2), am(3), pm(4), january(5), february(6), march(7),
  april(8), may(9), june(10), july(11), august(12), september(13), october(14),
  november(15), december(16), monday(17), tuesday(18), wednesday(19),
  thursday(20), friday(21), saturday(22), sunday(23), decimalSeparator(24),
  thousandsSeparator(25)};
```

time, **date**, and **dateAndTime** are available through the **XTime** interface; they may be used as templates in calls to XTime.ParseReader or XTime.Append.

Months: TYPE = Keys [january..december];

DaysOfWeek: TYPE = Keys [monday..sunday];

53.3 Usage/Examples

```
OPEN XCSM: XComSoftMessage;

systemMsgs: XMessage.Handle ← XCSM.GetHandle [];
mondayString: XString.Reader ← XMessage.Get [
    systemMsgs, XCSM.DaysOfWeek.monday.ORD];
```

53.4 Index of Interface Items

54

XFormat

54.1 Overview

The **XFormat** package provides procedures for formatting various types into **XString.Readers**. The procedures require the client to supply an output procedure and a piece of data to be formatted. Where appropriate, a format specification is also required.

54.1.1 Major Data Structures

The major data structure is the **Handle**,which points to an object containing a **FormatProc**, an **XString.Context**,and some **ClientData**. All the formatting operations take a handle as the destination of the formatted character string. The **FormatProc** is the main component of an **Object**. It should pass the characters of its reader parameter to the output sink it implements and update the object's context to reflect the context of the last character of the reader parameter.

The other major data structure is the **NumberFormat**, which defines how numbers are to be converted to text strings. It includes the base of the number, the number of columns the text string should contain, whether to treat the number as signed or unsigned, and whether to fill leading columns with zeros or spaces.

A **FormatProc** is the destination of all output from the format routines. It is the main component of an **Object**. It should pass the characters of **r** to the appropriate sink and update **h.context** to reflect the context of the last character of **r**.

54.1.2 Operations

There are two major classes of operations in **XFormat**. The first class is used to format various data types and pass them to a format procedure. These operations contain simple text operations such as **Blanks**, **Reader**, and **String**; numeric operations such as **Decimal** and **Number**; network- related operations such as **NetworkAddress** and **HostNumber**;and some compatibility routines such as **NSString**. All these operations direct their output to the format procedure in their **handle** parameter. If this parameter is defaulted, it is directed to the default output sink.

The second class of operations provide built-in format procedures that direct their output to the following well-known data types: **XString.Writer**, **Stream.Handle**, **TTY.Handle**,and **NSString.String**.

54.2 Interface Items

54.2.1 Handles and Objects

```
Handle: TYPE = LONG POINTER TO Object;

Object: TYPE = RECORD [
  proc: FormatProc,
  context: XString.Context ← XString.vanillaContext,
  data: ClientData ← NIL];

FormatProc:TYPE = PROCEDURE [r: XString.Reader, h: Handle];

ClientData: TYPE = LONG POINTER;
```

A **Handle** is a parameter to all the formatting operations. Its object encapsulates the output sink that is the destination of all formatted text. The **proc** field is called one or more times for each formatting operation; it should pass the characters of its reader parameter to the output sink it implements. The **context** field is used to hold the context of the last character sent to the format procedure. It should be updated by the format procedure. The data field allows client-specific information to be passed to the format procedure.

54.2.2 Default Output Sink

```
SetDefaultOutputSink: PROCEDURE [new: Object] RETURNS [old: Object];
```

SetDefaultOutputSink sets the default object that is the default destination for all formatted output. For each of the formatting operations, if the handle parameter is NIL, it is directed to the default output sink. The default output sink is initialized to an object that ignores all results.

54.2.3 Text Operations

```
Blanks: PROCEDURE [h: Handle ← NIL, n: CARDINAL ← 1];
```

Blanks calls on **h.proc** with readers that contain a total of **n** blanks. **h.proc** may be called more than once.

```
Block: PROCEDURE [h: Handle ← NIL, block: Environment.Block];
```

Block calls on **h.proc** with a reader that contains the characters in **block**.

```
Char: PROCEDURE [h: Handle ← NIL, char: XString.Character];
```

Char calls on **h.proc** with a reader that contains only the character **char**.

CR: PROCEDURE [h: Handle ← NIL, n: CARDINAL ← 1];

CR calls on **h.proc** with readers that contain a total of **n** carriage returns (15C). **h.proc** may be called more than once.

Line: PROCEDURE [h: Handle ← NIL, r: XString.Reader, n: CARDINAL ← 1];

Line calls on **h.proc** with **r** and then readers that contain a total of **n** carriage returns (15C). **h.proc** will be called more than once.

Reader: PROCEDURE [h: Handle ← NIL, r: XString.Reader];

Reader calls on **h.proc** with **r**.

ReaderBody: PROCEDURE [h: Handle ← NIL, rb: XString.Reader];

ReaderBody calls on **h.proc** with **@rb**.

String: PROCEDURE [h: Handle ← NIL, s: LONG STRING];

String calls on **h.proc** with readers that contain the characters in **s**.

54.2.4 Number Formats

```
NumberFormat: TYPE = RECORD [base: [2..36] ← 10,
  zerofill: BOOLEAN ← FALSE, signed: BOOLEAN ← FALSE, columns: [0..255] ← 0 ];
```

NumberFormat is used by the number-formatting procedures. The number will be formatted in base **base** in a field at least **columns** wide (zero means "use as many as needed"). If **zerofill** is **TRUE**, the extra columns are filled with zeros; otherwise, spaces are used. If **signed** is **TRUE** and the number is less than zero, a minus sign preceeds all output, except for columns that are filled with spaces. For bases greater than 10, the characters 'A..'Z are used as digits.

```
DecimalFormat: NumberFormat = [
  base: 10, zerofill: FALSE, signed: TRUE, columns: 0];

HexFormat: NumberFormat = [
  base: 16, zerofill: FALSE, signed: FALSE, columns: 0];

OctalFormat: NumberFormat = [
  base: 8, zerofill: FALSE, signed: FALSE, columns: 0];

UnsignedDecimalFormat: NumberFormat = [
  base: 10, zerofill: FALSE, signed: FALSE, columns: 0];
```

These are useful number format constants. The output will fill as many columns as needed.

54.2.5 Numeric Operations

Number: PROCEDURE [
  h: Handle ← NIL, n: LONG UNSPECIFIED, **format: NumberFormat];**

Number formats **n** to a string according to the number format **format**. The number will be formatted in base **base** in a field at least **columns** wide (zero means "use as many as needed"). If **zerofill** is TRUE, the extra columns are filled with zeros; otherwise, spaces are used. If **signed** is TRUE and the number is less than zero, a minus sign preceeds all output, except for columns that are filled with spaces. For bases greater than 10, the characters 'A..'Z are used as digits. **h.proc** will be called several times with pieces of the output as they are generated.

Decimal: PROCEDURE **[h: Handle ← NIL, n:** LONG INTEGER**];**

Decimal converts **n** to signed base 100. It is equivalent to **Number[h, n, DecimalFormat]**.

Hex: PROCEDURE **[h: Handle ← NIL, n:** LONG CARDINAL**];**

Hex converts **n** to signed base 160. It is equivalent to **Number[h, n, HexFormat]**.

Octal: PROCEDURE **[h: Handle ← NIL, n:** LONG UNSPECIFIED**];**

Octal convert **n** to base 80. When **n** is greater than 7, the character 'B is appended. It is equivalent to **Number[h, n, OctalFormat];** IF **n > 7** THEN **Char[h, 'B.**ORD**]**.

54.2.6 Built-in Sinks

The **XFormat** interface provides several built-in format procedures that know how to send output to particular destinations. For each of the four known types of destinations (**XString.Writer**, **Stream.Handle**, **TTY.Handle**, and **NSString.String**), there are both the format procedure as well as an operation that returns an object initialized with the appropriate format procedure and destination data. Both the format procedures and the object operations may raise the error **Error[nilData]** if the expected data is NIL.

NSStringProc: FormatProc;

NSStringObject: PROCEDURE **[s:** LONG POINTER TO **NSString.String]** RETURNS **[Object];**

NSStringProc appends the reader to an **NSString.String**. It expects **h.data** to be a LONG POINTER TO **NSString.String**. **NSStringObject** constructs an object whose proc is **NSStringProc** and whose data is **s**.

StreamProc: FormatProc;

StreamObject: PROCEDURE **[sH: Stream.Handle]** RETURNS **[Object];**

StreamProc puts the bytes of the reader to a **Stream.Handle**. It expects **h.data** to be a **Stream.Handle**. **StreamObject** constructs an object whose proc is **StreamProc** and whose data is **sH**.

TTYProc: FormatProc;

TTYObject: PROCEDURE [h: TTY.Handle] RETURNS [Object];

TTYProc puts the bytes of the reader to a **TTY.Handle**. It expects **h.data** to be a **TTY.Handle**. **TTYObject** constructs an object whose proc is **TTYProc** and whose data is **h**.

WriterProc: FormatProc;

WriterObject: PROCEDURE [w: XString.Writer] RETURNS [Object];

WriterProc appends the reader to a **XString.Writer**. It expects **h.data** to be a **XString.Writer**. **WriterObject** constructs an object whose proc is **WriterProc** and whose data is **w**.

54.2.7 Date Operation

DateFormat: TYPE = {dateOnly, timeOnly, dateAndTime};

DateFormat allows the user to specify which template from **XTime** is used when the date is to be formatted by the procedure **Date**.

```
Date: PROCEDURE [
  h: Handle ← NIL, time: System.GreenwichMeanTime ← System.gmtEpoch,
  format: DateFormat ← dateAndTime];
```

Date converts **time** to a string by calling **XTime.Append**, using **format** to specify which template to use. **h.proc** is then called. If **time** is defaulted, the current time is used.

54.2.8 Network Data Operations

NetFormat: TYPE = {octal, hex, productSoftware};

NetFormat is used by the procedures that format network addresses. **octal** converts the number to octal, **hex** converts to hex, and **productSoftware** converts the item to a decimal number and then inserts a "-" every three characters, starting from the right. An example of a number in product software format is 4-294-967-295.

```
HostNumber: PROCEDURE [
  h: Handle ← NIL, hostNumber: System.HostNumber, format: NetFormat];
```

HostNumber calls on **h.proc** with a reader that contains **hostNumber** formatted as defined by **format**.

```
NetworkAddress: PROCEDURE
   h: Handle ← NIL, networkAddress: System.NetworkAddress, format: NetFormat];
```

NetworkAddress calls on **h.proc** with a reader that contains **networkAddress** with the form *network-number#host-number#socket-number*, where the format of the various components isdetermined by **format**.

NetworkNumber: PROCEDURE [
    h: Handle ← NIL, networkNumber: System.NetworkNumber, format: NetFormat];

NetworkNumber calls on h.proc with a reader that contains networkNumber formatted as defined by format.

SocketNumber: PROCEDURE [
    h: Handle ← NIL, socketNumber: System.SocketNumber, format: NetFormat];

SocketNumber calls on h.proc with a reader that contains socketNumber formatted as defined by format.

54.2.9 NSString Operations

NSChar: PROCEDURE [h: Handle ← NIL, char: NSString.Character];

NSChar calls on h.proc with a reader that contains the character char.

NSLine: PROCEDURE [h: Handle ← NIL, s: NSString.String, n: CARDINAL ← 1];

NSLine calls on h.proc with a reader that contains the characters in s, then calls on readers that contain a total of n carriage returns (15C). h.proc may be called more than once.

NSString: PROCEDURE [h: Handle ← NIL, s: NSString.String];

NSString calls on h.proc with a reader that contains the characters in s.

54.2.10 Errors

Error: ERROR [code: ErrorCode] ;

ErrorCode: TYPE = {invalidFormat, nilData};

invalidFormat	The term invalidFormat means an invalid operation has been attempted
nilData	The term nilData means h.data was NIL, but the format procedures wanted valid data.

54.3 Usage/Examples

54.3.1 Using Built-in Sinks

The XFormat interface allows clients to convert data types to their textual representation. By using the built-in sinks, clients can put this text into streams, tty.handle, and append to writers. In particular, although the XString interface does not include any append number operations, XFormat may be used to accomplish this task.

```
AppendNumber: PROCEDURE [
  w: XString.Writer, n: LONG INTEGER, format: XFormat.NumberFormat] = {
```

```
xfo: XFormat.Object ← XFormat.WriterObject[w];
XFormat.Number[h: @xfo, n: n, format: format]};
```

54.3.2 Creating New Format Procedures

While **XFormat** provides some useful output sinks, clients may wish to build new sinks. The following example hypothesizes a log window that can display text in a window and allows appending of text to the end.

```
LogWindow: DEFINITIONS = {
  Create: PROCEDURE [w: Window.Handle, file: NSFile.Handle];
  Destroy: PROCEDURE [w: Window.Handle];

  LogReader: PROCEDURE [w: Window.Handle, r: XString.Reader];
  Info: PROCEDURE [w: Window.Handle] RETURNS [
    file: NSFile.Handle, nChars: LONG INTEGER, endContext: XString.Context];

  LogFormatProc: XFormat.FormatProc;
  LogFormatObject: PROCEDURE [w: Window.Handle] RETURNS [object: XFormat.Object]

  ErrorCode: TYPE = {notALogWindow};
  Error: Error [code: ErrorCode];
  }..

LogWindowImpl: PROGRAM = {

  Create: PUBLIC PROCEDURE [w: Window.Handle, file: NSFile.Handle] = {...};
  Destroy: PUBLIC PROCEDURE [w: Window.Handle] = {...};

  LogReader: PUBLIC PROCEDURE [w: Window.Handle, r: XString.Reader] = {...};
  Info: PUBLIC PROCEDURE [w: Window.Handle] RETURNS [
    file: NSFile.Handle, nChars: LONG INTEGER, endContext: XString.Context] = {...};

  LogFormatProc: PUBLIC XFormat.FormatProc = {
    w: Window.Handle = h.data;
    IF w = NIL THEN ERROR XFormat.Error[nilData];
    LogReader[w: w, r: r];
    h.context ← Info[w].endContext};

  LogFormatObject: PUBLIC PROCEDURE [
    w: Window.Handle] RETURNS [object: XFormat.Object] = {
      IF w = NIL THEN ERROR XFormat.Error[nilData];
      RETURN[[proc: LogFormatProc, context: Info[w].endContext, data: w]]};

  }..
```

The bulk of the work is done in the **LogReader** procedure. It is assumed that the log window keeps track of the context of the end of the log so that it will add the necessary character set shift information when a reader that begins with a different character set is logged. If the log window didn't take care of this, the format procedure would have to set that itself, as the stream format procedure example below shows.

```
StreamProc: PUBLIC XFormat.FormatProc = {
  stream: Stream.Handle = h.data;
  startsWith377B: BOOLEAN;
  c: XString.Context;
  IF stream = NIL THEN ERROR XFormat.Error[nilData];
  [context: c, startsWith377B: startsWith377B] ← XString.ReaderInfo[r];
  SELECT TRUE FROM
    startsWith377B => NULL;
    c.suffixSize = 2 =>
      IF h.context.suffixSize = 1 THEN {
        stream.PutByte[377B]; stream.PutByte[377B]; stream.PutByte[0]};
    h.context.suffixSize = 2, c.prefix # h.context.prefix => {
      stream.PutByte[377B]; stream.PutByte[c.prefix]};
    ENDCASE;
  stream.PutBlock[block: XString.Block[r]];
  h.context ← XString.ComputeEndContext[r]};
```

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55

XLReal

55.1 Overview

XLReal supports manipulation of real numbers with greater precision than Mesa REALs.

55.2 Interface Items

55.2.1 Representation

Numbers are maintained as 13 decimal digits of signed mantissa with a 10-bit exponent (-512 to 511). All routines maintain the normalized numbers, i.e., the first digit is non-zero. The assumed decimal point is after the first digit. Numbers are stored as opaque objects occupying 4 words (64 bits).

```
Digit: TYPE = [0..9];
Number: TYPE [4];
Bits: TYPE = ARRAY [0..4) OF CARDINAL;
ValidExponent: TYPE = [-512..511];
Digits: TYPE = PACKED ARRAY [0..accuracy) OF Digit;
accuracy: NATURAL = 13;
```

55.2.2 Conversion

```
ReadNumber: PROCEDURE [
  get: PROC RETURNS [XChar.Character], putback: PROC [XChar.Character]] RETURNS [Number];
```

```
ReaderToNumber: PROCEDURE[r: XString.Reader] RETURNS [Number];
```

ReadNumber and ReaderToNumber may raise Error[overflow].

```
NumberToPair: PROCEDURE [
  n: Number, digits: [1..accuracy]] RETURNS [negative: BOOLEAN, exp: INTEGER, mantissa:
  Digits];
```

PairToNumber: PROCEDURE[
  negative: BOOLEAN, exp:INTEGER, mantissa: Digits] RETURNS [n: Number];

In **PairToNumber** and **NumberToPair**, the decimal point. is between mantissa[0] and mantissa[1]. **NumberToPair** may raise **Error[notANumber]**. **PairToNumber** may raise **Error[underflow]**.

IntegerPart, FractionPart: PROCEDURE [Number] RETURNS [Number];

IntegerPart and **FractionPart** may raise **Error[notANumber]**. **FractionPart** may also raise **Error[overflow]**.

Fix:PROCEDURE [Number] RETURNS [LONG INTEGER];
Float: PROCEDURE [LONG INTEGER] RETURNS [Number];

Fix may raise **Error[notANumber]** and **Error[overflow]**.

FormatReal: PROCEDURE [h: XFormat.Handle ← NIL, r: Number, width: NATURAL];

FormatReal formats **r** into a field **width** elements wide and passes the resulting text to **h**.

PictureReal: PROCEDURE [
  h: XFormat.Handle ← NIL, r: Number, template: XString.Reader];

PictureReal is not implemented.

55.2.3 Comparison

Comparison: TYPE = {less, equal, greater};

Compare: PROCEDURE [a, b: Number] RETURNS [Comparison];

Less, LessEq, Equal, GreaterEq, Greater, NotEq: PROCEDURE [
  a, b: Number] RETURNS [BOOLEAN];

Any of the compare operations may raise **Error[notANumber]**.

55.2.4 Operations

Add, Subtract, Multiply, Divide, Remainder: PROCEDURE [
  a, b: Number]RETURNS [Number];

Add, Multiply, Divide and **Remainder** may raise **Error[notANumber]** and **Error[overflow]** **Divide** may also raise **Error[divideByZero]**.

Exp: PROCEDURE [Number] RETURNS [Number];

Exp computes the results by continued fractions. **Exp** may raise **Error[underflow]**, **Error[notANumber]** and **Error[overflow]**.

Log: PROCEDURE **[base, arg: Number]** RETURNS **[Number];**

Log computes the logarithm to the base **base** of **arg** by **Ln(arg)/Ln(base)**. **Log** may raise **Error[overflow]**, **Error[invalidOperation]**, and **Error[notANumber]**.

Ln: PROCEDURE **[Number]** RETURNS **[Number];**

Ln may raise **Error[notANumber]** , **Error[overflow]** , and **Error[invalidOperation]**.

Power: PROCEDURE **[base, exponent: Number]** RETURNS **[Number];**

Power calculates **base** to the **exponent** power by e(**exponent*Ln(base)**). **Power** may raise **Error[notANumber]** and **Error[overflow]**.

Root: PROCEDURE **[index, arg: Number]** RETURNS **[Number];**-

Root calculates the **index** root of **arg** by e(**Ln(arg)/index**). Root may raise **Error[overflow]**, **Error[notANumber]**, and **Error[underflow]**.

SqRt: PROCEDURE **[Number]** RETURNS **[Number];**

SqRt calculates the square root of the input value by Newton's iteration. **SqRt** may raise **Error[notANumber]** and **Error[invalidOperation]**.

Abs, Negative, Double, Half: PROCEDURE **[Number]** RETURNS **[Number];**

Abs, **Negative, Double** and **Half** may raise **Error[notANumber] Double** may also raise **Error[overflow]**.

Cos: PROCEDURE **[radians: Number]** RETURNS **[cos: Number];**
Sin: PROCEDURE **[radians: Number]** RETURNS **[sin: Number];**
Tan: PROCEDURE **[radians: Number]** RETURNS **[tan: Number];**

Sin, Cos and **Tan** may raise **Error[notANumber]** and **Error[invalidOperation]**. **Tan** may also raise **Error[overflow]**. Computes the trigonometric function by polynomial.

ArcCos PROCEDURE **[x: Number]** RETURNS **[radians: Number];**
ArcSin PROCEDURE **[x: Number]** RETURNS **[radians: Number];**
ArcTan PROCEDURE **[x: Number]** RETURNS **[radians: Number];**

Transcendental functions have an accuracy of about $1 \times 10_{-}^{11}$. **ArcCos, ArcSin** and **ArcTan** may raise **Error[notANumber]**. **ArcSin** may also raise **Error[invalidOperation]**.

55.2.5 Special Numbers

A client can create special numbers that will cause the **Error[notANumber]** to be raised if used in any arithmetic operation.

SpecialIndex: TYPE = NATURAL;

MakeSpecial: PROCEDURE **[index: SpecialIndex]** RETURNS **[Number];**
IsSpecial: PROCEDURE **[Number]** RETURNS **[yes:** BOOLEAN**, index: SpecialIndex];**

55.2.6 Errors

```
Error: ERROR [code: ErrorCode];

ErrorCode: TYPE = {bug, divideByZero, invalidOperation, notANumber, overflow,
   underflow, unimplemented};
```

notANumber	The term **not ANumber** means the number passed in is a special number.

55.2.7 Special Constants

```
zero: Number = LOOPHOLE[ Bits[0, 0, 0] ];

Pi: PROCEDURE RETURNS [Number];
E: PROCEDURE RETURNS [Number];
```

55.3 Usage/Examples

55.3.1 Special Numbers

```
--Make the special number

special:XLReal.Number ← XLReal.MakeSpecial[1];

--do some computations with Numbers

...
--If a problem occurs during computation, assign
 n←special
...

[] ←XLReal.Ln[n];
--If n = special this call to XLReal.Ln will raise Error[notANumber]
```

55.3.1 Times of Common Operations

For the four arithmetic operations, typical timings (in microseconds) compared with the current Common Software 32-bit IEEE floating-point package (with no microcode assist) are:

	XLReal	REAL
Add or Subtract	500	800
Multiply	800	1000
Divide	1500	1900

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XMessage

56.1 Overview

The **XMessage** interface supports the multinational requirements of systems that require that the text to be displayed to the user be separable from the code and algorithms that utilize it. This allows messages to be defined by workstation applications and the international representations of the text to be supplied by developers and translators. The **XMessage** interface defines the message transfer mechanism necessary for applications to define application-specific messages, register them with the system, and access them.

The **XMessage** interface is just part of the whole message machinery that provides multinational text. Applications must be written to rely on messages for their text. There is a tool that translates messages and produces a file containing the translated version of the messages.

56.1.1 Message Usage

Applications define collection of messages and refer to them using a **Handle**. Each message is represented by a unique key relative to that handle. To get the text of a message, the client calls **Get** or **GetList**. During development of applications, message handles are obtained by calling **AllocateMessages** and **RegisterMessages**. When the development is completed and a message file is generated, message handles are obtained by calling **MessagesFromFile** or **MessagesFromReference**.

Applications should be broken into three parts: the main code of the application that uses the messages, the code that defines and initializes the messages, and the code that gets message handles from the message file.

56.1.2 Message Composition and Templates

Frequently, text presented to the user should include items like names and sizes of objects, dates, etc. When defining such messages, it is best to define a single message template that allows certain fields to be filled in with this information. The piecemeal approach to constructing a understandable sentence normally will not work when the message is translated to a different language.

Templates are messages that will have additional text merged into them. The fields in templates are defined by numbers enclosed in angle brackets if the template contains multiple fields, or simply angle brackets, if there is only one field.

56.2 Interface Items

56.2.1 Handles

Handle: TYPE = LONG POINTER TO **Object;**

Object: TYPE;

A **Handle** represents a collection of messages. It is normally associated with a particular application. It is obtained from the **AllocateMessages** operation and is a parameter of most operations.

56.2.2 Getting Messages

Get: PROCEDURE [**h**: **Handle**, **msgKey**: **MsgKey**] RETURNS [**msg**: XString.**ReaderBody**];

Get returns the message corresponding to the given message key within the group of messages specified by **h**.

GetList: PROCEDURE [**h**: **Handle**, **msgKeys**: **MsgKeyList**, **msgs**: **StringArray**];

MsgKeyList: TYPE = LONG DESCRIPTOR FOR ARRAY OF **MsgKey;**

StringArray: TYPE = LONG DESCRIPTOR FOR ARRAY OF XString.**ReaderBody;**

GetList fills the array of reader bodies with the bodies of the messages whose keys are in the message key list. This procedure is equivalent to:

```
FOR i IN [0..msgKeys.LENGTH) DO msgs[i] ← Get[msgKeys[i]]; ENDLOOP.
```

This procedure will raise **Error[invalidMsgKeyList]** if **msgKeys** is NIL, **Error[invalidStringArray]** if **msgs** is NIL and **Error[arrayMismatch]** if the lengths of the two descriptors are not equal.

56.2.3 Composing Messages

```
ComposeToFormatHandle: PROCEDURE [
   source: XString.Reader, destination: XFormat.Handle, args: StringArray];
```

```
Compose: PROCEDURE [
   source: XString.Reader, destination: XString.Writer, args: StringArray];
```

ComposeToFormatHandle and **Compose** compose a message by replacing the fields in **source** with the text in **args**. **ComposeToFormatHandle** uses an XFormat.**Handle** as the destination of the message, while **Compose** uses an XString.**Writer**. A field is specified by a number enclosed in angle brackets. These operations may raise **Error[invalidString]** if **source** is empty and **Error[notEnoughArguments]** if **args** is NIL. In order to maintain backward compatibility with existing messages, the string array is one origin; i.e., the field <1> will access **args[0]**;

```
ComposeOneToFormatHandle: PROCEDURE [
  source: XString.Reader, destination: XFormat.Handle, arg: XString.Reader];

ComposeOne: PROCEDURE [
  source: XString.Reader, destination: XString.Writer, arg: XString.Reader];
```

ComposeOneToFormatHandle and **ComposeOne** compose a message by replacing the single field in **source** with **arg**. **ComposeOneToFormatHandle** uses an **XFormat.Handle** as the destination of the message, while **ComposeOne** uses an **XString.Writer**. The single field is specified by empty angle brackets, < >. These operations may raise **Error[invalidString]** if **source** is empty and **Error[notEnoughArguments]** if **arg** is **NIL**.

```
Decompose: PROCEDURE [source: XString.Reader] RETURNS [args: StringArray];
```

Decompose currently does nothing.

56.2.4 Defining Messages

Messages are defined by constructing an array of message entries and registering them with the system.

```
Messages: TYPE = LONG DESCRIPTOR FOR ARRAY OF MsgEntry;

MsgEntry: TYPE = RECORD [
  msgKey: MsgKey,
  msg: XString.ReaderBody,
  translationNote: LONG STRING ← NIL,
  translatable: BOOLEAN ← TRUE,
  type: MsgType ← userMsg,
  id: MsgID];

MsgKey: TYPE = CARDINAL;

MsgType: TYPE = {userMsg, template, argList, menuItem, pSheetItem, commandItem,
  errorMsg, infoMsg, promptItem, windowMenuCommand, others};

MsgID: TYPE = CARDINAL;
```

Messages describes a group of message entries and is a parameter to **RegisterMessages**. A **MsgEntry** contains information about each message. The **msgKey** field is the **Handle**-relative key of the message. The **msg** field contains the text of the message itself, while all other fields are to help in the translation process. The **tranlationNote** field provides notes to the translator. The **translatable** boolean indicates whether the message should be translated. The **MsgType** enumerated provides a hint how the message will be used. The **MsgID** is a unique identifier for the message. For a given group of messages, each message should have a unique value for its **MsgID**. This id allows the translators to determine when a new message has been added or an old message deleted.

```
AllocateMessages: PROCEDURE [
   applicationName: LONG STRING, maxMsgIndex: CARDINAL,
   clientData: ClientData, proc: DestroyMsgsProc]
   RETURNS [h: Handle];
```

```
ClientData: TYPE = LONG POINTER;
```

```
DestroyMsgsProc: TYPE = PROCEDURE [clientData: ClientData];
```

AllocateMessages allows a client to define a domain of messages for subsequent registry and access. All access to messages will be relative to the returned handle. The **applicationName** parameter names the message domain to the message implementation. **maxMsgIndex** defines the maximum number of messages that will be registered for this domain. The **ClientData** and **DestroyMsgsProc** parameters are provided to notify the client when the **DestroyMessages** operation is invoked.

```
RegisterMessages: PROCEDURE [
   h: Handle, messages: Messages, stringBodiesAreReal: BOOLEAN];
```

RegisterMessages allows a client to initialize a domain of messages. It uses the **stringBodiesAreReal** boolean to decide whether to copy the byte sequences of the messages. If **stringBodiesAreReal** is FALSE, it copies the reader body and bytes of the messages field in each entry of **messages**. If it is TRUE, **RegisterMessages** copies the reader body of the entry and relies on the bytes to not be deallocated until after a call to **DestroyMessages**

56.2.6 Obtaining Messages from a File

```
MessagesFromFile: PROCEDURE [
   fileName: LONG STRING, clientData: ClientData, proc: DestroyMsgsProc]
   RETURNS [msgDomains: MsgDomains];
```

```
MessagesFromReference: PROCEDURE [
   file: NSFile.Reference, clientData: ClientData, proc: DestroyMsgsProc]
   RETURNS [msgDomains: MsgDomains];
```

```
MsgDomains: TYPE = LONG DESCRIPTOR FOR ARRAY OF MsgDomain;
```

```
MsgDomain: TYPE = RECORD [
   applicationName: XString.ReaderBody,
   handle: Handle];
```

MessagesFromFile and **MessagesFromReference** return a sequence of message domains, which are name, message handle pairs. **MessagesFromFile** gets the messages from the file named **fileName** in the system folder, while **MessagesFromReference** gets the messages from the file whose reference is **file**. Storage for **msgDomains** must by freed by calling **FreeMsgDomainStorage**. The **ClientData** and **DestroyMsgsProc** parameters are provided to notify the application when the **DestroyMessages** operation is invoked.

```
FreeMsgDomainsStorage: PROCEDURE [msgDomains: MsgDomains];
```

56.2.7 Destroying Message Handles

```
DestroyMessages: PROCEDURE [h: Handle];
```

DestroyMessages invokes the **DestroyMsgsProc** associated with the handle and then frees any resources that are currently associated with **h**. The handle should no longer be used.

56.2.6 Error

```
Error: ERROR [type: ErrorType];

ErrorType: TYPE = {
  arrayMismatch, invalidArgIndex, invalidMsgKey, invalidMsgKeyList,
  invalidStringArray, invalidString, notEnoughArguments};
```

56.3 Usage/Examples

56.3.1 Structuring Applications to Use Messages

Applications that use messages have at least two parts. The first part is the code that implements the functionality of the application. It is produced by programming tools such as the compiler and binder with Mesa source programs as input. The second part consists of the messages that provide text to the user. The application defines its messages and provides initial information to the translators of the messages.

A serious operational consideration of a workable message facility is that of communicating messages (to be translated) in a precise type-safe manner. A consistent key/message correspondence with the original versions must be verifiable throughout the translation process.

The cleanest and safest possible interface between application developers (message definers) and translators is the delivery of a bcd that contains all the messages used by the application as well as a well-defined mechanism for communicating them to some client. The **RegisterMessages** procedure provides the mechanism; all that is needed is to avoid other distractions (like importing or exporting of application private facilities). To that end, the following conventions are proposed for modules/configurations that define and register messages:

1. Message definition code must be isolated into modules whose sole function is to define and register the message text for the application.

2 The allocation of the **Handle** and registration of all messages must be accomplished via the modules' configuration's START code.

3 If multiple modules are required to define the application messages, provide a configuration that will start all modules in the the correct order and provide the correct IMPORTS and EXPORTS.

4 **XMessage** definition modules/configurations must not depend upon application-specific facilities. Specifically, this means that the IMPORTS list of any message-defining module should be restricted to procedures defined in the **XMessage** interface (such as **RegisterMessages**, **AllocateMessages**, etc.).

As a consequence of conventions 2 and 4 above, applications must provide a mechanism for communicating the **Handle** between suppliers of messages (callers of **ResisterMessages**) and users of messages (callers of **GetMsg** and and so forth) . A simple solution is to have the message-definition module export a procedure that returns the handle.

56.3.2 Example of Message Usage

The following message example has three segments. The first is an interface that defines the messages for the example. The second is the module that provides the raw material for the messages. This module is used to supply the message text while running the application while it is being developed and is used to supply the raw data to the message translators. The third part is the module that uses the messages.

```
-- ExampleMessage.mesa

DIRECTORY
  XMessage USING [Handle];

ExampleMessage: DEFINITIONS = BEGIN

  Keys: TYPE = MACHINE DEPENDENT {
    delete(0), confirmDelete(1), deleteDone(3)...};

  GetHandle: PROCEDURE RETURNS[h: XMessage.Handle];

  END. -- of ExampleMessage:


-- ExampleMessageImpl.mesa

DIRECTORY ...

ExampleMessageImpl: PROGRAM
  IMPORTS ...
  EXPORTS ExampleMessage = BEGIN

  h: XMessage.Handle;

  GetHandle: PUBLIC PROCEDURE RETURNS [XMessage.Handle] = {RETURN[h]};

  DeleteMessages: XMessage.DestroyMsgsProc = {};

  Init: PROCEDURE = {
    msgArray: ARRAY Keys OF XMessage.MsgEntry ← [
      delete: [
        msgKey: Keys.delete.ORD,
        msg: XString.FromSTRING["Delete"L],
        translationNote: "Delete command name"L,
        translatable: TRUE,
            type: menuItem,
            id: 0],
         confirmDelete: [
            msgKey: Keys.confirmDelete.ORD,
            msg: XString.FromSTRING["Are you sure you want to delete that item"L],
            translatable: TRUE,
            type: userMsg,
            id: 1],
         deleteDone: [
            msgKey: Keys.deleteDone.ORD,
            msg: XString.FromSTRING["The item <1> has been deleted"L],
            translatable: TRUE,
            type: template,
            id: 3]];

      h ← XMessage.AllocateMessages[
         "Example"L, Keys.LAST.ORD.SUCC, NIL, DeleteMessages];
      XMessage.RegisterMessages[h, LOOPHOLE[LONG[DESCRIPTOR[msgArray]]], FALSE]};

   Init[];

   END. -- of ExampleMessageImpl

-- ExampleImpl.mesa

DIRECTORY ...

ExampleImpl: PROGRAM
   IMPORTS XMessage, ExampleMessage = BEGIN

   h: XMessage.Handle = ExampleMessage.GetHandle[]

   DeleteOne: PROCEDURE [ . . . ] = {
      r: XString.Reader = XMessage.Get[h, ExampleMessage.Keys.confirmDelete.ORD];
      . . .
      };

   }. -- of ExampleImpl
```

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57

XString

57.1 Overview

The **XString** interface is part of a string package that supports the Xerox Character Standard. It provides the basic data structures for representing encoded sequences of characters and some operations on these data structures.

57.1.1 Character Standard

The *Xerox Character Code Standard* defines a large number of characters, encompassing not only familiar ASCII characters but Japanese and Chinese Kanji characters and other characters to provide a comprehensive character set able to handle international information-processing requirements. Because of the large number of characters, the data structures in **XString** are more complicated than a **LONG STRING**'s simple array of ASCII characters, but the operations provided are more comprehensive.

Characters are 16-bit quantities that are composed of two 8-bit quantities: their character set and character code within a character set. The Character Standard defines how characters may be encoded, either as runs of 8-bit character codes of the character set or as 16-bit characters where the character set and character code are in consecutive bytes. See the XChar chapter for information and operations on characters.

57.1.2 Data Structures

Three main data structures are defined by **XString**: **Context**, **ReaderBody** and **WriterBody**. Contexts provide information for determining how characters are encoded. Reader bodies and readers describe a sequence of readonly characters. Writer bodies and writers describe a sequence of writeable characters.

A **Context** contains information about how characters are encoded in the byte sequence. The **suffixSize** field describes whether the first byte is encoded as an 8-bit character or a 16-bit character, the **prefix** field contains the character set of the first character if the encoding is 8-bit characters, and the **homogeneous** field is **TRUE** only if there are no character set shifts in the sequence of characters.

A **ReaderBody** describes some readonly characters that are stored as a sequence of bytes. The reader body contains a pointer to the allocation unit containing the bytes, **bytes**, the offset from the pointer to the first byte, **offset**, the offset from the pointer of the byte after the last byte in the byte sequence, **limit**, and the context information describing how the first character is encoded, **context**. Most clients should not have to access fields of a reader body. Many operations take a **Reader**, a pointer to a reader body, as a parameter to reduce the number of words of parameters.

A **WriterBody** describes some characters that may be edited. In addition to containing all the information in a reader body, it also contains an offset from the pointer to the first character not in the allocation unit, **maxLimit**, the context that describes how the last character is encoded, **endContext**, and the zone that contains the allocation unit, **zone**. Writer bodies are typically passed by reference.

The designers of **XString** felt there is a fundamental difference between a string that will only be read and one that will be constructed. They felt that the major usage of strings was to describe and examine existing strings, not construct new ones. This difference is reflected in the two types, readers and writers.

57.1.3 Operations

There are a wide range of operations on both readers and writers. Some operations that return simple information about readers, such as **ByteLength** and **Empty**. Others access characters in a reader, such as **First**, **NthCharacter**, and **Lop**. The operation **ReaderFromWriter** can be used to convert a writer to a reader.

There are operations that create reader bodies from other data structures, such as **FromSTRING**. Similarily, there are operations that create writer bodies from other structures, such as **WriterBodyFromSTRING**.

Routines allocate and deallocate byte sequences of both readers and writers. **CopyToNewReaderBody** makes a copy of the characters of a reader. **NewWriterBody** will create an empty writer body that can hold a given number of bytes. **CopyToNewWriterBody** is similar to **NewWriterBody** but initializes the writer with a given reader.

Other operations compare the characters in readers: **Equal** checks for equality and **Compare** does a multinational lexical comparison. There are operations for scanning readers for specific characters. The operation **ReaderToNumber** converts a reader to a numeric value. There are **Courier** description routines for both readers and reader bodies. There is also support for backward-accessing characters in a reader.

Routines are provided for appending to writers and editing writers. **AppendReader** appends the characters of a reader to a writer. **ReplacePiece** provides a general editing operation for writers. Only the basic appending primitives are provided in **XString**. The **XFormat** interface can be used to append converted values, such as numbers, to writers.

57.2 Interface Items

57.2.1 Contexts

```
Context: TYPE = MACHINE DEPENDENT RECORD [
  suffixSize(0:0..6): [1..2],
  homogeneous(0:7..7): BOOLEAN,
  prefix(0:8..15): Byte];
```

A **Context** contains information about how characters are encoded in the byte sequence. The **suffixSize** field describes whether the first byte is encoded as an 8-bit character or a 16-bit character, the **prefix** field contains the character set of the first character if the encoding is 8-bit characters, and the **homogeneous** field is TRUE only if there are no character set shifts in the sequence of characters.

The Character Set Standard describes how characters may be encoded as a sequence of bytes. They call the 8-bit character encoding stringlet8 and call the 16-bit character encoding stringlet16. In 8-bit character encoding, consecutive bytes contain character codes of characters in the same character set. In 16-bit character encoding, the character set and character code are contained in consecutive bytes. The **suffixSize** field describes how the characters are encoded; it is 1 for 8-bit character encoding and 2 for 16-bit character encoding.

The **prefix** field contains the character set of the first character if it is an 8-bit encoded character. Subsequent characters in the string use this same prefix unless a character set or encoding transition is encountered. It is not used for 16-bit encoded characters.

The **homogeneous** field is an accelerator. If it is TRUE, some operations may be faster. It is important to set it TRUE only if the byte sequence contains no character set shifts. It is always safe to set it to FALSE.

```
emptyContext: Context = [suffixSize: 1, homogeneous: TRUE, prefix: 0];

vanillaContext: Context = [suffixSize: 1, homogeneous: FALSE, prefix: 0];

unknownContext: Context = [suffixSize: 1, homogeneous: FALSE, prefix: 377B];
```

emptyContext, **vanillaContext**, and **unknownContext** are three **Context** constants. An empty writer should have **emptyContext** as its context and endContext. **vanillaContext** is the default context. **unknownContext** signifies that the context is unknown. It is generally used only for an end context, a context that describes the last character of a sequence.

57.2.2 Readers and ReaderBodies

```
Reader: TYPE = LONG POINTER TO ReaderBody;

ReaderBody: TYPE = PRIVATE MACHINE DEPENDENT RECORD [
  context(0): Context,
  limit(1): CARDINAL,
  offset(2): CARDINAL,
  bytes(3): ReadOnlyBytes];

ReadOnlyBytes: TYPE = LONG POINTER TO READONLY ByteSequence;

ByteSequence: TYPE = RECORD [
  PACKED SEQUENCE COMPUTED CARDINAL OF Byte];
```

```
Byte: TYPE = Environment.Byte;
```

A **ReaderBody** describes some readonly characters that are stored as a sequence of bytes. The reader body contains a pointer to the allocation unit containing the bytes, **bytes**, the offset from the pointer to the first byte, **offset**, the offset from the pointer of the byte after the last byte in the byte sequence, **limit**, and the context information describing how the first character is encoded, **context**. Most clients should not have to access fields of a reader body. Reader bodies can be thought of as fat pointers. Many operations take a **Reader**, a pointer to a reader body, as a parameter to reduce the number of words of parameters.

A **ReaderBody** is like a substring descriptor. The **offset** and **limit** fields can be changed to describe a subsequence of bytes. Routines such as **Lop** and **ScanForCharacter** take advantage of this substring-like behavior.

```
nullReaderBody: ReaderBody = [
   limit: 0, offset: 0, bytes: NIL, context: vanillaContext];
```

nullReaderBody defines a null value for a reader body. To test for an empty reader body, it should *not* be compared to **nullReaderBody**. The operation **Empty** should be used instead.

57.2.3 Writers and WriterBodies

```
Writer: TYPE = LONG POINTER TO WriterBody;

WriterBody: TYPE = PRIVATE MACHINE DEPENDENT RECORD [
   context(0): Context,
   limit(1): CARDINAL,
   offset(2): CARDINAL,
   bytes(3): Bytes,
   maxLimit(5): CARDINAL,
   endContext(6): Context,
   zone(7): UNCOUNTED ZONE];

Bytes: TYPE = LONG POINTER TO ByteSequence;
```

Writers describe a sequence of bytes that may be changed. Writers are bit-wise compatible with a reader and contain additional information for storage management and appending characters. The **maxLimit** field describes the limits of the allocation unit, the **zone** field is the zone used for allocating and freeing the bytes, and the **endContext** field is an accelerator for operations that append characters.

By including a zone in the writer body, operations that add characters to the writer are able to allocate a larger byte sequence, copy the old bytes, and update the byte pointer in the writer body without invalidating the writer variable that the caller owns.

```
nullWriterBody: WriterBody = [
   limit: 0, offset: 0, bytes: NIL, context: vanillaContext, maxLimit: 0,
   endContext: vanillaContext, zone: NIL];
```

nullWriterBody defines a null value for a writer body.

57.2.4 Simple Reader Operations

ByteLength: PROCEDURE [r: Reader] RETURNS [CARDINAL] = INLINE ...;

ByteLength returns the number of bytes in **r**. If **r** is **NIL**, it returns zero.

CharacterLength: PROCEDURE [r: Reader] RETURNS [CARDINAL];

CharacterLength returns the number of logical characters in **r**. If **r** is **NIL** it returns zero. If **r** is a valid reader, then **ByteLength[r] = 0** iff **CharacterLength[r] = 0**. If **r** contains an invalid encoding, **CharacterLength** will raise the error **InvalidEncoding**.

Dereference: PROCEDURE [r: Reader] RETURNS [rb: ReaderBody];

Dereference returns **nullReaderBody** if **r** is **NIL** and **r↑** otherwise.

Empty: PROCEDURE [r: Reader] RETURNS [BOOLEAN] = INLINE ...;

Empty returns **TRUE** if **r** is **NIL** or **ByteLength[r] = 0**.

ReaderInfo: PROCEDURE [r: Reader] RETURNS [context: Context, startsWith377B: BOOLEAN] ;

ReaderInfo returns the context of the reader and whether the first byte of the reader is 377B, the character set shift code.

57.2.5 Accessing Characters

Because of the large number of characters in the character set standard and the way they are encoded, it is normally not possible to access characters of a reader by indexing. Instead, a number of operations are provided to access characters.

First: PROCEDURE [r: Reader] RETURNS [c: Character];

First returns the first logical character. It is equivalent to **NthCharacter[s, 0]** but is usually more efficient. If **Empty[r]** then **XChar.not** is returned. It may raise the **InvalidEncoding** error.

NthCharacter: PROCEDURE [r: Reader, n: CARDINAL] RETURNS [c: Character];

NthCharacter returns the nth logical character. **First** should be used if **n** = 0. If **CharacterLength[r] <= n** then **XChar.not** is returned. It may raise the **InvalidEncoding** error.

Lop: PROCEDURE [r: Reader] RETURNS [c: Character];

Lop removes the first character from the front of a reader and returns it. If **r** is empty it returns **XChar.not**. If **r** contains one logical character, **Lop** sets **r** to be empty and returns the first logical character. Otherwise, **Lop** modifies **r** to point to the second logical character and returns the first. It may raise the **InvalidEncoding** error.

Map: PROCEDURE [r: Reader, proc: MapCharProc] RETURNS [c: Character];

MapCharProc: TYPE = PROC [c: Character] RETURNS [stop: BOOLEAN];

Map enumerates the reader, calling **proc** once for each character in **r**. If **proc** returns TRUE it returns that character; otherwise it returns **XChar.not**. It is equivalent to:

```
FOR i: CARDINAL IN [0..CharacterLength[r]) DO
   IF proc[c ← NthCharacter[r, i]] THEN RETURN[c]; ENDLOOP
RETURN[XChar.not] ;
```

Map may raise the **InvalidEncoding** error.

57.2.6 Errors

Error: ERROR [code: ErrorCode] ;

ErrorCode: TYPE = {
   invalidOperation, multipleCharSets, tooManyBytes, invalidParameter};

invalidOperation	an invalid operation has been attempted.
multipleCharSets	**InitBreakTable** has been called with a reader that contains multiple character sets.
tooManyBytes	a LONG STRING has been passed to **FromSTRING** or **WriterBodyFromSTRING** and the string contains too many bytes. These operations use the string as the byte pointer so the offset is non-zero, reducing the number of bytes it may hold. This is also raised by **CopyReader** for a similar reason.
invalidParameter	The term **invalidParameter** means an operation has been invoked with an invalid parameter.

InvalidEncoding: ERROR [invalidReader: Reader, firstBadByteOffset: CARDINAL] ;

The error **InvalidEncoding** is raised by operations when they detect a sequence of bytes that is not a valid character encoding. While two character set shifts with no intervening character is an invalid encoding according to the character standard, only **ValidateReader** will raise **InvalidEncoding** if it detects that case. The other operations will ignore the first character set shift. Invalid encodings include ending with a character set shift or partial character set shift and having a non-zero byte following two 377B bytes.

57.2.7 Conversion to Readers

ReaderFromWriter: PROCEDURE [w: Writer] RETURNS [Reader] = INLINE ... ;

ReaderFromWriter provides a conversion from the type **Writer** to the type **Reader**. This operation takes advantage of the fact that the first part of writer bodies are bit-wise compatible with reader bodies, and hence this operation simply loopholes the writer into the reader.

FromBlock: PROCEDURE [
  block: Environment.Block, context: Context ← vanillaContext] RETURNS [ReaderBody];

FromBlock returns a reader body that describes the block.

FromChar: PROCEDURE [char: LONG POINTER TO Character] RETURNS [ReaderBody];

FromChar returns a reader body that describes the character. The pointer to the character must remain valid for the lifetime of the reader body.

FromNSString: PROCEDURE [s: NSString.String, homogeneous: BOOLEAN ← FALSE]
  RETURNS [ReaderBody];

FromNSString returns a reader body that describes the characters in the **NSString**. The context of the reader body will be **[suffixSize: 1, homogeneous: homogeneous, prefix: 0]**.

FromSTRING: PROCEDURE [s: LONG STRING, homogeneous: BOOLEAN ← FALSE]
  RETURNS [ReaderBody];

FromSTRING returns a reader body that describes the characters in the LONG STRING. The context of the reader body will be **[suffixSize: 1, homogeneous: homogeneous, prefix: 0]**. This operation may raise **Error[tooManyBytes]** if the string contains more than CARDINAL.LAST - StringBody.SIZE * Environment.bytesPerWord bytes.

57.2.8 Reader Allocation

CopyReader: PROCEDURE [r: Reader, z: UNCOUNTED ZONE] RETURNS [new: Reader];

CopyReader makes a copy of the reader body and characters of **r**, allocating from **z** as a single allocation unit, the byte sequence for the characters, and the reader body. Note that this operation returns a reader while all other operations in this interface that create a reader or reader body return the reader body. The reason is to avoid a double allocation problem in which the byte sequence and reader body are allocated from two separate nodes. **FreeReaderBytes** can be used to free the new reader and the associated bytes. Note: This operation may raise **Error[tooManyBytes]** if the reader contains more than CARDINAL.LAST - ReaderBody.SIZE * Environment.bytesPerWord bytes. Errors in allocating from the zone are allowed to propagate.

CopyToNewReaderBody: PROCEDURE [r: Reader, z: UNCOUNTED ZONE] RETURNS [ReaderBody];

CopyToNewReaderBody allocates a copy of the bytes of **r** using **z** and returns a reader body describing them. If **r** is NIL it returns **nullReaderBody**. Errors in allocating from the zone are allowed to propagate.

FreeReaderBytes: PROCEDURE [r: Reader, z: UNCOUNTED ZONE];

FreeReaderBytes may be used to free the storage allocated by **CopyReader** and **CopyToNewReaderBody**. If **r** is non-NIL and **z** is non-NIL, it frees **r.bytes** to the zone. When the reader has been obtained from **CopyReader**, **FreeReaderBytes** will free the single allocation unit that contains both the reader body and byte sequence. When the reader has been obtained from **CopyToNewReaderBody**, **FreeReaderBytes** will free the allocation unit that contains the byte sequence but will not free the reader body. Errors in freeing to the zone are allowed to propagate.

57.2.9 Simple Writer Operations

ClearWriter: PROCEDURE [w: Writer];

ClearWriter makes w empty. It is analogous to the LONG STRING statement s.length ← 0.

WriterInfo: PROCEDURE [w: Writer]
RETURNS [unused: CARDINAL, endContext: Context, zone: UNCOUNTED ZONE];

WriterInfo returns the number of allocated but unused bytes of a writer as well as its endContext and its zone.

57.2.10 Conversion to Writers

WriterBodyFromBlock: PROCEDURE [block: Environment.Block, inUse: CARDINAL ← 0]
RETURNS [WriterBody];

WriterBodyFromBlock returns a writer body that describes the block. The writer body's offset and maxLimit fields are set from the block's startIndexandstopIndexPlusOne fields, respectively. The inUse parameter is used to set the limit field of the writer body. If the block's pointer is NIL or inUse is larger than the number of bytes in the block, Error[invalidParameter] is raised.

WriterBodyFromNSString: PROCEDURE [
s: NSString.String, homogeneous: BOOLEAN ← FALSE] RETURNS [WriterBody];

WriterBodyFromNSString returns a writer body that describes the characters in the NSString. Its context is [suffixSize: 1, homogeneous: homogeneous, prefix: 0].

WriterBodyFromSTRING: PROCEDURE [
s: LONG STRING, homogeneous: BOOLEAN ← FALSE] RETURNS [WriterBody];

WriterBodyFromSTRING returns a writer body that describes the characters in the LONG STRING. Its context is [suffixSize: 1, homogeneous: homogeneous, prefix: 0]. This operation may raise Error[tooManyBytes] if the string contains more than CARDINAL.LAST - StringBody.SIZE * Environment.bytesPerWord bytes.

57.2.11 Writer Allocation

NewWriterBody: PROCEDURE [maxLength: CARDINAL, z: UNCOUNTED ZONE]
RETURNS [WriterBody];

NewWriterBody allocates a byte sequence that has room for maxLength bytes using z and returns an empty writer body that contains the bytes. Errors in allocating ByteSequence[maxLength] from the zone are allowed to propagate.

```
CopyToNewWriterBody: PROCEDURE [
   r: Reader, z: UNCOUNTED ZONE, endContext: Context ← unknownContext,
   extra: CARDINAL ← 0] RETURNS [w: WriterBody];
```

CopyToNewWriterBody allocates a byte sequence that has room for **ByteLength[r] + extra** bytes using **z**, copies the bytes of **r** into the newly allocated byte sequence, and returns an writer body that contains the bytes. The end context of the writer body is **endContext**. Errors in allocating from the zone are allowed to propagate.

```
ExpandWriter: PROCEDURE [w: Writer, extra: CARDINAL];
```

ExpandWriter assures that at least **extra** bytes are available in the writer's bytes. If **w.zone** is NIL, then **Error[invalidOperation]** is raised. Errors in allocating a new byte sequence if required are allowed to propagate.

```
FreeWriterBytes: PROCEDURE [w: Writer];
```

FreeWriterBytes may be used to free the byte sequence of a writer as long as it was allocated from the writer's zone. It may be used to free the byte sequence of writers created by **CopyToNewWriterBody** and **NewWriterBody**. If **w** is non-NIL and **w.zone** is non-NIL, it frees **w.bytes** to the zone. Note that it does not free the writer body. Errors in freeing to the writer's zone are allowed to propagate.

57.2.12 Comparison of Readers

```
Equal: PROCEDURE [r1, r2: Reader] RETURNS [BOOLEAN];
```

Equal returns TRUE if and only if the number of logical characters is equal and the strings match when compared character by character, i.e., effectively **CharacterLength[r1] = CharacterLength[r2]** and **NthCharacter[r1, i] = NthCharacter[r2, i]** for i in the range **[0.. CharacterLength[r1])**. It may raise the **InvalidEncoding** error.

```
Equivalent: PROCEDURE [r1, r2: Reader] RETURNS [BOOLEAN];
```

Equivalent returns TRUE if and only if the number of logical characters is equal and the strings match when compared character by character, ignoring case. It is equivalent to:

```
 IF CharacterLength[r1] # CharacterLength[r2] THEN RETURN[FALSE];
 FOR i: CARDINAL IN [0..CharacterLength[r1]) DO
    IF Decase[NthCharacter[r1, i]] # Decase[NthCharacter[r2, i]] THEN RETURN[FALSE];
    ENDLOOP;
 RETURN[TRUE ].
```

Equivalent may raise the **InvalidEncoding** error.

```
SortOrder: TYPE = MACHINE DEPENDENT {
   standard(0), spanish(1), swedish(2), danish(3), firstFree(4), null(377B)};
```

SortOrder is a parameter to **Compare** and **CompareStringsAndStems** that specifies the sort order. **danish**, **spanish**, and **swedish** differ from **standard** only in some characters in character set zero.

```
Compare: PROCEDURE [
  r1, r2: Reader, ignoreCase: BOOLEAN ←TRUE, sortOrder: SortOrder ← standard]
  RETURNS [Relation];

CompareStringsAndStems: PROCEDURE [
  r1, r2: Reader, ignoreCase: BOOLEAN ←TRUE, sortOrder: SortOrder ← standard]
  RETURNS [relation: Relation, equalStems: BOOLEAN];

Relation: TYPE = {less, equal, greater};
```

Compare and **CompareStringsAndStems** compare two readers. They return a relation indicating the sorted relationship of their arguments with the case of characters optionally ignored during the comparison. In **CompareStringsAndStems**, **equalStems** will be TRUE if both readers are equal up to the length of the shorter. They may raise the **InvalidEncoding** error.

57.2.13 Numeric Conversion of Readers

```
ReaderToNumber: PROCEDURE [
  r: Reader, radix: CARDINAL ← 10, unsigned: BOOLEAN ←FALSE] RETURNS [LONG INTEGER];
```

ReaderToNumber converts the characters in the reader to a number. If **radix** is other than 8, 10, or 16, **XString.Error[invalidOperation]** is raised. The syntax for a number is:

{'- | '+} {*baseNumber*} {'b | 'B | 'd | 'D | 'h | 'H} {*scaleFactor*}

where {} indicates an optional part and "|" indicates a choice, and *baseNumber* and *scaleFactor* are sequences of digits. The value returned is ± *baseNumber* * *radix* ** *scaleFactor*. The *radix* depends on the contexts of **r** and **radix**. If **r** contains a 'B or 'b, *radix* is 8; if it contains a 'D or 'd, *radix* is 10, if it contains a 'h or 'H, *radix* is 16; otherwise it is **radix**. The number *scaleFactor* is always expressed in radix 10. If **r** does not have valid form, or **r** does not contain any characters, or *radix* is 8 and non-octal digits are used, or **unsigned** is TRUE and the reader contains a minus sign, the signal **InvalidNumber** is raised. If it is resumed, the operation returns zero. If **unsigned** is TRUE and the number would overflow 2^{32}-1 or **unsigned** is FALSE and the number is not in the range [-2^{31} .. 2^{31}), the signal **Overflow** is raised. If it is resumed, the operation returns zero. **ReaderToNumber** may raise the **InvalidEncoding** error.

```
InvalidNumber: SIGNAL;
```

The signal **InvalidNumber** is raised by the string to number operations when the string is the wrong syntax for a number. Resuming this signal results in the operation returning zero.

```
Overflow: SIGNAL;
```

The signal **Overflow** is raised by the string to number operations when the string describes a number that is too large. Resuming this signal results in the operation returning zero.

57.2.14 Character Scanning

```
ScanForCharacter: PROCEDURE [r: Reader, char: Character, option: BreakCharOption]
  RETURNS [breakChar: Character, front: ReaderBody]
```

```
BreakCharOption: TYPE = {ignore, appendToFront, leaveOnRest};
```

ScanForCharacter scans the string for the first instance of **char**. If **char** is found in **r**, the characters before it will be described by **front** and the characters after it will be described by **r**. **char** will be on the end of **front**, discarded, or left on the front of **r↑** if **option** is **appendToFront**, **ignore**, or **leaveOnRest**, respectively. **char** will be returned as **breakChar**. If it does not encounter **char** in **r**, then **front** will be equal to **r↑** as it was when the procedure was invoked and **r↑** will be updated to be 0 characters long. **XChar.not** will be returned as **breakChar**. **ScanForCharacter** may raise the **InvalidEncoding** error.

```
Scan: PROCEDURE [r: Reader, break: BreakTable, option: BreakCharOption]
  RETURNS [breakChar: Character, front: ReaderBody];
```

```
BreakTable: TYPE = LONG POINTER TO BreakTableObject;
```

```
BreakTableObject: TYPE = RECORD
  otherSets: StopOrNot ← stop,
  set:Environment.Byte ← 0,
  codes: PACKED ARRAY [0..256) OF StopOrNot ← ALL[not]];
```

```
StopOrNot: TYPE = {stop, not} ← not;
```

Scan is like **ScanForCharacter** except that it can scan for any number of character codes in a particular character set. The **BreakTable** defines which character codes of a character set are scanned for. Scanning is searching for the first character, **c**, such that

```
(XChar.Set[c] = break.set AND break.codes[XChar.Code[c]] = stop) OR
(XChar.Set[c] # break.set AND break.otherSets = stop).
```

The disposition of the character that terminates scanning depends on **option** as in **ScanForCharacter**. If the character terminated scanning because it was in a different character set, **XChar.not** will be returned as **breakChar**. **Scan** may raise the **InvalidEncoding** error.

```
InitBreakTable: PROCEDURE [
  r: Reader, stopOrNot: StopOrNot, otherSets: StopOrNot]
  RETURNS [break: BreakTableObject];
```

InitBreakTable initializes a **BreakTableObject** to stop (or not stop) on the characters of **r** depending on **stopOrNot**. If **r** has multiple character sets, **Error[multipleCharSets]** is raised. **InitBreakTable** may raise the **InvalidEncoding** error.

57.2.15 Other Reader Operations

```
ComputeEndContext: PROCEDURE [r: Reader] RETURNS [c: Context];
```

ComputeEndContext returns the context of the last character in **r**. If **CharacterLength[r] = 0** then **emptyContext** is returned. **ComputeEndContext** may raise the **InvalidEncoding** error.

DescribeReader: Courier.Description;

DescribeReader is a Courier description routine. It is provided for clients that need to serialize and deserialize readers.

DescribeReaderBody: Courier.Description;

DescribeReaderBody is a Courier description routine. It is provided for clients that need to serialize and deserialize readers bodies.

Run: PROCEDURE [r: Reader] RETURNS [run: ReaderBody];

Run is like **Lop** except that it deals in homogeneous runs of characters instead of single characters. It will return a reader body describing the first homogeneous run of **r** and update **r** to remove the run. If **Empty[r]** it returns **nullReaderBody**. It may raise the **InvalidEncoding** error.

ValidateReader: PROCEDURE [r: Reader];

ValidateReader checks the bytes of **r** to ensure that it is a valid encoding. If it is not a valid encoding, the error **InvalidEncoding** is raised. Possible invalid encodings include ending in a character set shift with no character or following two successive 377B bytes by a non-zero byte. null run, two character set shifts with no intervening character, is an invalid encoding that is checked by **ValidateReader**. If the offset is greater than the limit or the byte pointer is **NIL** and the offset and limit are not equal, then **Error[invalidParameter]** is raised.

57.2.16 Appending to Writers

The operations in this section append to writers. When there is insufficient space in the writer to hold the bytes to be appended, the operations attempt to allocate from the writer's zone a new byte sequence of sufficient size. If there is insufficient space and the writer's zone is **NIL**, the signal **InsufficientRoom** is raised. If it is resumed, the operations will append as many characters as will fit. Errors resulting from allocating from the zone are allowed to propagate. An expanded set of appending operations are available using the **XFormat** interface.

```
AppendReader: PROCEDURE [
  to: Writer, from: Reader, fromEndContext: Context ← unknownContext,
  extra: CARDINAL ← 0];
```

AppendReader appends the reader to the writer. If either the reader or writer is **NIL**, this operation simply returns. The end context of the writer is updated to **fromEndContext** if it is not **unknownContext** and **ComputeEndContext[r]** otherwise. The signal **InsufficientRoom** may be raised as described above.

AppendChar: PROCEDURE [to: Writer, c: Character, extra: CARDINAL ← 0];

AppendChar appends the character to the writer. If the writer is NIL, this operation simply returns. The signal **InsufficientRoom** may be raised as described above. If it is resumed, nothing is appended.

```
AppendStream: PROCEDURE [
   to: Writer, from: Stream.Handle, nBytes: CARDINAL,
   fromContext: Context ← unknownContext, extra: CARDINAL ← 0]
   RETURNS [bytesTransferred: CARDINAL];
```

AppendStream appends **nBytes** from the stream **from** to the writer. If either the stream or writer is NIL, this operation simply returns. The end context of the writer is updated to **fromEndContext** if it is not **unknownContext** and **ComputeEndContext[r]** otherwise. The signal **InsufficientRoom** may be raised as described above. If it is resumed, as much of the reader as will fit in the space available is appended. **AppendStream** returns the actual number of bytes transferred.

Note: There is currently a bug in the interface such that the **fromContext** parameter is defaulted to **vanillaContext** instead of **unknownContext**.

```
AppendSTRING: PROCEDURE [
   to: Writer, from: LONG STRING, homogeneous: BOOLEAN ← FALSE, extra: CARDINAL ← 0];
```

AppendSTRING appends the string to the writer. If either the string or writer is NIL, this operation simply returns. The end context of the writer is updated to **vanillaContext** if **homogeneous** is TRUE, otherwise its value is computed from the parameter **from**. The signal **InsufficientRoom** may be raised as described above.

```
InsufficientRoom: SIGNAL [needsMoreRoom: Writer, amountNeeded: CARDINAL];
```

The signal **InsufficientRoom** is raised by the append operations when the writer does not have enough room to contain the appendee and the writer's zone is NIL. Resuming this signal will result in as much as possible being appended.

```
AppendExtensionIfNeeded: PROCEDURE [to: Writer, extension: Reader]
   RETURNS [didAppend: BOOLEAN];
```

AppendExtensionIfNeeded checks to see if there is a period somewhere in the writer other than the last character. If there is, FALSE is returned If not, it appends a period if the writer does not already end in one, then appends **extension** and returns TRUE. **AppendChar** and **AppendReader** are used to append and they may raise **InsufficientRoom**.

57.2.17 Editing Writers

```
Piece: PROCEDURE [r: Reader, firstChar, nChars: CARDINAL]
   RETURNS [piece: ReaderBody, endContext: Context];
```

Piece returns a reader body that describes the **firstChar** through **firstChar + nChars** logical characters of **r**. **piece** will describe as many characters of **r** that are in that range, possibly none if **CharacterLength[r]** is less than or equal to **firstChar**. The context of the last character of **piece** is also returned. It may raise the **InvalidEncoding** error.

```
ReplacePiece: PROCEDURE [
  w: Writer, firstChar, nChars: CARDINAL, r: Reader,
  endContext: Context ← unknownContext];
```

ReplacePiece is an editing operation for writers. It replaces **nChars** of **w** starting at **firstChar** with the characters of **r**. **nChars** may be zero and **r** may be empty. If the reader is not empty, **endContext** is needed to update the end context of the writer if the piece replacement is at the end, or to determine if there needs to be a character set shift between the bytes of **r** and the (**firstChar + nChar**)th character of **w**. If **endContext** is **unknownContext** it will be computed from r. The signal **InsufficientRoom** may be raised as described above if the operation resulted in a net addition of bytes. **ReplacePiece** may raise the **InvalidEncoding** error.

57.2.18 Conversion from Readers

```
Block: PROCEDURE [r: Reader] RETURNS [block: Environment.Block, context: Context] ;
```

Block returns both a block that describes the bytes in **r** as well as the context of **r**. This operation may be used by clients that need to examine the bytes directly. **Note:** The bytes of the block should not be written.

```
NSStringFromReader: PROCEDURE [r: Reader, z: UNCOUNTED ZONE]
  RETURNS [ns: NSString.String] ;
```

NSStringFromReader creates an **NSString.String** from a reader. It always copies the bytes of the reader into a new allocation unit allocated from the zone. The resulting string should be deallocated using operations from the **NSString** interface. Errors from allocating from the zone are allowed to propagate.

57.2.19 Reverse Character Operations

```
ReverseMap: PROCEDURE [r: Reader, proc: MapCharProc] RETURNS [c: Character];
```

ReverseMap is similar to **Map**, except it enumerates the characters in reverse order. It is less efficient than **Map** because encoding characters makes backward scanning difficult. It may raise the **InvalidEncoding** error.

```
ReverseLop: PROCEDURE [
  r: Reader, endContext: LONG POINTER TO Context,
  backScan: BackScanClosure ← [NIL, NIL]]
  RETURNS [c: Character];

BackScanClosure: TYPE = RECORD [proc: BackScanProc, env: LONG POINTER];

BackScanProc: TYPE = PROCEDURE [beforePos: CARDINAL, env: LONG POINTER]
  RETURNS [pos: CARDINAL, context: Context];
```

ReverseLop is similar to **Lop**, except it takes characters off the end of the reader. It is less efficient than **Lop** because encoding characters makes backward scanning difficult. If the reader is empty, it returns **XChar.not**. If **endContext↑** is not **unknownContext**, then it must be correct. It may be changed by a call to **ReverseLop**. If **ReverseLop** backs up over a character set shift, it will set **endContext↑** to **unknownContext**. It may raise the **InvalidEncoding** error.

The **BackScanClosure** and **BackScanProc** provide a way for the client to inform **ReverseLop** of the context in effect before a character set shift. If **endContext↑** is **unknownContext**, then **backScan.proc** is called with a byte offset before which it desires a context and **backScan.env**. It should return a context for some position before the passed one, as well as the actual position corresponding to that context. Simple clients of **ReverseLop** need not provide a **BackScanClosure**. It is provided for clients that have information about location of character set changes within the reader.

57.3 Usage/Examples

57.3.1 Designing Interfaces with Readers

Designing interfaces to use readers is more complicated than LONG STRINGs. The biggest complication is the two-level allocation scheme involving readers → reader bodies → bytes. In most cases, the bytes are relatively static and are relatively easy to deal with. The main problem is determining whether to use a reader or a reader body. It helps to keep in mind the following guideline: *keep reader bodies to describe the bytes.* Save a pointer to a string by putting the reader body, not the reader, in the data structure. This way, one doesn't have to worry about who owns the storage for the reader body. Consider the following interface fragment:

```
Handle: TYPE = LONG POINTER TO Object;

Object: TYPE = RECORD [
  next: Handle,
  count: CARDINAL,
  name: XString.ReaderBody];

AddAnother: PROCEDURE [name: XString.Reader];
```

Instead of storing the name in the object as a reader, it is stored as a reader body. A reader is quickly generated when needed by the expression **@h.name**.

Another guideline is for a procedure to *take a reader and return a reader body.* The idea is that passing readers as parameters reduces the number of words of parameters. Returning reader bodies allows the client to manage the storage for the reader body.

A third guideline is that *clients should be able to pass pointers to local reader bodies.* If an implementation kept strings passed to it by saving readers, clients would have to allocate the reader body from permanent storage, not from the local frame. If implementations keep reader bodies instead of readers, passing **@localReaderBody** will not result in dangling pointers. For example, consider the following fictional procedure that renames a file:

```
RenameFile: PROCEDURE [oldName:XString.Reader] = {
  rb: XString.ReaderBody;
  rb ← SomeInterface.GetNewName[];
file ← SomeInterface.LookupByName[oldName];
SomeInterface.Rename[file: file, newName: @rb]};
```

The procedure **RenameFile** takes a reader that it simply passes to another operation. While taking a reader body is equilvalent, it is more efficient to take a reader, particularily when strings are just being passed around. The operation **GetNewName** returns a reader body. If it returned a reader, it would have to define where the storage for the reader body was kept. Either it would have to be global, or it would have to be deallocated from a known place after **RenameFile** was done with it. It is just simplier to return reader bodies than to deal with the allocation problems of reader bodies. It is hard enough to make sure ownership of the bytes is handled correctly. The new name to the **Rename** operation is a pointer to a local reader body. **Rename** should copy the reader body (and the bytes) if it intends to save the characters.

Warning: Designing interfaces that do not allow passing pointers to local reader bodies should be avoided.

57.3.2 Using Readers

One of the simple things to do with strings is to pass string literals. Because there is no compiler support for **XString**, it is harder to do. The code fragment below gives an example of how to pass string literals:

```
GetUserCmFile: PROCEDURE RETURNS [file: SomeInterface.FileHandle] = {
  rb: XString.ReaderBody ← XString.FromSTRING["User.cm"L];
  file ← SomeInterface.LookupByName[name: @rb]};
```

Looking at all the characters in a string for something like switch processing is another common operation:

```
Options: TYPE = RECORD [debug, verify, start: BOOLEAN ← FALSE];

ParseSwitches1: PROCEDURE [r: XString.Reader] RETURNS [options: Options] = {
  rb: XString.ReaderBody ← XString.Dereference[r];
  c: XString.Character;
  sense: BOOLEAN ← TRUE;
  WHILE (c ← XString.Lop[@rb]) # XChar.not DO
    SELECT c FROM
      'd.ORD => {options.debug ← sense; sense ← TRUE};
      'v.ORD => {options.verify ← sense; sense ← TRUE};
      's.ORD => {options.start ← sense; sense ← TRUE};
      '-.ORD => sense ← FALSE;
      ENDCASE => sense ← TRUE;
    ENDLOOP;
  RETURN};
```

ParseSwitches1 uses **Lop** to look at each character of **r** and set the appropriate option. Because **Lop** changes the reader body to remove the first character, **ParseSwitches1** uses **Dereference** to copy the reader body to a local variable.

The operations **Lop**, **Run**, **ScanForCharacter**, and **Scan** all update the reader body of their reader parameter. If the reader body must not be altered, it should be copied as in the above example.

```
ParseSwitches2: PROCEDURE [r: XString.Reader] RETURNS [options: Options] = {
  sense: BOOLEAN ← TRUE;
  proc: XString.MapCharProc = {
    SELECT c FROM
      'd.ORD => {options.debug ← sense; sense ← TRUE};
      'v.ORD => {options.verify ← sense; sense ← TRUE};
      's.ORD => {options.start ← sense; sense ← TRUE};
      '-.ORD => sense ← FALSE;
      ENDCASE => sense ← TRUE;
    RETURN[stop: FALSE]};
  [] ←XString.Map[r: r, proc: proc];
  RETURN};
```

ParseSwitches2 uses **Map** to look at each character of **r** and set the appropriate option.

57.3.3 Simple Parser Example

Below is a simple program that accepts a sequence of characters from a procedure and parses them into tokens. It collects characters one a a time and appends them to the writer **buffer**. If the string of characters is empty, it returns a keyword token of *invalid*. If the first character is a digit, it returns a number token, converting the string into the number. Otherwise it compares the string with the four keywords. If it is not a keyword, it copies the string from the buffer to a new reader and returns the id token.

```
-- Example.mesa

DIRECTORY
  XString USING [
    AppendChar, Character, ClearWriter, Empty, Equal, First, InvalidNumber,
    NewWriterBody, OverFlow, Reader, ReaderBody, ReaderFromWriter,
    ReaderToNumber, WriterBody];

Example: PROGRAM IMPORTS XString = {
  OPEN XString;

TokenClass: TYPE = {keyword, id, number};
Keyword: TYPE = {begin, end, do, endloop, eof, invalid};
Token: TYPE = RECORD [
  SELECT class: TokenClass FROM
    keyword => [keyword: Keyword],
    id => [id: ReaderBody],
    number => [number: LONG INTEGER],
    ENDCASE];

Input: TYPE = PROCEDURE RETURNS [Character];

eof, space: Character = ... ;
keywords: LONG DESCRIPTOR FOR ARRAY Keyword[begin..endloop] OF ReaderBody = ... ;
```

```
zone: UNCOUNTED ZONE ← ... ;
buffer: WriterBody ← NewWriterBody[maxLength: 40, z: zone] ;

Parse: PROCEDURE [input: Input] RETURNS [token: Token] = {
  r: Reader ← ReaderFromWriter[@buffer];
  c: Character;
  ClearWriter[buffer];
  DO
    SELECT (c ← input[]) FROM
      space = > EXIT;
      eof = > RETURN[[keyword[IF Empty[r] THEN invalid ELSE eof]]];
      ENDCASE = > AppendChar[@buffer, c];
    ENDLOOP;
  IF Empty[r] THEN RETURN[[keyword[invalid]];
  IF First[r] IN ['0.ORD..'9.ORD] THEN {
    token ← [number[ReaderToNumber[r, 10 !
      InvalidNumber, Overflow = > {token ← [keyword[invalid]]; CONTINUE}]]];
    RETURN};
  SELECT TRUE FROM
    Equal[r, @keywords[begin]] = > token ← [keyword[begin]];
    Equal[r, @keywords[end]] = > token ← [keyword[end]];
    Equal[r, @keywords[do]] = > token ← [keyword[do]];
    Equal[r, @keywords[endloop]] = > token ← [keyword[endloop]];
    ENDCASE = >
      token ← [id[CopyToNewReaderBody[r: r, z: zone]]];
    RETURN};

}...
```

57.4 Index of Interface Items

58

XTime

58.1 Overview

The **XTime** interface provides functions to acquire and edit times into strings or strings into times. It provides the same function as the XDE **Time** interface but deals with **XString.Readers** instead of **LONG STRINGs**.

58.2 Interface Items

58.2.1 Acquiring Time

Current: PROCEDURE RETURNS [time: System.GreenwichMeanTime];

Current returns the current time.

```
ParseReader: PROCEDURE [
  r: XString.Reader, treatNumbersAs: TreatNumbersAs ← dayMonthYear]
  RETURNS [time:System.GreenwichMeanTime, notes: Notes, length: CARDINAL];

ParseWithTemplate: PROCEDURE [r, template: XString.Reader]
  RETURNS [time: System.GreenwichMeanTime, notes: Notes, length: CARDINAL];

TreatNumbersAs: TYPE = {dayMonthYear, monthDayYear, yearMonthDay,
  yearDayMonth, dayYearMonth, monthYearDay};
```

The **ParseReader** procedure parses the reader, **r**, and returns a GMT **time** according to the Pilot standard. **treatNumbersAs** indicates how to interpret **r**. **ParseWithTemplate** parses **r** according to **template**. **template** serves as an interpreter for deriving time fields from **r**, see § 58.3. The date syntax is a somewhat less restrictive version of RFC733; full RFC733 is recognized, plus forms like "month day, year", "mm/dd/yy", and variations with Roman numerals used for the month. The form "year month day" is also accepted if the year is a full four-digit quantity. Forms with "-" instead of significant space are also acceptable, as well as forms in which a delimiter (space or "-") can be elided without confusion. The time is generally assumed to be in RFC733 format, optionally including a time zone specification. In addition, am or pm may optionally appear following the time (but preceding the time zone, if any). **notes** is interpreted as described below. **length** indicates the number of characters consumed by the parser; that is, it is the index of the first character of the argument that was not examined by the parser. This procedure can raise the error **Unintelligible**.

Notes: TYPE = {normal, noZone, zoneGuessed, noTime, timeAndZoneGuessed};

Notes is used as one of the return values from the call on **ParseReader**. **normal** means the value returned is unambiguous; **noZone** means that a time-of-day was present, but without a time zone indication. (The local time zone as provided by **System.LocalTimeParameters** is assumed.) **zoneGuessed** is returned instead of **noZone** if local time parameters are not available, and the time zone is assumed to be Pacific Time (standard or daylight time is determined by the date). **noTime** and **timeAndZoneGuessed** are equivalent to **noZone** and **zoneGuessed** respectively, where the time is assumed to be 00:00:00 (local midnight).

Unintelligible: ERROR [vicinity: CARDINAL];

If **ParseReader** cannot reasonably interpret its input as a date, **Unintelligible** is raised; **vicinity** gives the approximate index in the input string where the parser gave up.

58.2.2 Editing Time

```
Append: PROCEDURE [
  w: XString.Writer, time: System.GreenwichMeanTime ← defaultTime,
  template: XString.Reader ← dateAndTime, ltp: LTP ← useSystem];
```

Append appends the **time** in human-readable form to **w**. **template** determines which fields are appended. **ltp** is used to provide the local time parameters (discussed below).

```
Format: PROCEDURE [
  xfh: XFormat.Handle ← NIL, time: System.GreenwichMeanTime ← defaultTime,
  template: XString.Reader ← dateAndTime, ltp: LTP ← useSystem];
```

Format converts **time** to a string by calling **XTime.Append** using **template** to specify which template to use. **xfh.proc** is then called. If **time** is defaulted, the current time is used.

```
Pack: PROCEDURE [unpacked: Unpacked, useSystemLTP: BOOLEAN ← TRUE]
  RETURNS [time: System.GreenwichMeanTime];
```

Pack converts **unpacked** into the Pilot-standard **System.GreenwichMeanTime**. **useSystemLTP** indicates that **Pack** should use the system's parameters. If the local time parameters are not available to Pilot, **System.LocalTimeParametersUnknown** is raised. If **unpacked** is invalid, **Invalid** is raised.

Packed: TYPE = System.GreenwichMeanTime;

Packed is retained for compatability.

```
Unpack: PROCEDURE [
  time: System.GreenwichMeanTime ← defaultTime, ltp: LTP ← useSystem]
  RETURNS [unpacked: Unpacked];
```

Unpack converts **time** into its unpacked representation. If **time** is defaulted, the current time is used. **ltp** provides local time parameters. If the local time parameters are not available to Pilot, **System.LocalTimeParametersUnknown** is raised. If **time** is invalid, **Invalid** is raised.

```
Unpacked: TYPE = RECORD[
  year: [0..2104], month: [0..12), day: [0..31],
  hour: [0..24), minute: [0..60), second: [0..60),
  weekday: [0..6], dst: BOOLEAN, zone: System.LocalTimeParameters];
```

Unpacked values record dates by their pieces. The fields are filled by **Unpack**, described above, which operates on the time and date as kept internally by Pilot. **year** = 0 corresponds to 1968. For **month**, January is numbered 0, 1, etc. Days of the month have their natural assignments. For **weekday**, Monday is numbered 0. **dst** indicates Daylight Standard Time. **zone** indicates time zones.

```
LTP: TYPE = RECORD[
  r: SELECT t: * FROM
    useSystem = > [],
    useThese = > [lpt: System.LocalTimeParameters]]
  ENDCASE];
```

LTP is used to pass local time parameters to several procedures. Usually they are defaulted to the system's parameters.

```
Invalid: ERROR;
```

58.2.3 Useful Constants and Variables

```
dateAndTime: XString.Reader;
dateOnly: XString.Reader;
timeOnly: XString.Reader;
```

These variables are templates that are supplied by **XComSoftMessage** for use in the **Append** operation.

```
defaultTime: System.GreenwichMeanTime = System.gmtEpoch;
```

defaultTime always means the current time.

```
useSystem: useSystem LTP = [useSystem[]];
useGMT: useThese LTP = [useThese[[west, 0, 0, 0, 0]]];
```

These local time parameters are exported for client convenience.

58.3 Usage/Examples

58.3.1 ParseReader Template Definitions

The template for times is a reader with fields, using the standard definiton of naming fields, that is, a number enclosed by angle brackets. The definition of the fields for times are:

<1>	Month as a number*
<2>	Day as a number*
<3>	Year as a four-digit number
<4>	Year as a two-digit number
<5>	Month name.
<6>	Month name with a maximum of three characters
<7>	Hour as digits in range [0..12)*
<8>	Hour as digits in range [0..24)*
<9>	Minutes, always two digits, zerofilled (e.g., 23, 04)
<10>	Seconds, always two digits, zerofilled (e.g., 23, 04)
<11>	Day of week
<12>	Time zone
<13>	AM or PM

* If the number begins with a 0, the number is zerofilled to two digits.

Examples

<2>-<6>-<4> <7>:<9>	18-Nov-83 8:36
<2> <5> <3>	18 November 1983
<2>-<6>-<4> <7>:<9>:<10> <12> (<11>)	18-Nov-83 08:36:42 PST (Friday)
<7>:<9> <13>	8:36 AM
<08><9> hrs	0836 hrs

58.3.2 Example

```
-- Data structure to record time in both Packed and Unpacked form.
Data: TYPE = RECORD [
   startTime: XString.ReaderBody ← XString.nullReaderBody,
   endTime: XString.ReaderBody ← XString.nullReaderBody,
   pStartTime: XTime.Packed ← System.gmtEpoch,
   pEndTime: XTime.Packed ← System.gmtEpoch];

-- Retrieves, unpacks, stores, and displays the time.
GetAndDisplayTime: PROC[packTime: XTime.Packed] = {
   time: XTime.Unpacked ← XTime.Unpack[packTime];
   TimeDisplay [time.year, time.month, time.day];
   };
```

```
ParseTimes: PROC[data: Data] = {
   data.pStartTime ← XTime.ParseReader[@data.startTime !
      XTime.Unintelligible = > Error[BadStartTime, vicinity]].time;
   data.pEndTime ← XTime.ParseReader[@data.endTime !
      XTime.Unintelligible = > Error[BadEndTime, vicinity]].time;
   };

-- Parses time into an XString.ReaderBody
PackedToString: PROC[time: System.GreenwichMeanTime]
   RETURNS [rb:XString.ReaderBody ← XString.nullReaderBody] = {
   template: XString.ReaderBody ← XString.FromSTRING[
      "<2>-<6>-<4> <8>:<9>"L];
   wb: XString.WriterBody ← XString.NewWriterBody[24, zone];
   XTime.Append[ @wb, time, @template ];
   rb ← XString.CopyToNewReaderBody[XString.ReaderFromWriter[@wb], zone];
   XString.FreeWriterBytes[@wb];
   };
```

58.4 Index of Interface Items

59

XToken

59.1 Overview

The **XToken** interface provides general scanning and simple parsing facilities for collecting tokens from a character input stream.

The basic data structure is the **Object**, which encapsulates the source of characters to be parsed. It contains a procedure that returns the next character in the input stream and the final character that is read from the input stream.

The basic operations collect characters from the input stream into tokens. Clients can define arbitrary token classes by using filters. Clients can define their own filters or use one of the standard filters provided by **XToken**. Frequently, some portion of the input stream, such as blanks, are only delimiters and are usually skipped when collecting a token. The type **SkipMode** defines the options for skipping characters. Quoted tokens are a feature provided by **XToken**. By using procedures to define opening- and closing-quote characters, **XToken** allows the client to define a large number of quoting schemes. Several common quote procedures are supplied.

XToken provides operations that collect standard tokens such as boolean and numeric values. It also provides built-in handles that understand **XString.Readers** and **Stream.Handles** as sources of characters.

Operations that return a reader body allocate their storage from the implementation's own heap. Clients should call **FreeTokenString** to release this storage.

59.2 Interface Items

59.2.1 Character Source Definitions

```
Handle: TYPE = LONG POINTER TO Object;

Object: TYPE = MACHINE DEPENDENT RECORD [
  getChar(0):GetCharProcType, break(1): XChar.Character ← 0];

GetCharProcType: TYPE = PROCEDURE [h: Handle] RETURNS [c: XChar.Character];
```

The **Object** encapsulates the source of characters to be parsed. The **XToken** package uses the **getChar** field to obtain the stream of characters. It assumes that the source has been exhausted when **getChar** returns XChar.null or XChar.not. **XToken** uses the **break** field to record the final character that it reads. It records the final character because there is no way to put back a character into the character source. It must read one character beyond the token it is parsing to ensure that it has reached the end of the input. If it simply returned the token, this character would be lost. Since the **XToken** package stores the last character in the **Object**, that character is available to the client. The client can ignore it, inspect it to decide what to parse next, or put it back into the character source.

A **GetCharProcType** provides a stream of characters to be parsed. It should return either XChar.null or XChar.not when the stream of characters has been exhausted. The **Handle** is passed into the **GetCharProcType** so that a client can hide instance data in his object. Although there is not an instance data field in **Object**, the client could LOOPHOLE a pointer to a larger record that contained its data.

59.2.2 Filter Definitions

```
FilterProcType: TYPE = PROCEDURE [
  c: XChar.Character, data: FilterState] RETURNS [inClass: BOOLEAN];

FilterState: TYPE = LONG POINTER TO StandardFilterState;

StandardFilterState: TYPE = ARRAY [0..2) OF UNSPECIFIED;
```

A **FilterProcType** is the mechanism by which a client defines classes of characters. Procedures that use filters will call them once for each candidate character. The filter should return TRUE if the character is in the class and FALSE otherwise. The **FilterState** permits the filter to maintain the state of the parse. Operations that require a **FilterProcType** and **FilterState**, will initialize the **StandardFilterState** to ALL[0]. If the filter requires filter state but **data** is NIL, the signal **NilData** should be raised.

Some clients' filters may need more than two words of state for their filter. In that case they should define a record that first contains a **StandardFilterState**, then define the additional space they need, and then loophole the filter state to a pointer to the record they defined.

59.2.3 Skip Mode Definitions

```
SkipMode: TYPE = {none, whiteSpace, nonToken};
```

SkipMode controls what characters an operation will skip before collecting a token.

none	The term **none** means no characters should be skipped, and the token should start with the next character.
whiteSpace	The term **whiteSpace** means characters (space, carriage return, and tab) should be skipped before collecting the token.
nonToken	The term **non Token** means any characters that are not legal token characters should be skipped before collecting the token.

59.2.4 Quoted Token Definitions

QuoteProcType: TYPE = PROCEDURE [
  c: XChar.Character] RETURNS [closing: XChar.Character];

nonQuote: XChar.Character = . . . ;

QuoteProcType defines the procedure used by **MaybeQuoted** to recognize quoted tokens. If **c** is a quote character, it should return the corresponding closing-quote character. If **c** is not a quote character, it should return **nonQuote**.

59.2.5 Built-in Handles

ReaderToHandle: PROCEDURE [r: XString.Reader]
  RETURNS [h: Handle];

ReaderToHandle creates a **Handle** whose source of characters are the characters in **r**. The bytes of **r** are not copied, so clients are responsible for synchronizing access to the reader with the **XToken** package.

FreeReaderHandle: PROCEDURE [h: Handle] RETURNS [nil: Handle];

FreeReaderHandle destroys a **Handle** created by **ReaderToHandle**. It does not destroy the underlying reader. It returns NIL.

StreamToHandle: PROCEDURE [s: Stream.Handle] RETURNS [h: Handle];

StreamToHandle creates a **Handle** whose source of characters is a stream. The stream should signify the end of characters by raising the signal **Stream.EndOfStream**.

FreeStreamHandle: PROCEDURE [h: Handle] RETURNS [s: Stream.Handle];

FreeStreamHandle destroys a **Handle** created by **StreamToHandle**. It returns the underlying stream.

59.2.6 Boolean and Numeric Tokens

Boolean: PROCEDURE [h: Handle, signalOnError: BOOLEAN ← TRUE] RETURNS [true: BOOLEAN];

Boolean parses the next characters of the source as a boolean constant. Valid Boolean values are "TRUE" or "FALSE," but unlike the Mesa language, case does not matter ("true" and "false" are also acceptable). In case of a syntax error, the signal **SyntaxError** is optionally raised. If **signalOnError** is FALSE, or **SyntaxError** is resumed, then FALSE is returned for a syntax error. This procedure skips leading white space.

Number: PROCEDURE [h: Handle, radix: CARDINAL, signalOnError: BOOLEAN ← TRUE]
  RETURNS [u: LONG UNSPECIFIED];

Number parses the next characters of the source as a number in radix **radix**. Numbers have the format specified in **XString.ReaderToNumber**. In case of a syntax error, the signal

SyntaxError is optionally raised. If **signalOnError** is FALSE, or **SyntaxError** is resumed, zero is returned for a syntax error. This procedure skips leading white space.

```
Decimal: PROCEDURE [
  h: Handle, signalOnError: BOOLEAN ← TRUE] RETURNS [i: LONG INTEGER];
```

Decimal is just like **Number**, but with a **radix** of 10.

```
Octal: PROCEDURE [
  h: Handle, signalOnError: BOOLEAN ← TRUE] RETURNS [c: LONG CARDINAL];
```

Octal is just like **Number**, but with a **radix** of 8.

59.2.7 Basic Token Routines

```
Filtered: PROCEDURE [
  h: Handle, data: FilterState, filter: FilterProcType, skip: SkipMode ← whiteSpace,
  temporary: BOOLEAN ← TRUE]
  RETURNS [value: XString.ReaderBody];
```

Filtered collects the token string defined by the client's filter. If the client-instance data parameter **data** is not NIL, the first two words of **data** are set to zero before any calls are made to **filter**. **filter** is called with **data** once on each character until it returns FALSE. The string returned, which may be **XString.nullReaderBody**, must be freed by calling **FreeTokenString**. Leading characters are skipped according to the value of **skip**. If **temporary** is TRUE, it is assumed that the string will be freed shortly, and no effort is made to use the minimum storage for it. If **temporary** is FALSE, the minimum amount of storage is used. **filter** may raise **NilData**.

```
FreeTokenString: PROCEDURE [s: XString.Reader] RETURNS [nil: XString.Reader ← NIL];
```

FreeTokenString frees bytes of the reader. It is used to free the strings allocated by **Filtered**, **Item**, and **MaybeQuoted**. It returns NIL.

```
Item: PROCEDURE [
  h: Handle, temporary: BOOLEAN ← TRUE] RETURNS [value: XString.ReaderBody];
```

Item returns the next token delimited by white space. Leading white space is skipped and the characters are collected until another white-space character is encountered. The string returned must be freed by calling **FreeTokenString**. If **temporary** is TRUE, it is assumed that the string will be freed shortly, and no effort is made to use the minimum storage for it. If **temporary** is FALSE, only as much storage is used for the string as is needed.

```
MaybeQuoted: PROCEDURE [
  h: Handle, data: FilterState, filter: FilterProcType ← NonWhiteSpace,
  isQuote: QuoteprocType ← Quote, skip: SkipMode ← whiteSpace,
  temporary: BOOLEAN ← TRUE]
  RETURNS [value: XString.ReaderBody];
```

MaybeQuoted returns the next quoted token. The first candidate character is passed to **isQuote**, which either returns **nonQuote** or the closing-quote character. If a closing-quote character other than **nonQuote** is returned, characters are collected in the token until the closing quote is encountered. If the input is exhausted before the closing quote is encountered, the signal **UnterminatedQuote** will be raised. If it is resumed, **MaybeQuoted** returns the token collected up until that point. The closing-quote character may be included in the token by including two instances of the character in the input; that is, if **MaybeQuoted** encounters two closing-quote characters in a row, it will insert one closing-quote character in the token rather than terminating the token on the first closing quote. The outer quote characters are not part of the token and are discarded. If **nonQuote** is returned from the **isQuote** procedure, the filter is used to collect characters the same way it is used in **Filtered**: **filter** is called with client-instance data parameter **data** once on each character until it returns FALSE. In either case (quoted or filtered), the break character returned in the **Handle** is the character following the token.

Leading characters are skipped according to the value of **skip**.

If **temporary** is TRUE, it is assumed that the string will be freed shortly and no effort is made to use the minimum storage for it. If **temporary** is FALSE, only as much storage is used for the string as is needed. The string returned must be freed by calling **FreeTokenString**.

```
Skip: PROCEDURE [
  h: Handle, data: FilterState, filter: FilterProcType, skipInClass: BOOLEAN ← TRUE];
```

Skip is used to skip over characters. A filter is provided to define the class of characters, and the boolean **skipInClass** indicates whether the characters to be skipped are those accepted by the filter or those rejected by it. If the client-instance data parameter **data** is not NIL, the first two words of **data** are set to zero before any calls are made to **filter**. If **data** is NIL and **filter** references data, the signal **NilData** should be raised.

59.2.8 Signals and Errors

```
SyntaxError: SIGNAL [r: XString.Reader];
```

The resumable SIGNAL **SyntaxError** can be raised if incorrect syntax is encountered by **Boolean, Decimal, Number**, or **Octal**. In each case, resuming the signal causes the procedure to return a default value (described in the discussion of the various procedures). The reader parameter is the token collected that has the wrong syntax.

```
NilData: SIGNAL;
```

Procedures that take a **FilterProcType** argument also take an argument that is a pointer to client instance data. If the client has no need for instance data, it can pass a NIL as the instance data pointer. If a **FilterProcType** attempts to access the client-instance data, but the client passed in NIL instead of a pointer to instance data, the signal **NilData** should be raised. Implementors of **FilterProcTypes** are strongly encouraged to check for NIL and raise this condition if they use client-instance data.

```
UnterminatedQuote:SIGNAL;
```

The resumable SIGNAL **UnterminatedQuote** is raised from **MaybeQuoted** if the **getChar** procedure of the **Handle** returns XChar.not or XChar.null before the terminating quote character has been read. If the signal is resumed, **MaybeQuoted** will return as if it had read a closing-quote character.

59.2.9 Built-in Filters

Alphabetic: FilterProcType;

Alphabetic defines the class of alphabetic characters; that is, the characters **'a** through **'z** and **'A** through **'Z**. This procedure requires no filter state.

AlphaNumeric: FilterProcType;

AlphaNumeric defines the class of alphanumeric characters, that is, the characters **'a** through **'z**, **'A** through **'Z**, and **'0** through **'9**. This procedure requires no filter state.

Delimited: FilterProcType;

When **Delimited** is passed to a procedure such as **Filtered**, the value of **skip** passed along with it must be **nonToken**. It will skip leading white space, then define the first character of the token to be both the opening-quote character and the closing-quote character, returning all characters occurring between the first and second appearance of that character.

Line: FilterProcType;

Line defines a class containing all characters except the carriage return. It can be used to collect a line of information. This procedure requires no filter state.

NonWhiteSpace: FilterProcType;

NonWhiteSpace FilterProc defines all characters that are not white space; that is, **WhiteSpace[char] = ~NonWhiteSpace[char]**. This procedure requires no client data (**data** may be **NIL**.)

Numeric: FilterProcType;

Numeric defines the class of numeric characters (the characters **'0** through **'9**) This procedure requires no filter state.

Switches: FilterProcType;

Switches can be used to collect switch characters. It accepts the characters '~, '-, and alphanumeric characters. This procedure requires no filter state.

WhiteSpace: FilterProcType;

The **WhiteSpace FilterProcType** defines the white space characters. This filter is used by **Token** for skipping white space. This procedure requires no filter state.

59.2.10 Built-in Quote Procedures

Brackets: QuoteProcType;

Brackets recognizes the following sets of matching open/close quote pairs: ( ), [ ], { }, and < >.

Quote: QuoteProcType;

Quote recognizes single quote and double quote.

59.3 Usage/Examples

59.3.1 Collecting Tokens

The following example collects name and number pairs from a stream. It uses the built-in stream handle provided by **XToken** for the source of characters. It uses the **Item** operation.

```
ProcessItemsFromStream: PROCEDURE [stream: Stream.Handle] = {
  tH: XToken.Handle ← XToken.HandleFromStream[stream];
  name: XString.ReaderBody ← XToken.Item[tH];
  number: LONG INTEGER;
  UNTIL XString.Empty[@name] DO
    number ← XToken.Decimal[h: tH, signalOnError: FALSE];
    ProcessItem[@name, number]; -- do work
    [] ← XToken.FreeTokenString[@name];
    name ← XToken.Item[tH];
    ENDLOOP;
  [] ← XToken.FreeStreamHandle[tH]};
```

The following example demonstrates how the **XToken** interface could be used to parse input into tokens, optionally followed by switches. In this context, tokens and switches are defined to be any sequence of non-white-space characters, not including the slash character (/).

```
GetToken: PROCEDURE RETURNS [token, switches: XString.ReaderBody] =
  BEGIN
  get: XToken.GetCharProcType = {RETURN[GetCommandLineChar[]]};
  getToken: XToken.Object ← [getChar: get, break: XChar.not];
  slash: XChar.Character = '/.ORD;
  MyFilter: XToken.FilterProcType = {
    RETURN[SELECT TRUE FROM
      XToken.WhiteSpace[c, data], c = XChar.not = > FALSE,
      c = slash = > FALSE,
      ENDCASE = > TRUE]};
  token ← XToken.Filtered[@getToken, NIL, MyFilter];
  IF getToken.break = slash THEN switches ← Xoken.Filtered[@getToken, NIL, MyFilter]
  ELSE switches ← XString.nullReaderBody;
  END;
```

We can extend this example so that the token is defined to be either a sequence of non-white-space characters or a sequence of characters, containing white space characters, between double quotes.

```
GetToken: PROCEDURE RETURNS [token, switches: XString.ReaderBody] =
  BEGIN
  get: XToken.GetCharProcType = {RETURN[GetCommandLineChar[]]};
  getToken: XToken.Object ← [getChar: get, break: XChar.not];
  slash: XChar.Character = '/.ORD;
  doubleQuote: XChar.Character = '".ORD;
  IsQuote: XToken.QuoteProcType = {
    RETURN[IF c = doubleQuote THEN c ELSE XToken.nonQuote]};
  MyFilter: XToken.FilterProcType = {
    RETURN[SELECT TRUE FROM
      XToken.WhiteSpace[c, data], c = XChar.not = > FALSE,
      c = slash = > FALSE,
      ENDCASE = > TRUE]};
  token ← XToken.MaybeQuoted[@getToken, NIL, MyFilter, IsQuote];
  IF getToken.break = slash THEN switches ← Xoken.Filtered[@getToken, NIL, MyFilter]
  ELSE switches ← XString.nullReaderBody;
  END;
```

59.4 Index of Interface Items

Appendix A

System TIP Tables

A.1 Overview

The **TIP** Tables used by ViewPoint are listed on the following pages to provide the programmer with a list of the productions available in the general purpose tables. The Normal tables described in §A.2.1 are placed in the **TIPStar** watershed at boot time and are therefore available for use by application programs. See the **TIPStar** interface for further information about the **TIPStar** watershed. Clients are encouraged to use the productions in the Normal tables whenever possible rather than generating new tables. Examples of use are provided in §A.3.

A.2 Tables

A.2.1 Normal Tables

The set of Normal tables (**NormalMouse.TIP**, **NormalSoftKeys.TIP**, **NormalKeyboard.TIP**, **NormalSideKeys.TIP**, **NormalBackstop.TIP**) are registered at startup and pushed into the list of TIP Tables at the appropriate **TIPStar** placeholder (**mouseActions, softKeys, blackKeys, sideKeys, backstopSpecialFocus**). (See **TIPStar** for further explanation about placeholders.) The set of Normal tables provides productions for all possible user input. Table entries are divided up into logical groups corresponding to the placeholder the table will be pushed onto. Thus input actions pertaining to the mouse (Point Down, Adjust Down, etc.) appear in the **NormalMouse.TIP** table and **NormalMouse.TIP** is pushed onto the **mouseActions** placeholder. Key actions from the side function key group that are directed at the input focus (MOVE Down, COPY Down, etc.) appear in the **NormalSideKeys.TIP** table and are pushed onto the **sideKeys** placeholder. Key actions such as the alphanumeric keys (A Down, 3 Down, etc.) appear in the **NormalKeyboard.TIP** table and are pushed onto the **blackKeys** placeholder. Key actions pertaining to the row of function keys at the top of the keyboard (CENTER Down, BOLD Down, etc.) appear in the **NormalSoftKeys.TIP** table and are pushed onto the **softKeys** placeholder. Key actions from the side function key group that are not directed at the input focus (KEYBOARD Down, HELP Down) appear in the **NormalBackstop.TIP** table and are pushed onto the **backstopSpecialFocus** placeholder.

At the end of ViewPoint boot sequence, the list of **TIP.Tables** in ViewPoint will appear as in Fig. A-1.

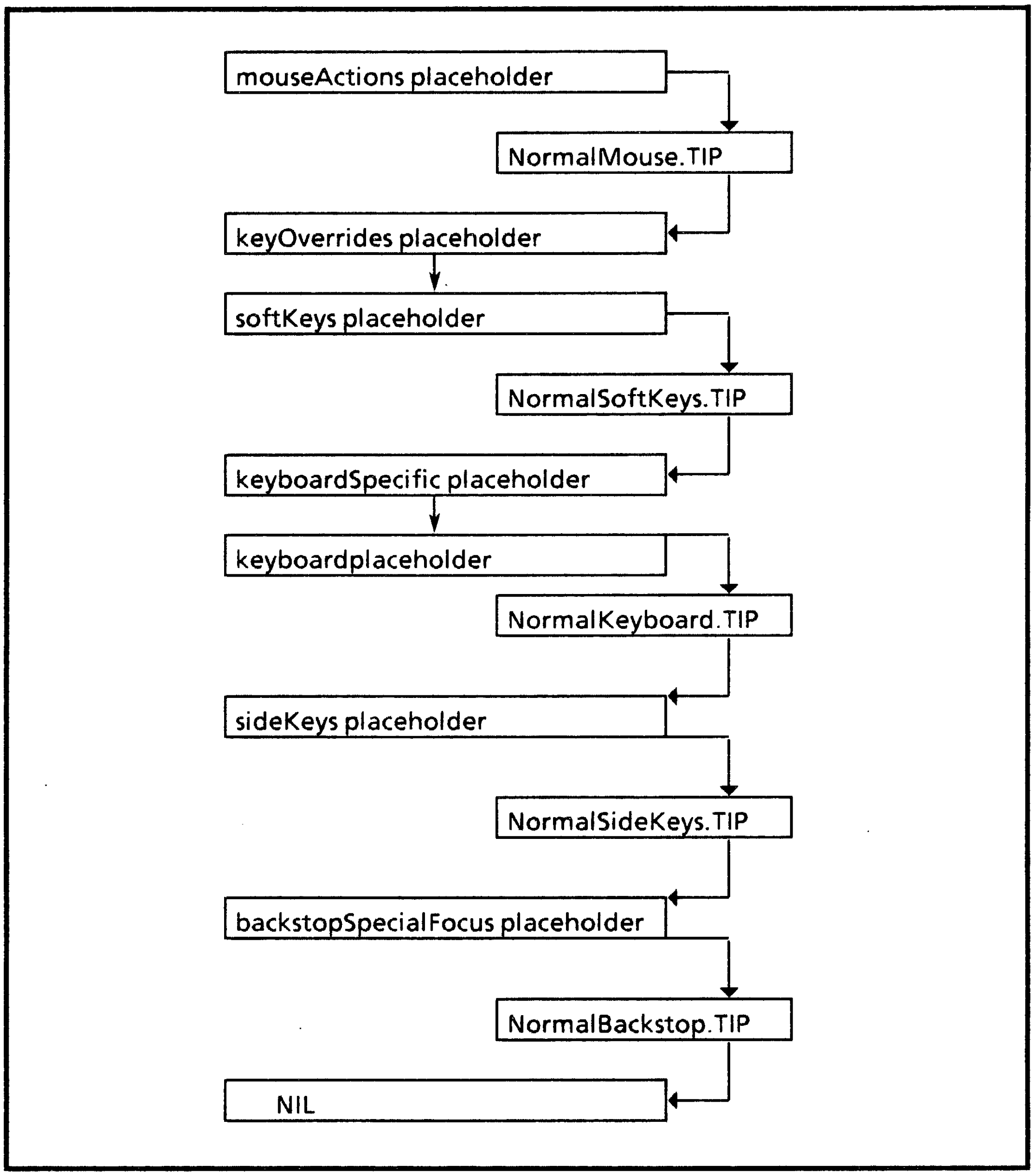

Figure A.1 TIP Tables after boot

```
--File: NormalBackstop.TIP last edit:    23-Oct-84 20:20:59
--This file is the NormalBackstop for the 8010

[DEF,IfShift,(SELECT ENABLE FROM
  LeftShift Down => ~1;
  RightShift Down => ~1;
  Key47 Down => ~1;  -- JLevelIV keyboard
  A12 Down => ~1;    -- JLevelIV keyboard
  ENDCASE => ~2)]

SELECT TRIGGER FROM

 FONT Down => [IfShift,ShiftFontDown,FontDown];
FONT Up => [IfShift,ShiftFontUp,FontUp];
KEYBOARD Down => [IfShift,ShiftKeyboardDown,KeyboardDown];
KEYBOARD Up => [IfShift,ShiftKeyboardUp,KeyboardUp];
HELP Down => [IfShift,ShiftHelpDown,HelpDown];
HELP Up => [IfShift,ShiftHelpUp,HelpUp];
STOP Down => [IfShift,ShiftStop,Stop];
STOP Up => [IfShift,ShiftStopUp,StopUp];

ENDCASE...
```

```
--File: NormalBackstop.TIP last edit:    21-Jun-85 15:00:42
--This file is the NormalBackstop for the 6085.

[DEF,IfShift,(SELECT ENABLE FROM
  LeftShift Down = > ~1;
  RightShift Down = > ~1;
  LeftShiftAlt Down = > ~1;    -- JLevelIV keyboard
  RightShiftAlt Down = > ~1;   -- JLevelIV keyboard
  ENDCASE = > ~2)]

SELECT TRIGGER FROM

 KEYBOARD Down = > [IfShift,ShiftKeyboardDown,KeyboardDown];
 KEYBOARD Up = > [IfShift,ShiftKeyboardUp,KeyboardUp];
 STOP Down = > [IfShift,ShiftStop,Stop];
 STOP Up = > [IfShift,ShiftStopUp,StopUp];

 ENDCASE...
```

--File: NormalKeyboard.TIP *last edit: 28-Nov-84 17:05:52*

```
[DEF,IfShift,(SELECT ENABLE FROM
 LeftShift Down = > ~1;
 RightShift Down = > ~1;
 Key47 Down = > ~1; -- JLevelIV keyboard
 A12 Down = > ~1;  -- JLevelIV keyboard
ENDCASE = > ~2)]

SELECT TRIGGER FROM

BS Down = > [IfShift, BackWord, BackSpace];
Return Down = > [IfShift, NewLine, NewParagraph];


Zero Down = > BUFFEREDCHAR;
One Down = > BUFFEREDCHAR;
Two Down = > BUFFEREDCHAR;
Three Down = > BUFFEREDCHAR;
Four Down = > BUFFEREDCHAR;
Five Down = > BUFFEREDCHAR;
Six Down = > BUFFEREDCHAR;
Seven Down = > BUFFEREDCHAR;
Eight Down = > BUFFEREDCHAR;
Nine Down = > BUFFEREDCHAR;

A Down = > BUFFEREDCHAR;
B Down = > BUFFEREDCHAR;
C Down = > BUFFEREDCHAR;
D Down = > BUFFEREDCHAR;
E Down = > BUFFEREDCHAR;
F Down = > BUFFEREDCHAR;
G Down = > BUFFEREDCHAR;
H Down = > BUFFEREDCHAR;
I Down = > BUFFEREDCHAR;
J Down = > BUFFEREDCHAR;
K Down = > BUFFEREDCHAR;
L Down = > BUFFEREDCHAR;
M Down = > BUFFEREDCHAR;
N Down = > BUFFEREDCHAR;
O Down = > BUFFEREDCHAR;
P Down = > BUFFEREDCHAR;
Q Down = > BUFFEREDCHAR;
R Down = > BUFFEREDCHAR;
S Down = > BUFFEREDCHAR;
T Down = > BUFFEREDCHAR;
U Down = > BUFFEREDCHAR;
V Down = > BUFFEREDCHAR;
W Down = > BUFFEREDCHAR;
X Down = > BUFFEREDCHAR;
Y Down = > BUFFEREDCHAR;
Z Down = > BUFFEREDCHAR;
```

```
CloseQuote Down => BUFFEREDCHAR;
Comma Down => BUFFEREDCHAR;
Minus Down => BUFFEREDCHAR;
Equal Down => BUFFEREDCHAR;
LeftBracket Down => BUFFEREDCHAR;
Period Down => BUFFEREDCHAR;
OpenQuote Down => BUFFEREDCHAR;
RightBracket Down => BUFFEREDCHAR;
SemiColon Down => BUFFEREDCHAR;
Space Down => BUFFEREDCHAR;
Slash Down => BUFFEREDCHAR;

PARATAB Down => TabDown;
TAB Down => ParaTabDown;
LOCK Down => LockDown;
LOCK Up => LockUp;

A11 Down => BUFFEREDCHAR; -- JLevelIV keyboard

A8 Down => A8Down; -- JLevelIV keyboard
A9 Down => A9Down; -- JLevelIV keyboard

-- nonexistent keys
A10 Down => A10Down;
D1 Down => D1Down;
D2 Down => D2Down;
L1 Down => L1Down;
L4 Down => L4Down;
L7 Down => L7Down;
L10 Down => L10Down;
R3 Down => R3Down;
R4 Down => R4Down;
R9 Down => R9Down;
R10 Down => R10Down;
T1 Down => T1Down;
T10 Down => T10Down;

ENDCASE..
```

```
--File: NormalMouse.TIP last edit: 9-Mar-84 15:45:33

OPTIONS Small;

[DEF,SHIFT,(LeftShift Down | RightShift Down | Key47 Down | A12 Down)]

SELECT TRIGGER FROM

 MOUSE = > SELECT ENABLE FROM
   Point Down = > COORDS, PointMotion;
   Adjust Down = > COORDS, AdjustMotion;
   MouseMiddle Down = > COORDS, MouseMiddleMotion;
 ENDCASE;

 Point Down = > SELECT ENABLE FROM
  [SHIFT] = > TIME, COORDS, Shift, PointDown;
 ENDCASE = > TIME, COORDS, PointDown;

 Point Up = > SELECT ENABLE FROM
  [SHIFT] = > TIME, COORDS, Shift, PointUp;
 ENDCASE = > TIME, COORDS, PointUp;

 Adjust Down = > SELECT ENABLE FROM
  [SHIFT] = > TIME, COORDS, Shift, AdjustDown;
 ENDCASE = > TIME, COORDS, AdjustDown;
 Adjust Up = > SELECT ENABLE FROM
  [SHIFT] = > TIME, COORDS, Shift, AdjustUp;
 ENDCASE = > TIME, COORDS, AdjustUp;

 MouseMiddle Down = > SELECT ENABLE FROM
  [SHIFT] = > TIME, COORDS, Shift, MouseMiddleDown;
 ENDCASE = > TIME, COORDS, MouseMiddleDown;

 MouseMiddle Up = > SELECT ENABLE FROM
  [SHIFT] = > TIME, COORDS, Shift, MouseMiddleUp;
 ENDCASE = > TIME, COORDS, MouseMiddleUp;

 ENTER = > Enter;
 EXIT = > Exit;

ENDCASE..
```

```
--File: NormalSideKeys.TIP last edit: 18-Mar-85 15:01:54
--This file contains sidekey translations for the 8010.

[DEF,IfShift,(SELECT ENABLE FROM
  LeftShift Down => ~1;
  RightShift Down => ~1;
  Key47 Down => ~1; -- JLevelIV keyboard
  A12 Down => ~1;   -- JLevelIV keyboard
  ENDCASE => ~2)]


SELECT TRIGGER FROM

-- left function keys
 AGAIN Down => [IfShift,ShiftAgainDown,AgainDown];
 AGAIN Up => [IfShift,ShiftAgainUp,AgainUp];
 DELETE Down => [IfShift,ShiftDeleteDown,DeleteDown];
 DELETE Up => [IfShift,ShiftDeleteUp,DeleteUp];
 FIND Down => [IfShift,ShiftFindDown,FindDown];
 FIND Up => [IfShift,ShiftFindUp,FindUp];
 COPY Down => [IfShift,ShiftCopyDown,CopyDown];
 COPY Up => [IfShift,ShiftCopyUp,CopyUp];
 SAME Down => [IfShift,ShiftSameDown,SameDown];
 SAME Up => [IfShift,ShiftSameUp,SameUp];
 MOVE Down => [IfShift,ShiftMoveDown,MoveDown];
 MOVE Up => [IfShift,ShiftMoveUp,MoveUp];
 OPEN Down => [IfShift,ShiftOpenDown,OpenDown];
 OPEN Up => [IfShift,ShiftOpenUp,OpenUp];
 PROPS Down => [IfShift,ShiftPropsDown,PropsDown];
 PROPS Up => [IfShift,ShiftPropsUp,PropsUp];

-- right function keys
 NEXT Down => [IfShift,SkipDown,NextDown];
 NEXT Up => [IfShift,SkipUp,NextUp];
 UNDO Down => [IfShift,ShiftUndoDown,UndoDown];
 UNDO Up => [IfShift,ShiftUndoUp,UndoUp];
 MARGINS Down => [IfShift,ShiftMarginsDown,MarginsDown];
 MARGINS Up => [IfShift,ShiftMarginsUp,MarginsUp];
 EXPAND Down => [IfShift,DefineDown,ExpandDown];
 EXPAND Up => [IfShift,DefineUp,ExpandUp];


 ENDCASE...
```

```
--File: NormalSideKeys.TIP last edit: 18-Mar-85 15:01:54
--This file contains sidekey translations for the 6085.

[DEF,IfShift,(SELECT ENABLE FROM
  LeftShift Down => ~1;
  RightShift Down => ~1;
  LeftShiftAlt Down => ~1;   -- JLevelIV keyboard
  RightShiftAlt Down => ~1;   -- JLevelIV keyboard
  ENDCASE => ~2)]


SELECT TRIGGER FROM

-- left function keys
 AGAIN Down => [IfShift,ShiftAgainDown,AgainDown];
 AGAIN Up => [IfShift,ShiftAgainUp,AgainUp];
 DELETE Down => [IfShift,ShiftDeleteDown,DeleteDown];
 DELETE Up => [IfShift,ShiftDeleteUp,DeleteUp];
 FIND Down => [IfShift,ShiftFindDown,FindDown];
 FIND Up => [IfShift,ShiftFindUp,FindUp];
 COPY Down => [IfShift,ShiftCopyDown,CopyDown];
 COPY Up => [IfShift,ShiftCopyUp,CopyUp];
 SAME Down => [IfShift,ShiftSameDown,SameDown];
 SAME Up => [IfShift,ShiftSameUp,SameUp];
 MOVE Down => [IfShift,ShiftMoveDown,MoveDown];
 MOVE Up => [IfShift,ShiftMoveUp,MoveUp];
 OPEN Down => [IfShift,ShiftOpenDown,OpenDown];
 OPEN Up => [IfShift,ShiftOpenUp,OpenUp];
 PROPS Down => [IfShift,ShiftPropsDown,PropsDown];
 PROPS Up => [IfShift,ShiftPropsUp,PropsUp];
 UNDO Down => [IfShift,ShiftUndoDown,UndoDown];
 UNDO Up => [IfShift,ShiftUndoUp,UndoUp];

-- beside space bar
 EXPAND Down => [IfShift,DefineDown,ExpandDown];
 EXPAND Up => [IfShift,DefineUp,ExpandUp];

-- right function keys
 NEXT Down => [IfShift,SkipDown,NextDown];
 NEXT Up => [IfShift,SkipUp,NextUp];

-- calculator key pad
 KeypadZero Down => [IfShift,ShiftZeroDown,ZeroDown];
 KeypadZero Up => [IfShift,ShiftZeroUp,ZeroUp];
 KeypadOne Down => [IfShift,ShiftOneDown,OneDown];
 KeypadOne Up => [IfShift,ShiftOneUp,OneUp];
 KeypadTwo Down => [IfShift,ShiftTwoDown,TwoDown];
 KeypadTwo Up => [IfShift,ShiftTwoUp,TwoUp];
 KeypadThree Down => [IfShift,ShiftThreeDown,ThreeDown];
 KeypadThree Up => [IfShift,ShiftThreeUp,ThreeUp];
 KeypadFour Down => [IfShift,ShiftFourDown,FourDown];
 KeypadFour Up => [IfShift,ShiftFourUp,FourUp];
```

```
KeypadFive Down => [IfShift,ShiftFiveDown,FiveDown];
KeypadFive Up => [IfShift,ShiftFiveUp,FiveUp];
KeypadSix Down => [IfShift,ShiftSixDown,SixDown];
KeypadSix Up => [IfShift,ShiftSixUp,SixUp];
KeypadSeven Down => [IfShift,ShiftSevenDown,SevenDown];
KeypadSeven Up => [IfShift,ShiftSevenUp,SevenUp];
KeypadEight Down => [IfShift,ShiftEightDown,EightDown];
KeypadEight Up => [IfShift,ShiftEightUp,EightUp];
KeypadNine Down => [IfShift,ShiftNineDown,NineDown];
KeypadNine Up => [IfShift,ShiftNineUp,NineUp];
KeypadAdd Down => [IfShift,ShiftAddDown,AddDown];
KeypadAdd Up => [IfShift,ShiftAddUp,AddUp];
KeypadSubtract Down => [IfShift,ShiftSubtractDown,SubtractDown];
KeypadSubtract Up => [IfShift,ShiftSubtractUp,SubtractUp];
KeypadMultiply Down => [IfShift,ShiftMultiplyDown,MultiplyDown];
KeypadMultiply Up => [IfShift,ShiftMultiplyUp,MultiplyUp];
KeypadDivide Down => [IfShift,ShiftDivideDown,DivideDown];
KeypadDivide Up => [IfShift,ShiftDivideUp,DivideUp];
KeypadClear Down => [IfShift,ShiftClearDown,ClearDown];
KeypadClear Up => [IfShift,ShiftClearUp,ClearUp];
KeypadPeriod Down => [IfShift,ShiftPeriodDown,PeriodDown];
KeypadPeriod Up => [IfShift,ShiftPeriodUp,PeriodUp];
KeypadComma Down => [IfShift,ShiftCommaDown,CommaDown];
KeypadComma Up => [IfShift,ShiftCommaUp,CommaUp];

ENDCASE...
```

```
-- File: NormalSoftKeys.TIP  last edit:  23-Oct-84 20:21:33
-- This file contains softkeys translations for the 8010.

[DEF,IfShift,(SELECT ENABLE FROM
  LeftShift Down = > ˜1;
  RightShift Down = > ˜1;
  Key47 Down = > ˜1;  -- JLevelIV keyboard
  A12 Down = > ˜1;   -- JLevelIV keyboard
  ENDCASE = > ˜2)]


SELECT TRIGGER FROM
-- top function keys
 CENTER Down = > [IfShift,ShiftCenterDown,CenterDown];
 CENTER Up = > [IfShift,ShiftCenterUp,CenterUp];
 BOLD Down = > [IfShift,UnboldDown,BoldDown];
 BOLD Up = > [IfShift,UnboldUp,BoldUp];
 ITALICS Down = > [IfShift,ShiftItalicsDown,ItalicsDown];
 ITALICS Up = > [IfShift,ShiftItalicsUp,ItalicsUp];
 UNDERLINE Down = > [IfShift,ShiftUnderlineDown,UnderlineDown];
 UNDERLINE Up = > [IfShift,ShiftUnderlineUp,UnderlineUp];
 SUPERSCRIPT Down = > [IfShift,ShiftSuperscriptDown,SuperscriptDown];
 SUPERSCRIPT Up = > [IfShift,ShiftSuperscriptUp,SuperscriptUp];
 SUBSCRIPT Down = > [IfShift,ShiftSubscriptDown,SubscriptDown];
 SUBSCRIPT Up = > [IfShift,ShiftSubscriptUp,SubscriptUp];
 SMALLER Down = > [IfShift,LargerDown,SmallerDown];
 SMALLER Up = > [IfShift,LargerUp,SmallerUp];
 DEFAULTS Down = > [IfShift,ShiftDefaultsDown,DefaultsDown];
 DEFAULTS Up = > [IfShift,ShiftDefaultsUp,DefaultsUp];

 ENDCASE...
```

```
-- File: NormalSoftKeys.TIP  last edit:  23-Oct-84 20:21:33
-- This file contains softkeys translations for the 6085.

[DEF,IfShift,(SELECT ENABLE FROM
  LeftShift Down = > ~1;
  RightShift Down = > ~1;
  LeftShiftAlt Down = > ~1;    -- JLevelIV keyboard
  RightShiftAlt Down = > ~1;   -- JLevelIV keyboard
  ENDCASE = > ~2)]


SELECT TRIGGER FROM
-- top function keys
 CENTER Down = > [IfShift,ShiftCenterDown,CenterDown];
 CENTER Up = > [IfShift,ShiftCenterUp,CenterUp];
 BOLD Down = > [IfShift,UnboldDown,BoldDown];
 BOLD Up = > [IfShift,UnboldUp,BoldUp];
 ITALICS Down = > [IfShift,ShiftItalicsDown,ItalicsDown];
 ITALICS Up = > [IfShift,ShiftItalicsUp,ItalicsUp];
 Case Down = > [IfShift,ShiftCaseDown,CaseDown];
 Case Up = > [IfShift,ShiftCaseUp,CaseUp];
 UNDERLINE Down = > [IfShift,ShiftDbkUnderlineDown,DbkUnderlineDown];
 UNDERLINE Up = > [IfShift,ShiftDbkUnderlineUp,DbkUnderlineUp];
 Strikeout Down = > [IfShift,ShiftStrikeoutDown,StrikeoutDown];
 Strikeout Up = > [IfShift,ShiftStrikeoutUp,StrikeoutUp];
 SuperSub Down = > [IfShift,ShiftSuperSubDown,SuperSubDown];
 SuperSub Up = > [IfShift,ShiftSuperSubUp,SuperSubUp];
 SMALLER Down = > [IfShift,DbkLargerDown,DbkSmallerDown];
 SMALLER Up = > [IfShift,DbkLargerUp,DbkSmallerUp];
 MARGINS Down = > [IfShift,ShiftMarginsDown,MarginsDown];
 MARGINS Up = > [IfShift,ShiftMarginsUp,MarginsUp];
 FONT Down = > [IfShift,ShiftFontDown,FontDown];
 FONT Up = > [IfShift,ShiftFontUp,FontUp];

 ENDCASE...
```

A.2.2 Mouse Mode Tables

The mouse mode tables refer to the set of tables that will be swapped in and out of the **TIPStar** watershed at the **mouseActions** placeholder, depending on the mode set by TIPStar.SetMode. Note: mode = normal will return **NormalMouse.TIP** to the watershed.

```
--File: CopyModeMouse.TIP last edit: 28-May-85 18:12:42

OPTIONS Small;

SELECT TRIGGER FROM

 MOUSE = > SELECT ENABLE FROM
  Point Down = > COORDS, CopyModeMotion;
  Adjust Down = > COORDS, CopyModeMotion;
 ENDCASE;
 Point Down = > COORDS, CopyModeDown;
 Point Up = > COORDS, CopyModeUp;
 Adjust Down = > COORDS, CopyModeDown;
 Adjust Up = > COORDS, CopyModeUp;

ENTER = > CopyModeEnter;
EXIT = > CopyModeExit;

ENDCASE..
```

--File: MoveModeMouse.TIP *last edit: 28-May-85 16:37:23*

```
OPTIONS Small;

SELECT TRIGGER FROM

 MOUSE = > SELECT ENABLE FROM
  Point Down = > COORDS, MoveModeMotion;
  Adjust Down = > COORDS, MoveModeMotion;
  ENDCASE;

 Point Down = > COORDS, MoveModeDown;
 Point Up = > COORDS, MoveModeUp;
 Adjust Down = > COORDS, MoveModeDown;
 Adjust Up = > COORDS, MoveModeUp;

ENTER = > MoveModeEnter;
EXIT = > MoveModeExit;

 ENDCASE..
```

--File: SameAsModeMouse.TIP *last edit: 13-Jul-83 10:42:03*

```
OPTIONS Small;

SELECT TRIGGER FROM

 MOUSE = > SELECT ENABLE FROM
  Point Down = > COORDS, SameAsModeMotion;
  Adjust Down = > COORDS, SameAsModeMotion;
 ENDCASE;

 Point Down = > COORDS, SameAsModeDown;
 Point Up = > COORDS, SameAsModeUp;
 Adjust Down = > COORDS, SameAsModeDown;
 Adjust Up = > COORDS, SameAsModeUp;

ENTER = > SameAsModeEnter;
EXIT = > SameAsModeExit;

ENDCASE...
```

A.2.3 Miscellaneous Tables

Any TIP.Tables created for ViewPoint should be added to this appendix by the responsible implementor.

A.3 Usage/Examples

A.3.1 Using NormalSoftKeys.TIP when installing client softKeys

```
-- define the Atoms for my NotifyProc to use --
centerDown, boldDown, italicsDown, underlineDown, superscriptDown,
  subscriptDown, smallerDown, defaultsDown : Atom.ATOM ← Atom.null;

Init: PROCEDURE =
BEGIN
 -- initialize my Atoms --
   centerDown ← Atom.MakeAtom["CenterDown"];
   boldDown ← Atom.MakeAtom["BoldDown"L];
   italicsDown ← Atom.MakeAtom["ItalicsDown"L];
   underlineDown ← Atom.MakeAtom["UnderlineDown"L];
   superscriptDown ← Atom.MakeAtom["SuperscriptDown"L];
   subscriptDown ← Atom.MakeAtom["SubscriptDown"L];
   smallerDown ← Atom.MakeAtom["SmallerDown"L];
END; --Init

-- somewhere in the code --
 softKeyHandle ← SoftKeys.Push[
   notifyProc: MyNotifyProc,
   labels: DESCRIPTOR[labels, SoftKeys.numberOfKeys] ];

MyNotifyProc: TIP.NotifyProc =
  BEGIN
   FOR input: TIP.Results ← results, input.next UNTIL input = NIL DO
     WITH z: input SELECT FROM
     atom => SELECT z.a FROM
       centerDown => --Do something interesting--;
       boldDown => --Do something interesting--;
       italicsDown => --Do something interesting--;
       underlineDown => --Do something interesting--;
       superscriptDown => --Do something interesting--;
       subscriptDown => --Do something interesting--;
       smallerDown => --Do something interesting--;
       defaultsDown => --Do something interesting--;

       ENDCASE
     ENDCASE
   ENDLOOP
  END; -- MyNotifyProc
```

MyNotifyProc will be attached to NormalSoftKeys.TIP by the SoftKeys implementation. Until this client does a SoftKeys.Remove, whenever the user presses one of the top row function keys MyNotifyProc will be called with the appropriate production from the NormalSoftKeys.TIP.

A.3.2 Attaching a NotifyProc to One of the Normal Tables

If a client application wants to grab the use, for example, of all the side keys for some period of time, it can attach a **notifyProc** to the **NormalSideKeys.TIP** table by calling:

```
old ←TIP.SetNotifyProcForTable[TIPStar.GetTable[sideKeys], MyNotifyProc];
```

A.4 Index of TIP Tables

Appendix B

References

The following documents should be studied before or in conjunction with this manual:

- *Mesa Language Manual*, - 610E00170.
- *XDE User Guide*, - 610E00140.
- *Pilot Programmer's Manual*, - 610E00160.
- *Srvices Programmer's Guide: Filing Programmer's Manual*, - 610E00180.

In addition, any other documentation accompanying a release of ViewPoint should be consulted before writing any programs.

Appendix C

Atoms

C.1 Overview

Atoms (see **Atom** interface) are used in several places in ViewPoint. This appendix contains a list of the strings that represent them.

C.1.1 Atoms as TIP Results in the System TIP Tables

Most of the right-hand sides (TIP results) of the productions in the system-provided TIP Tables (see Appendix A) contain atoms.

A10Down
A8Down
A9Down
AdjustDown
AdjustMotion
AdjustUp
AgainDown
BackSpace
BackWord
BoldDown
CenterDown
CopyDown
CopyModeDown
CopyModeMotion
CopyModeUp
CopyUp
D1Down
D2Down
DefaultsDown
DefineDown
DeleteDown
EnablePointInvoke
Enter
Exit
ExpandDown
FindDown

Finish Finish
FontDown
FontUp
HelpDown
HelpUp
Invoke
ItalicsDown
KeyboardDown
KeyboardUp
L10Down
L1Down
L4Down
L7Down
LargerDown
LockDown
LockUp
MarginsDown
MouseMiddleDown
MouseMiddleMotion
MouseMiddleUp
MoveDown
MoveModeDown
MoveModeMotion
MoveModeUp
MoveUp
NewLine
NewParagraph
NextDown
OpenDown
ParaTabDown
PointDown
PointMotion
PointUp
PropsDown
R10Down
R3Down
R4Down
R9Down
SameAsModeDown
SameAsModeMotion
SameAsModeUp
SameDown
Shift
SkipDown
SmallerDown
Stop
SubscriptDown
SuperscriptDown
T10Down
T1Down
TabDown
Track

UnboldDown
UnderlineDown
UndoDown

C.1.2 Passed as the "Atom" Parameter to a Containee.GenericProc

These atoms may be passed to a **Containee.GenericProc** as the **atom** parameter, indicating what operation the **GenericProc** should perform:

CanYouTakeSelection
Open
Props
TakeSelection
TakeSelectionCopy

C.1.3 Event Atoms

Events are identified by atoms (see the **Event** interface). The following events are explained in further detail in the chapter indicated.

Event	Chapter where discussed
AttemptingStarLogoff	StarDesktop
BlackKeysChange	BlackKeys
DesktopWindowAvailable	StarDesktop
NewIcon	StarDesktop
StarLogoff	StarDesktop
StarLogon	StarDesktop

C.1.4 AtomicProfile Atoms

AtomicProfile is used to save various values globally. Values are saved with the following atoms.

FullUserName-Fully qualified user's name as entered by the user at logon.
UserPassword-User's password as entered by the user at logon.

C.1.5 Other

The **Atom** interface allows any value to be associated with any pair of atoms (see **Atom.GetProp**, **Atom.Pair**, etc.).

Atom	Property atom	Value
CurrentUser	IdentityHandle	**Identity.Handle** for the currently logged on user. This is created at logon if the user enters a password; it can be used to access any Network Service.

Appendix D

Listing of Public Symbols

This appendix lists all public items from the public interfaces, i. e. the files in XStringPublic.df and BWSPublic.df.

Atom AtomicProfile Attention BlackKeys Containee ContaineeExtra ContainerCache ContainerCacheExtra ContainerSource ContainerWindow Context Cursor Display DisplayExtra Event FileContainerShell FileContainerSource FileContainerSourceExtra FormWindow FormWindowMessageParse IdleControl KeyboardKey KeyboardWindow LevelIVKeys MenuData MessageWindow PopupMenu PropertySheet Selection SimpleTextDisplay SimpleTextEdit SimpleTextFont SoftKeys StarDesktop StarWindowShell TIP TIPStar Undo Window XChar XCharSet0 XCharSet164 XCharSet356 XCharSet357 XCharSet41 XCharSet42 XCharSet43 XCharSet44 XCharSet45 XCharSet46 XCharSet47 XCharSets XComSoftMessage XFormat XLReal XMessage XString XStringExtra XStringX XTime XToken

Abs: --*XLReal*-- PROCEDURE [Number] RETURNS [Number];
accuracy: --*XLReal*-- NATURAL = 13;
Acquire: --*Context*-- PROCEDURE [type: Type, window: Window.Handle]
  RETURNS [Data];
Action: --*ContainerSource*-- TYPE = {destroy, reList, sleep, wakeup};
Action: --*Selection*-- TYPE = MACHINE DEPENDENT{
  clear, mark, unmark, delete, clearIfHasInsert, save, restore, firstFree,
  last(255)};
actionToWindow: --*TIP*-- PACKED ARRAY KeyName OF BOOLEAN;
ActOn: --*ContainerSource*-- ActOnProc;
ActOn: --*Selection*-- PROCEDURE [action: Action];
ActOnProc: --*ContainerSource*-- TYPE = PROCEDURE [
  source: Handle, action: Action];
ActOnProc: --*Selection*-- TYPE = PROCEDURE [data: ManagerData, action: Action]
  RETURNS [cleared: BOOLEAN ← FALSE];
Add: --*XLReal*-- PROCEDURE [a: Number, b: Number] RETURNS [Number];
AddClientDefinedCharacter: --*SimpleTextFont*-- PROCEDURE [
  width: CARDINAL, height: CARDINAL, bitsPerLine: CARDINAL, bits: LONG POINTER,
  offsetIntoBits: CARDINAL ← 0] RETURNS [XString.Character];
AddData: --*ContainerCache*-- TYPE = RECORD [
  clientData: LONG POINTER,
  clientDataCount: CARDINAL,
  clientStrings: LONG DESCRIPTOR FOR ARRAY CARDINAL OF XString.ReaderBody];
AddDependencies: --*Event*-- PROCEDURE [
  agent: AgentProcedure, myData: LONG POINTER,

Add: --*PrototypeExtra*-- PROCEDURE [
  file: NSFile.Handle, version: Prototype.Version,
  subtype: Prototype.Subtype ^ 0, session: NSFile.Session ^ LOOPHOLE[0]];
Add: --*XLReal*-- PROCEDURE [a: Number, b: Number] RETURNS [Number];
AddClientDefinedCharacter: --*SimpleTextFont*-- PROCEDURE [
  width: CARDINAL, height: CARDINAL, bitsPerLine: CARDINAL, bits: LONG POINTER,
  offsetIntoBits: CARDINAL ^ 0] RETURNS [XString.Character];
AddData: --*ContainerCache*-- TYPE = RECORD [
  clientData: LONG POINTER,
  clientDataCount: CARDINAL,
  clientStrings: LONG DESCRIPTOR FOR ARRAY CARDINAL OF XString.ReaderBody];
AddDependencies: --*Event*-- PROCEDURE [
  agent: AgentProcedure, myData: LONG POINTER,
  events: LONG DESCRIPTOR FOR ARRAY CARDINAL OF EventType,
  remove: FreeDataProcedure ^ NIL] RETURNS [dependency: Dependency];
AddDependency: --*Event*-- PROCEDURE [
  agent: AgentProcedure, myData: LONG POINTER, event: EventType,
  remove: FreeDataProcedure ^ NIL] RETURNS [dependency: Dependency];
AddItem: --*MenuData*-- PROCEDURE [menu: MenuHandle, new: ItemHandle];
AddMenuItem: --*Attention*-- PROCEDURE [item: MenuData.ItemHandle];
AddPopupMenu: --*StarWindowShell*-- PROCEDURE [
  sws: Handle, menu: MenuData.MenuHandle];
AddReferenceToDesktop: --*StarDesktop*-- PROCEDURE [
  reference: NSFile.Reference, place: Window.Place ^ nextPlace];
AddToSystemKeyboards: --*KeyboardKey*-- PROCEDURE [keyboard:
BlackKeys.Keyboard];
AdjustProc: --*StarWindowShell*-- TYPE = PROCEDURE [
  sws: Handle, box: Window.Box, when: When];
AgentProcedure: --*Event*-- TYPE = PROCEDURE [
  event: EventType, eventData: LONG POINTER, myData: LONG POINTER]
  RETURNS [remove: BOOLEAN ^ FALSE, veto: BOOLEAN ^ FALSE];
AllocateAndInsert: --*MessageWindow*-- PROCEDURE [
  parent: Window.Handle, place: Window.Place ^ LOOPHOLE[0],
  dims: Window.Dims ^ LOOPHOLE[23417B], zone: UNCOUNTED ZONE ^ LOOPHOLE[0],
  lines: CARDINAL ^ 10] RETURNS [Window.Handle];
AllocateCache: --*ContainerCache*-- PROCEDURE RETURNS [Handle];
AllocateMessages: --*XMessage*-- PROCEDURE [
  applicationName: LONG STRING, maxMessages: CARDINAL, clientData: ClientData,
  proc: DestroyMsgsProc] RETURNS [h: Handle];
Alphabetic: --*XToken*-- FilterProcType;
AlphaNumeric: --*XToken*-- FilterProcType;
Append: --*XTime*-- PROCEDURE [
  w: XString.Writer, time: System.GreenwichMeanTime ^ defaultTime,
  template: XString.Reader ^ dateAndTime, ltp: LTP ^ useSystem];
AppendChar: --*XString*-- PROCEDURE [
  to: Writer, c: Character, extra: CARDINAL ^ 0];
AppendExtensionIfNeeded: --*XString*-- PROCEDURE [to: Writer, extension: Reader]
  RETURNS [didAppend: BOOLEAN];
AppendItem: --*ContainerCache*-- PROCEDURE [cache: Handle, addData: AddData]
  RETURNS [handle: ItemHandle];

AppendItem: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, item: ItemKey, line: Line, preMargin: CARDINAL ^ 0,
  tabStop: CARDINAL ^ nextTabStop, repaint: BOOLEAN ^ TRUE];
AppendLine: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, spaceAboveLine: CARDINAL ^ 0] RETURNS [line: Line];
AppendReader: --*XString*-- PROCEDURE [
  to: Writer, from: Reader, fromEndContext: Context ^ unknownContext,
  extra: CARDINAL ^ 0];
AppendStream: --*XString*-- PROCEDURE [
  to: Writer, from: Stream.Handle, nBytes: CARDINAL,
  fromContext: Context ^ vanillaContext, extra: CARDINAL ^ 0]
  RETURNS [bytesTransferred: CARDINAL];
AppendSTRING: --*XString*-- PROCEDURE [
  to: Writer, from: LONG STRING, homogeneous: BOOLEAN ^ FALSE,
  extra: CARDINAL ^ 0];
ArabicFirstRightToLeftCharCode: --*XChar*-- Environment.Byte = 48;
Arc: --*Display*-- PROCEDURE [
  window: Handle, place: Window.Place, radius: INTEGER, startSector: CARDINAL,
  stopSector: CARDINAL, start: Window.Place, stop: Window.Place,
  lineStyle: LineStyle ^ NIL, bounds: Window.BoxHandle ^ NIL];
ArcCos: --*XLReal*-- PROCEDURE [x: Number] RETURNS [radians: Number];
ArcSin: --*XLReal*-- PROCEDURE [x: Number] RETURNS [radians: Number];
ArcTan: --*XLReal*-- PROCEDURE [x: Number] RETURNS [radians: Number];
ArrayHandle: --*MenuData*-- TYPE = LONG DESCRIPTOR FOR ARRAY CARDINAL OF
  ItemHandle;
ArrowFlavor: --*StarWindowShell*-- TYPE = {pageFwd, pageBwd, forward, backward};
ArrowScrollAction: --*StarWindowShell*-- TYPE = {start, go, stop};
ArrowScrollProc: --*StarWindowShell*-- TYPE = PROCEDURE [
  sws: Handle, vertical: BOOLEAN, flavor: ArrowFlavor,
  arrowScrollAction: ArrowScrollAction ^ go];
ATOM: --*Atom*-- TYPE [1];
ATOM: --*TIP*-- TYPE = Atom.ATOM;
attemptingLogoff: --*StarDesktop*-- Atom.ATOM;
AttentionProc: --*TIP*-- TYPE = PROCEDURE [window: Window.Handle];
AttributeFormatProc: --*FileContainerSource*-- TYPE = PROCEDURE [
  containeeImpl: Containee.Implementation, containeeData: Containee.DataHandle,
  attr: NSFile.Attribute, displayString: XString.Writer];
BackScanClosure: --*XString*-- TYPE = RECORD [
  proc: BackScanProc, env: LONG POINTER];
BackScanProc: --*XString*-- TYPE = PROCEDURE [
  beforePos: CARDINAL, env: LONG POINTER]
  RETURNS [pos: CARDINAL, context: Context];
backStopInputFocus: --*TIP*-- READONLY Window.Handle;
beforeItemZero: --*ContainerSource*-- ItemIndex = 177776B;
beforeLogonSession: --*Catalog*-- NSFile.Session;
BeginFill: --*ContainerCache*-- PROCEDURE [
  cache: Handle, fillProc: FillProc, clients: LONG POINTER,
  fork: BOOLEAN ^ TRUE];
Bit: --*LevelIVKeys*-- TYPE = KeyStations.Bit;
BitAddress: --*Display*-- TYPE = BitBlt.BitAddress;

BitAddressFromPlace: --*Display*-- PROCEDURE [
  base: BitAddress, x: NATURAL, y: NATURAL, raster: CARDINAL]
  RETURNS [BitAddress];
BitBltFlags: --*Display*-- TYPE = BitBlt.BitBltFlags;
bitFlags: --*Display*-- BitBltFlags;
Bitmap: --*Display*-- PROCEDURE [
  window: Handle, box: Window Box, address: BitAddress,
  bitmapBitWidth: CARDINAL, flags: BitBltFlags ^ paintFlags,
  bounds: Window.BoxHandle ^ NIL];
Bitmap: --*FormWindow*-- TYPE = RECORD [
  height: CARDINAL,
  width: CARDINAL,
  bitsPerLine: CARDINAL,
  bits: Environment.BitAddress];
BitmapPlace: --*Window*-- PROCEDURE [window: Handle, place: Place ^ LOOPHOLE[0]]
  RETURNS [Place];
BitmapPlaceToWindowAndPlace: --*Window*-- PROCEDURE [bitmapPlace: Place]
  RETURNS [window: Handle, place: Place];
Bits: --*XLReal*-- TYPE = ARRAY [0..3] OF CARDINAL;
Black: --*Display*-- PROCEDURE [
  window: Handle, box: Window.Box, bounds: Window.BoxHandle ^ NIL];
BlackParallelogram: --*Display*-- PROCEDURE [
  window: Handle, p: Parallelogram, dstFunc: DstFunc ^ null,
  bounds: Window.BoxHandle ^ NIL];
Blanks: --*XFormat*-- PROCEDURE [h: Handle ^ NIL, n: CARDINAL ^ 1];
Block: --*XFormat*-- PROCEDURE [h: Handle ^ NIL, block: Environment.Block];
Block: --*XString*-- PROCEDURE [r: Reader]
  RETURNS [block: Environment.Block, context: Context];
BodyEnumProc: --*StarWindowShell*-- TYPE = PROCEDURE [victim: Window.Handle]
  RETURNS [stop: BOOLEAN ^ FALSE];
Boolean: --*XToken*-- PROCEDURE [h: Handle, signalOnError: BOOLEAN ^ TRUE]
  RETURNS [true: BOOLEAN];
BooleanChangeProc: --*FormWindow*-- TYPE = PROCEDURE [
  window: Window.Handle, item: ItemKey, calledBecauseOf: ChangeReason,
  newValue: BOOLEAN];
BooleanFalseDefault: --*PropertySheet*-- TYPE = BOOLEAN ^ FALSE;
BooleanItemLabel: --*FormWindow*-- TYPE = RECORD [
  var: SELECT type: BooleanItemLabelType FROM
    string = > [string: XString.ReaderBody],
    bitmap = > [bitmap: Bitmap],
    ENDCASE];
BooleanItemLabelType: --*FormWindow*-- TYPE = {string, bitmap};
Box: --*KeyboardWindow*-- TYPE = RECORD [
  place: Window.Place, width: INTEGER, height: INTEGER];
Box: --*Window*-- TYPE = RECORD [place: Place, dims: Dims];
BoxEnumProc: --*Window*-- TYPE = PROCEDURE [Handle, Box];
BoxesAreDisjoint: --*Window*-- PROCEDURE [a: Box, b: Box] RETURNS [BOOLEAN];
boxFlags: --*Display*-- BitBltFlags;
BoxHandle: --*Window*-- TYPE = LONG POINTER TO Box;
Brackets: --*XToken*-- QuoteProcType;
BreakCharOption: --*XString*-- TYPE = {ignore, appendToFront, leaveOnRest};
BreakTable: --*XString*-- TYPE = LONG POINTER TO BreakTableObject;

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BreakTableObject: --XString-- TYPE = RECORD [
   otherSets: StopOrNot ˆ stop,
   set: Environment.Byte ˆ 0,
   codes: PACKED ARRAY [0..255] OF StopOrNot ˆ ALL[not]];
Brick: --Display-- TYPE = LONG DESCRIPTOR FOR ARRAY CARDINAL OF CARDINAL;
BufferProc: --SimpleTextDisplay-- TYPE = PROCEDURE [
   result: Result, string: XString.Reader, address: Environment.BitAddress,
   dims: Window.Dims, bitsPerLine: CARDINAL] RETURNS [continue: BOOLEAN];
Byte: --XString-- TYPE = Environment.Byte;
ByteLength: --XString-- PROCEDURE [r: Reader] RETURNS [CARDINAL];
Bytes: --XString-- TYPE = LONG POINTER TO ByteSequence;
ByteSequence: --XString-- TYPE = RECORD [
   PACKED SEQUENCE COMPUTED CARDINAL OF Byte];
CacheFillStatus: --ContainerCache-- TYPE = {
   no, inProgress, inProgressPendingAbort, inProgressPendingJoin, yes,
   yesWithError, spare};
CallBack: --TIP-- PROCEDURE [
   window: Window.Handle, table: Table, notify: CallBackNotifyProc];
CallBackNotifyProc: --TIP-- TYPE = PROCEDURE [
   window: Window.Handle, results: Results] RETURNS [done: BOOLEAN];
CancelPeriodicNotify: --TIP-- PROCEDURE [PeriodicNotify]
   RETURNS [null: PeriodicNotify];
CanYouConvert: --Selection-- PROCEDURE [
   target: Target, enumeration: BOOLEAN ˆ FALSE] RETURNS [yes: BOOLEAN];
CanYouTake: --ContainerSource-- CanYouTakeProc;
CanYouTakeProc: --ContainerSource-- TYPE = PROCEDURE [
   source: Handle, selection: Selection.ConvertProc ˆ NIL]
   RETURNS [yes: BOOLEAN];
caretRate: --TIP-- Process.Ticks;
CatalogProc: --Catalog-- TYPE = PROCEDURE [catalogType: NSFile.Type]
   RETURNS [continue: BOOLEAN ˆ TRUE];
ChangeInfo: --ContainerSource-- TYPE = RECORD [
   var: SELECT changeType: ChangeType FROM
      replace => [item: ItemIndex],
      insert => [insertInfo: LONG DESCRIPTOR FOR ARRAY CARDINAL OF EditInfo],
      delete => [deleteInfo: EditInfo],
      all => NULL,
      noChanges => NULL,
      ENDCASE];
ChangeProc: --Containee-- TYPE = PROCEDURE [
   changeProcData: LONG POINTER, data: DataHandle ˆ NIL,
   changedAttributes: NSFile.Selections ˆ [xxxx], noChanges: BOOLEAN ˆ FALSE];
ChangeProc: --ContainerSource-- TYPE = PROCEDURE [
   changeProcData: LONG POINTER, changeInfo: ChangeInfo];
ChangeReason: --FormWindow-- TYPE = {user, client, restore};
ChangeScope: --FileContainerSource-- PROCEDURE [
   source: ContainerSource.Handle, newScope: NSFile.Scope];
ChangeSizeProc: --SimpleTextEdit-- TYPE = PROCEDURE [
   f: Field, oldHeight: INTEGER, newHeight: INTEGER, repaint: BOOLEAN];
ChangeType: --ContainerSource-- TYPE = {
   replace, insert, delete, all, noChanges};
Char: --XFormat-- PROCEDURE [h: Handle ˆ NIL, char: XString.Character];
```

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Character: --XChar-- TYPE = WORD;
Character: --XString-- TYPE = XChar.Character;
CharacterLength: --XString-- PROCEDURE [r: Reader] RETURNS [CARDINAL];
CharRep: --XChar-- TYPE = MACHINE DEPENDENT RECORD [
   set(0:0..7): Environment.Byte, code(0:8..15): Environment.Byte];
CharTranslator: --TIP-- TYPE = RECORD [proc: KeyToCharProc, data: LONG POINTER];
ChoiceChangeProc: --FormWindow-- TYPE = PROCEDURE [
   window: Window.Handle, item: ItemKey, calledBecauseOf: ChangeReason,
   oldValue: ChoiceIndex, newValue: ChoiceIndex];
ChoiceHintsProc: --FormWindow-- TYPE = PROCEDURE [
   window: Window.Handle, item: ItemKey]
   RETURNS [
      hints: LONG DESCRIPTOR FOR ARRAY CARDINAL OF ChoiceIndex,
      freeHints: FreeChoiceHintsProc];
ChoiceIndex: --FormWindow-- TYPE = CARDINAL [0..37777B];
ChoiceItem: --FormWindow-- TYPE = RECORD [
   var: SELECT type: ChoiceItemType FROM
      string => [choiceNumber: ChoiceIndex, string: XString.ReaderBody],
      bitmap => [choiceNumber: ChoiceIndex, bitmap: Bitmap],
      wrapIndicator => NULL,
      ENDCASE];
ChoiceItems: --FormWindow-- TYPE = LONG DESCRIPTOR FOR ARRAY ChoiceIndex OF
   ChoiceItem;
ChoiceItemType: --FormWindow-- TYPE = {string, bitmap, wrapIndicator};
Circle: --Display-- PROCEDURE [
   window: Handle, place: Window.Place, radius: INTEGER,
   lineStyle: LineStyle ˆ NIL, bounds: Window.BoxHandle ˆ NIL];
Clarity: --Window-- TYPE = {isClear, isDirty};
Clear: --Attention-- PROCEDURE;
Clear: --MessageWindow-- PROCEDURE [window: Window.Handle];
Clear: --Selection-- PROCEDURE [unmark: BOOLEAN ˆ TRUE];
ClearInputFocusOnMatch: --TIP-- PROCEDURE [Window.Handle];
ClearManager: --TIP-- PROCEDURE;
ClearOnMatch: --Selection-- PROCEDURE [
   pointer: ManagerData, unmark: BOOLEAN ˆ TRUE];
ClearSticky: --Attention-- PROCEDURE;
ClearWriter: --XString-- PROCEDURE [w: Writer];
clickTimeout: --TIP-- System.Pulses;
ClientData: --XFormat-- TYPE = LONG POINTER;
ClientData: --XMessage-- TYPE = LONG POINTER;
clientDirectoryWords: --BWSAttributeTypes-- NSFile.ExtendedAttributeType =
   10373B;
clientFileWords: --BWSAttributeTypes-- NSFile.ExtendedAttributeType = 10372B;
Clients: --ContainerCache-- PROCEDURE [cache: Handle]
   RETURNS [clients: LONG POINTER];
clientSize: --BWSAttributeTypes-- NSFile.ExtendedAttributeType = 10375B;
clientStatus: --BWSAttributeTypes-- NSFile.ExtendedAttributeType = 10374B;
Code: --XChar-- PROCEDURE [c: Character] RETURNS [code: Environment.Byte];
Codes0: --XCharSet0-- TYPE = MACHINE DEPENDENT{
   null, tab(9), lineFeed, formFeed(12), newLine, esc(27), space(32),
   exclamationPoint, neutralDoubleQuote, numberSign, currency, percentSign,
   ampersand, apostrophe, openParenthesis, closeParenthesis, asterisk, plus,
  comma, minus, period, slash, digit0, digit1, digit2, digit3, digit4, digit5,
  digit6, digit7, digit8, digit9, colon, semicolon, lessThan, equals,
  greaterThan, questionMark, commercialAt, upperA, upperB, upperC, upperD,
  upperE, upperF, upperG, upperH, upperI, upperJ, upperK, upperL, upperM,
  upperN, upperO, upperP, upperQ, upperR, upperS, upperT, upperU, upperV,
  upperW, upperX, upperY, upperZ, openBracket, backSlash, closeBracket,
  circumflex, lowBar, grave, lowerA, lowerB, lowerC, lowerD, lowerE, lowerF,
  lowerG, lowerH, lowerI, lowerJ, lowerK, lowerL, lowerM, lowerN, lowerO,
  lowerP, lowerQ, lowerR, lowerS, lowerT, lowerU, lowerV, lowerW, lowerX,
  lowerY, lowerZ, openBrace, verticalBar, closeBrace, tilde,
  invertedExclamation(161), cent, poundSterling, dollar, yen, section(167),
  leftSingleQuote(169), leftDoubleQuote, leftDoubleGuillemet, leftArrow,
  upArrow, rightArrow, downArrow, degree, plusOrMinus, superscript2,
  superscript3, multiply, micro, paragraph, centeredDot, divide,
  rightSingleQuote, rightDoubleQuote, rightDoubleGuillemet, oneQuarter, oneHalf,
  threeQuarters, invertedQuestionMark, graveAccent(193), acuteAccent,
  circumflexAccent, tildeAccent, macronAccent, breveAccent, overDotAccent,
  dieresisAccent, overRingAccent(202), cedilla, underline, doubleAcuteAccent,
  ogonek, hachekAccent, horizontalBar, superscript1, registered, copyright,
  trademark, musicNote, oneEighth(220), threeEighths, fiveEighths, sevenEighths,
  ohmSign, upperAEdigraph, upperDstroke, feminineSpanishOrdinal, upperHstroke,
  upperIJdiagraph(230), upperLdot, upperLstroke, upperOslash, upperOEdiagraph,
  masculineSpanishOrdinal, upperThorn, upperTstroke, upperEng, lowerNapostrophe,
  lowerKgreenlandic, lowerAEdigraph, lowerDstroke, lowerEth, lowerHstroke,
  lowerIdotless, lowerIJdiagraph, lowerLdot, lowerLstroke, lowerOslash,
  lowerOEdiagraph, lowerSzed, lowerThorn, lowerTstroke, lowerEng, escape};
Codes164: --XCharSet164-- TYPE = MACHINE DEPENDENT{
  kabu(33), maruA, maruI, maruU, maruE, maruO, maruRo, maruHa, maruNi, maruHo,
  maruHe, maruTo, maruTi, maruRi, maruNu, reserved(255)};
Codes356: --XCharSet356-- TYPE = MACHINE DEPENDENT{
  thickSpace(33), fourEmSpace, hairSpace, punctuationSpace, decimalPoint(46),
  absoluteValue(124), similarTo(126), escape(255)};
Codes357: --XCharSet357-- TYPE = MACHINE DEPENDENT{
  nonBreakingSpace(33), nonBreakingHyphen, discretionaryHyphen, enDash, emDash,
  figureDash, neutralQuote, loweredLeftDoubleQuote, germanRightDoubleQuote,
  guillemetLeftQuote, guillemetRightQuote, enQuad, emQuad, figureSpace,
  thinSpace, dagger, doubleDagger, bra, ket, rightPointingIndex,
  leftPointingIndex, leftPerp, rightPerp, keft2Perp, right2Perp,
  leftWhiteLenticularBracket, rightWhiteLenticularBracket, nwArrow, seArrow,
  neArrow, swArrow, careOf, perThousand, muchLessThan, muchGreaterThan,
  notLessThan, notGreaterThan, divides, doesNotDivide, parallel, notParallel,
  isAMemberOf, isNotAMemberOf, suchThat, doubleBackArrow, doubleDoubleArrow,
  doubleRightArrow, reversibleReaction2, reversibleReaction1, doubleArrow,
  curlyArrow, contains1, containedIn1, intersection, union, containsOrEquals,
  containedInOrEquals, contains2, containedIn2, neitherConatainsNorIsEqualTo,
  neitherContainedInNorIsEqualTo, doesNotContain, isNotContainedIn,
  checketBallotBox, nullSet, abstractPlus, abstractMinus, abstractTimes,
  abstractDivide, centeredBullet, centeredRing, plancksConstant, litre, not,
  borkenVerticalBar, angle, sphericalAngle, identifier, because, perpendicular,
  isProportionalTo, equivalent, equalByDefinition, questionedEquality, integral,
  contourIntegral, approximatelyEqual1, isomorphic, approximatelyEqual2,
  summation, product, root, minusOrPlus, shade, cruzeiro(161), florin, francs,
    pesetas, europeanCurrency, milreis, genericInfinity, number, take, tel, yogh,
    complexNumber, naturalNumber, realNumber, integer, leftCeiling, rightCeiling,
    leftFloor, rightFloor, therExists, forAll, and, or, qed, nabla,
    partialDerivative, ocrHook, ocrFork, ocrChair, alternatingCurrent,
    doubleLowBar, arc, romanNumeralI, romanNumeralII, romanNumeralIII,
    romanNumeralIV, romanNumeralV, romanNumeralVI, romanNumeralVII,
    romanNumeralVIII, romanNumeralIX, romanNumeralX, spades, hearts, diamonds,
    clubs, checkMark, xMark, circled1, circled2, circled3, circled4, circled5,
    circled6, circled7, circled8, circled9, circled10, circledRightArrow,
    circledRightThenDownArrow, circledDownThenLeftArrow, peaceSymbol, smileFace,
    poison, thickVerticalLine, thickHorizontalLine, thickIntersectingLines,
    thinVerticalLine, thinHorizontalLine, thinIntersectingLines, sun,
    firstQuarterMoon, thirdQuarterMood, mercury, jupiter, saturn, uranus, neptune,
    pluto, aquarius, pisces, aries, taurus, gemini, cancer, leo, virgo, libra,
    scorpius, sagittarius, capricorn, telephone, oneThird, twoThirds, escape};
Codes360: --XCharSet360-- TYPE = MACHINE DEPENDENT{
    ligatureFF(33), ligatureFFI, ligatureFFL, ligatureFI, ligatureFL, ligatureFT,
    sigmaFinal(126), verticalTabGraphic(184), tabGraphic, lineFeedGraphic,
    formFeedGraphic, carriageReturnGraphic, newLineGraphic, available276B,
    available277B, available300B, available301B, pageFormatGraphic,
    startOfDocumentGraphic, stopGraphic, available305B, available306B,
    available307B, available310B, available311B, blackRectGraphic,
    checkerBoardGraphic, ibmDup, available315B, ibmFm, paraTabGraphic(217),
    available332B, available333B, available334B, newParagraphGraphic,
    available336B, available337B, available340B, boxMT, boxNOT, boxEllipsis,
    boxRange, boxUpperX, boxUpperA, boxdigit9, boxUpperZ, boxAsterisk,
    available352B, available353B, boxPlus, boxMinus, boxPeriod, boxComma,
    fieldFormatGreek(246), fieldFormatRussian, fieldFormatHiragana,
    fieldFormatKatakana, fieldFormatKanji, fieldFormatJapanese, spaceGraphicdot,
    spaceGraphicb, escape(255)};
Codes361: --XCharSet361-- TYPE = MACHINE DEPENDENT{
    upperAgrave(33), upperAacute, upperAcircumflex, upperAtilde, upperAmacron,
    upperAbrev, upperAumlaut, upperAring, upperAogonek, upperCacute,
    upperCcircumflex, upperChighDot, upperCcedilla, upperChachek, upperDhachek,
    upperEgrave, upperEacute, upperEcircumflex, upperEmacron, upperEhighDot,
    upperEumlaut, upperEogonek, upperEhachek, upperGcircumflex(57), upperGbrev,
    upperGhighDot, upperGcedilla, upperHcircumflex, upperIgrave, upperIacute,
    upperIcircumflex, upperItilde, upperImacron, upperIhighDot, upperIumlaut,
    upperIogonek, upperJcircumflex, upperKcedilla, upperLacute, upperLcedilla,
    upperLhachek, upperNacute, upperNtilde, upperNcedilla, upperNhachek,
    upperOgrave, upperOacute, upperOcircumflex, upperOtilde, upperOmacron,
    upperOumlaut, upperODoubleAcute, upperRacute, upperRogonek, upperRhachek,
    upperSacute, upperScircumflex, upperScedilla, upperShachek, upperTcedilla,
    upperThachek, upperUgrave, upperUacute, upperUcircumflex, upperUtilde,
    upperUmacron, upperUbrev, upperUumlaut, upperUring, upperUDoubleAcute,
    upperUogonek, upperWcircumflex, upperYgrave, upperYacute, upperYcircumflex,
    upperYumlaut, upperZacute, upperZhighDot, upperZhachek, lowerAgrave(161),
    lowerAacute, lowerAcircumflex, lowerAtilde, lowerAmacron, lowerAbrev,
    lowerAumlaut, lowerAring, lowerAogonek, lowerCacute, lowerCcircumflex,
    lowerChighDot, lowerCcedilla, lowerChachek, lowerDhachek, lowerEgrave,
    lowerEacute, lowerEcircumflex, lowerEmacron, lowerEhighDot, lowerEumlaut,
    lowerEogonek, lowerEhachek, lowerGacute, lowerGcircumflex, lowerGbrev,
    lowerGhighDot, lowerHcircumflex(189), lowerIgrave, lowerIacute,
    lowerIcircumflex, lowerItilde, lowerImacron, lowerIumlaut(196), lowerIogonek,
    lowerJcircumflex, lowerKcedilla, lowerLacute, lowerLcedilla, lowerLhachek,
    lowerNacute, lowerNtilde, lowerNcedilla, lowerNhachek, lowerOgrave,
    lowerOacute, lowerOcircumflex, lowerOtilde, lowerOmacron, lowerOumlaut,
    lowerODoubleAcute, lowerRacute, lowerRogonek, lowerRhachek, lowerSacute,
    lowerScircumflex, lowerScedilla, lowerShachek, lowerTcedilla, lowerThachek,
    lowerUgrave, lowerUacute, lowerUcircumflex, lowerUtilde, lowerUmacron,
    lowerUbrev, lowerUumlaut, lowerUring, lowerUDoubleAcute, lowerUogonek,
    lowerWcircumflex, lowerYgrave, lowerYacute, lowerYcircumflex, lowerYumlaut,
    lowerZacute, lowerZhighDot, lowerZhachek, escape(255)};
Codes41: --XCharSet41-- TYPE = MACHINE DEPENDENT{
    kanjiSpace(33), japaneseComma, japanesePeriod, dakuonMark(43), handakuonMark,
    repeatHiragana(51), repeatHiraganaWithDakuon, repeatKatakana,
    repeatKatakanaWithDakuon, reduplicate, reduplicateAboveItem, repeatKanji,
    shime, kanjiZero, longVowelBar, hyphen(62), parallelSign(66),
    threeDotLeader(68), twoDotLeader, leftBrokenBracket(76), rightBrokenBracket,
    leftJapaneseQuote(86), rightJapaneseQuote, leftJapaneseDoubleQuote,
    rightJapaneseDoubleQuote, leftBlackLenticularBracket,
    rightBlackLenticularBracket, notEqual(98), lessThanOrEqualTo(101),
    greaterThanOrEqualTo, infinity, therefore, male, female, minutes(108),
    seconds, degreesCelsius, whiteStar(121), blackStar, whiteCircle, blackCircle,
    bullsEye, whiteDiamond, escape(255)};
Codes42: --XCharSet42-- TYPE = MACHINE DEPENDENT{
    blackDiamond(33), whiteSquare, blackSquare, whiteUpTriangle, blackUpTriangle,
    whiteDownTriangle, blackDownTriangle, jisKome, jisPostOffice, escape(255)};
Codes43: --XCharSet43-- TYPE = MACHINE DEPENDENT{
    musicalFlat(172), soundRecordingCopyright(174), ayn(176), alifHamzah,
    lowerLeftQuote, musicalSharp(188), mjagkijZnak, tverdyjZnak, risingTone(192),
    umlaut(201), highCommaOffCentre(203), highInvertedComma, horn(206),
    hookToTheLeft(210), circleBelow(212), halfCircleBelow, dotBelow,
    doubleDotBelow, doubleUnderline(217), africanVerticalBar, circumflexUndermark,
    leftHalfOfLigature(221), rightHalfOfLigature, rightHalfOfDoubleTilda,
    escape(255)};
Codes44: --XCharSet44-- TYPE = MACHINE DEPENDENT{
    hirSmallA(33), hirA, hirSmallI, hirI, hirSmallU, hirU, hirSmallE, hirE,
    hirSmallO, hirO, hirKa, hirGa, hirKi, hirGi, hirKu, hirGu, hirKe, hirGe,
    hirKo, hirGo, hirSa, hirZa, hirSi, hirJi, hirSu, hirZu, hirSe, hirZe, hirSo,
    hirZo, hirTa, hirDa, hirTi, hirDi, hirSmallTu, hirTu, hirDu, hirTe, hirDe,
    hirTo, hirDo, hirNa, hirNi, hirNu, hirNe, hirNo, hirHa, hirBa, hirPa, hirHi,
    hirBi, hirPi, hirHu, hirBu, hirPu, hirHe, hirBe, hirPe, hirHo, hirBo, hirPo,
    hirMa, hirMi, hirMu, hirMe, hirMo, hirSmallYa, hirYa, hirSmallYu, hirYu,
    hirSmallYo, hirYo, hirRa, hirRi, hirRu, hirRe, hirRo, hirSmallWa, hirWa,
    hirWi, hirWe, hirWo, hirN, escape(255)};
Codes45: --XCharSet45-- TYPE = MACHINE DEPENDENT{
    katSmallA(33), katA, katSmallI, katI, katSmallU, katU, katSmallE, katE,
    katSmallO, katO, katKa, katGa, katKi, katGi, katKu, katGu, katKe, katGe,
    katKo, katGo, katSa, katZa, katSi, katJi, katSu, katZu, katSe, katZe, katSo,
    katZo, katTa, katDa, katTi, katDi, katSmallTu, katTu, katDu, katTe, katDe,
    katTo, katDo, katNa, katNi, katNu, katNe, katNo, katHa, katBa, katPa, katHi,
    katBi, katPi, katHu, katBu, katPu, katHe, katBe, katPe, katHo, katBo, katPo,
    katMa, katMi, katMu, katMe, katMo, katSmallYa, katYa, katSmallYu, katYu,
  katSmallYo, katYo, katRa, katRi, katRu, katRe, katRo, katSmallWa, katWa,
  katWi, katWe, katWo, katN, katVu, katSmallKa, katSmallKe, escape(255)};
Codes46: --XCharSet46-- TYPE = MACHINE DEPENDENT{
  smootheBreathing(37), roughBreathing, iotaScript, upperPrime(52), lowerPrime,
  raisedPeriod(59), upperAlpha(65), upperBeta, upperGamma(68), upperDelta,
  upperEpsilon, upperStigma, upperDigamma, upperZeta, upperEta, upperTheta,
  upperIota, upperKappa, upperLambda, upperMu, upperNu, upperXi, upperOmicron,
  upperPi, upperKoppa, upperRho, upperSigma, a127B, upperTau, upperUpsilon,
  upperPhi, upperKhi, upperPsi, upperOmega, upperSampi, lowerAlpha(97),
  lowerBeta, lowerBetaMiddleWord, lowerGamma, lowerDelta, lowerEpsilon,
  lowerStigma, lowerDigamma, lowerZeta, lowerEta, lowerTheta, lowerIota,
  lowerKappa, lowerLambda, lowerMu, lowerNu, lowerXi, lowerOmicron, lowerPi,
  lowerKoppa, lowerRho, lowerSigma, lowerSigmaMiddleWord, lowerTau,
  lowerUpsilon, lowerPhi, lowerKhi, lowerPsi, lowerOmega, lowerSampi,
  escape(255)};
Codes47: --XCharSet47-- TYPE = MACHINE DEPENDENT{
  upperA(33), upperBe, upperVe, upperGe, upperDe, upperYe, upperYo, upperZhe,
  upperZe, upperI, upperIKratkoye, upperKa, upperEl, upperEm, upperEn, upperO,
  upperPe, upperEr, upperEs, upperTe, upperU, upperEf, upperXa, upperTse,
  upperChe, upperSha, upperShCha, upperTvyordiiZnak, upperYeri,
  upperMyaxkiiZnak, upperEOborotnoye, upperYu, upperYa, lowerA(81), lowerBe,
  lowerVe, lowerGe, lowerDe, lowerYe, lowerYo, lowerZhe, lowerZe, lowerI,
  lowerIKratkoye, lowerKa, lowerEl, lowerEm, lowerEn, lowerO, lowerPe, lowerEr,
  lowerEs, lowerTe, lowerU, lowerEf, lowerXa, lowerTse, lowerChe, lowerSha,
  lowerShCha, lowerTvyordiiZnak, lowerYeri, lowerMyaxkiiZnak, lowerEOborotnoye,
  lowerYu, lowerYa, escape(255)};
ColumnContents: --FileContainerSource-- TYPE = LONG DESCRIPTOR FOR ARRAY
  CARDINAL OF ColumnContentsInfo;
ColumnContentsInfo: --FileContainerSource-- TYPE = RECORD [
  info: SELECT type: ColumnType FROM
    attribute => [
      attr: NSFile.AttributeType,
      formatProc: AttributeFormatProc ← NIL,
      needsDataHandle: BOOLEAN ← FALSE],
    extendedAttribute => [
      extendedAttr: NSFile.ExtendedAttributeType,
      formatProc: AttributeFormatProc ← NIL,
      needsDataHandle: BOOLEAN ← FALSE],
    multipleAttributes => [
      attrs: NSFile.Selections,
      formatProc: MultiAttributeFormatProc ← NIL,
      needsDataHandle: BOOLEAN ← FALSE],
    ENDCASE];
ColumnCount: --ContainerSource-- ColumnCountProc;
ColumnCountProc: --ContainerSource-- TYPE = PROCEDURE [source: Handle]
  RETURNS [columns: CARDINAL];
ColumnHeaderInfo: --ContainerWindow-- TYPE = RECORD [
  width: CARDINAL, wrap: BOOLEAN ← TRUE, heading: XString.ReaderBody];
ColumnHeaders: --ContainerWindow-- TYPE = LONG DESCRIPTOR FOR ARRAY CARDINAL OF
  ColumnHeaderInfo;
ColumnType: --FileContainerSource-- TYPE = {
  attribute, extendedAttribute, multipleAttributes},
CommandProc: --FormWindow-- TYPE = PROCEDURE [
   window: Window.Handle, item: ItemKey, clientData: LONG POINTER];
Compare: --XLReal-- PROCEDURE [a: Number, b: Number] RETURNS [Comparison];
Compare: --XString-- PROCEDURE [
   r1: Reader, r2: Reader, ignoreCase: BOOLEAN ˆ TRUE,
   sortOrder: SortOrder ˆ standard] RETURNS [Relation];
CompareStringsAndStems: --XString-- PROCEDURE [
   r1: Reader, r2: Reader, ignoreCase: BOOLEAN ˆ TRUE,
   sortOrder: SortOrder ˆ standard]
   RETURNS [relation: Relation, equalStems: BOOLEAN];
Comparison: --XLReal-- TYPE = {less, equal, greater};
compatibility: --BWSAttributeTypes-- NSFile.ExtendedAttributeType = 10376B;
Compose: --XMessage-- PROCEDURE [
   source: XString.Reader, destination: XString.Writer, args: StringArray];
ComposeOne: --XMessage-- PROCEDURE [
   source: XString.Reader, destination: XString.Writer, arg: XString.Reader];
ComposeOneToFormatHandle: --XMessage-- PROCEDURE [
   source: XString.Reader, destination: XFormat.Handle, arg: XString.Reader];
ComposeToFormatHandle: --XMessage-- PROCEDURE [
   source: XString.Reader, destination: XFormat.Handle, args: StringArray];
ComputeEndContext: --XString-- PROCEDURE [r: Reader] RETURNS [c: Context];
ConfirmChoices: --Attention-- TYPE = RECORD [
   yes: XString.Reader, no: XString.Reader];
Conic: --Display-- PROCEDURE [
   window: Handle, a: LONG INTEGER, b: LONG INTEGER, c: LONG INTEGER,
   d: LONG INTEGER, e: LONG INTEGER, errorTerm: LONG INTEGER,
   start: Window.Place, stop: Window.Place, errorRef: Window.Place,
   sharpCornered: BOOLEAN, unboundedStart: BOOLEAN, unboundedStop: BOOLEAN,
   lineStyle: LineStyle ˆ NIL, bounds: Window.BoxHandle ˆ NIL];
containedIn: --BWSAttributeTypes-- NSFile.ExtendedAttributeType = 10400B;
Context: --XString-- TYPE = MACHINE DEPENDENT RECORD [
   suffixSize(0:0..6): [1..2],
   homogeneous(0:7..7): BOOLEAN,
   prefix(0:8..15): Environment.Byte];
ConversionInfo: --Selection-- TYPE = RECORD [
   SELECT type: * FROM
   convert = > NULL,
   enumeration = > [proc: PROCEDURE [Value] RETURNS [stop: BOOLEAN]],
   query = > [query: LONG DESCRIPTOR FOR ARRAY CARDINAL OF QueryElement],
   ENDCASE];

Dummy: DEFINITIONS =
BEGIN

Convert: --Selection-- PROCEDURE [
   target: Target, zone: UNCOUNTED ZONE ˆ LOOPHOLE[0]] RETURNS [value: Value];
Converter: --ProductFactoringProducts-- Product = 7;
ConvertInteger: --UnitConversion-- PROCEDURE [
   n: LONG INTEGER, inputUnits: Units, outputUnits: Units]
   RETURNS [LONG INTEGER];
ConvertItem: --ContainerSource-- ConvertItemProc;
ConvertItemProc: --ContainerSource-- TYPE = PROCEDURE [
   source: Handle, itemIndex: ItemIndex, n: CARDINAL ˆ 1,
    target: Selection.Target, zone: UNCOUNTED ZONE,
    info: Selection.ConversionInfo ˆ xxx, changeProc: ChangeProc ˆ NIL,
    changeProcData: LONG POINTER ˆ NIL] RETURNS [value: Selection.Value];
ConvertNumber: --Selection-- PROCEDURE [target: Target]
    RETURNS [ok: BOOLEAN, number: LONG UNSPECIFIED];
ConvertProc: --Selection-- TYPE = PROCEDURE [
    data: ManagerData, target: Target, zone: UNCOUNTED ZONE,
    info: ConversionInfo ˆ xxx] RETURNS [value: Value];
ConvertReal: --UnitConversion-- PROCEDURE [
    n: XLReal.Number, inputUnits: Units, outputUnits: Units]
    RETURNS [XLReal.Number];
Copy: --Selection-- PROCEDURE [v: ValueHandle, data: LONG POINTER];
CopyMove: --Selection-- ValueCopyMoveProc;
CopyOrMove: --Selection-- TYPE = {copy, move};
CopyReader: --XString-- PROCEDURE [r: Reader, z: UNCOUNTED ZONE]
    RETURNS [new: Reader];
CopyToNewReaderBody: --XString-- PROCEDURE [r: Reader, z: UNCOUNTED
ZONE]
    RETURNS [ReaderBody];
CopyToNewWriterBody: --XString-- PROCEDURE [
    r: Reader, z: UNCOUNTED ZONE, endContext: Context ˆ unknownContext,
    extra: CARDINAL ˆ 0] RETURNS [w: WriterBody];
Cos: --XLReal-- PROCEDURE [radians: Number] RETURNS [cos: Number];
coversheetOn: --BWSAttributeTypes-- NSFile.ExtendedAttributeType =
10412B;
CR: --XFormat-- PROCEDURE [h: Handle ˆ NIL, n: CARDINAL ˆ 1];
Create: --Catalog-- PROCEDURE [
    name: XString.Reader, catalogType: NSFile.Type,
    session: NSFile.Session ˆ LOOPHOLE[0]] RETURNS [catalog:
NSFile.Reference];
Create: --ContainerWindow---PROCEDURE [
    window: Window.Handle, source: ContainerSource.Handle,
    columnHeaders: ColumnHeaders, firstItem: ContainerSource.ItemIndex ˆ 0]
    RETURNS [
        regularMenuItems: MenuData.ArrayHandle,
        topPusheeMenuItems: MenuData.ArrayHandle];
Create: --ContainerWindowExtra-- PROCEDURE [
    window: Window.Handle, source: ContainerSource.Handle,
    columnHeaders: ContainerWindow.ColumnHeaders,
    firstItem: ContainerSource.ItemIndex ˆ 0, readOnly: BOOLEAN ˆ FALSE]
    RETURNS [
        regularMenuItems: MenuData.ArrayHandle,
        topPusheeMenuItems: MenuData.ArrayHandle];
Create: --Context-- PROCEDURE [
    type: Type, data: Data, proc: DestroyProcType, window: Window.Handle];
Create: --FileContainerShell-- PROCEDURE [
    file: NSFile.Reference, columnHeaders: ContainerWindow.ColumnHeaders,
    columnContents: FileContainerSource.ColumnContents,
    regularMenuItems: MenuData.ArrayHandle ˆ xxx,
    topPusheeMenuItems: MenuData.ArrayHandle ˆ xxx, scope: NSFile.Scope ˆ
    xxx,
    position: ContainerSource.ItemIndex ˆ 0,
    options: FileContainerSource.Options ˆ LOOPHOLE[0]]
    RETURNS [shell: StarWindowShell.Handle];
```

```
Create: --FileContainerSource-- PROCEDURE [
   file: NSFile.Reference, columns: ColumnContents, scope: NSFile.Scope ^ xxx,
   options: Options ^ LOOPHOLE[0]] RETURNS [source: ContainerSource.Handle];
Create: --FormWindow-- PROCEDURE [
   window: Window.Handle, makeItemsProc: MakeItemsProc,
   layoutProc: LayoutProc ^ NIL, windowChangeProc: GlobalChangeProc ^ NIL,
   minDimsChangeProc: MinDimsChangeProc ^ NIL,
   zone: UNCOUNTED ZONE ^ LOOPHOLE[0], clientData: LONG POINTER ^ NIL];
Create: --MessageWindow-- PROCEDURE [
   window: Window.Handle, zone: UNCOUNTED ZONE ^ LOOPHOLE[0],
   lines: CARDINAL ^ 10];
Create: --PropertySheet-- PROCEDURE [
   formWindowItems: FormWindow.MakeItemsProc, menuItemProc: MenuItemProc,
   size: Window.Dims, menuItems: MenuItems ^ propertySheetDefaultMenu,
   title: XString.Reader ^ NIL, placeToDisplay: Window.Place ^ nullPlace,
   formWindowItemsLayout: FormWindow.LayoutProc ^ NIL,
   windowAttachedTo: StarWindowShell.Handle ^ LOOPHOLE[0],
   globalChangeProc: FormWindow.GlobalChangeProc ^ NIL, display: BOOLEAN ^ TRUE,
   clientData: LONG POINTER ^ NIL, afterTakenDownProc: MenuItemProc ^ NIL,
   zone: UNCOUNTED ZONE ^ LOOPHOLE[0]] RETURNS [shell: StarWindowShell.Handle];
Create: --Prototype-- PROCEDURE [
   name: XString.Reader, type: NSFile.Type, version: Version,
   subtype: Subtype ^ 0, size: LONG CARDINAL ^ 0, isDirectory: BOOLEAN ^ FALSE,
   session: NSFile.Session ^ LOOPHOLE[0]] RETURNS [prototype: NSFile.Handle];
Create: --StarWindowShell-- PROCEDURE [
   transitionProc: TransitionProc ^ NIL, name: XString.Reader ^ NIL,
   namePicture: XString.Character ^ 0, host: Handle ^ LOOPHOLE[0],
   type: ShellType ^ regular, sleeps: BOOLEAN ^ FALSE,
   considerShowingCoverSheet: BOOLEAN ^ TRUE,
   currentlyShowingCoverSheet: BOOLEAN ^ FALSE,
   pushersAreReadonly: BOOLEAN ^ FALSE, readonly: BOOLEAN ^ FALSE,
   scrollData: ScrollData ^ vanillaScrollData,
   garbageCollectBodiesProc: PROCEDURE [Handle] ^ NIL,
   isCloseLegalProc: IsCloseLegalProc ^ NIL, bodyGravity: Window.Gravity ^ nw,
   zone: UNCOUNTED ZONE ^ LOOPHOLE[0]] RETURNS [Handle];
Create: --Window-- PROCEDURE [
   display: DisplayProc, box: Box, parent: Handle ^ rootWindow,
   sibling: Handle ^ NIL, child: Handle ^ NIL, clearingRequired: BOOLEAN ^ TRUE,
   windowPane: BOOLEAN ^ FALSE, under: BOOLEAN ^ FALSE, cookie: BOOLEAN ^ FALSE,
   color: BOOLEAN ^ FALSE, zone: UNCOUNTED ZONE ^ LOOPHOLE[0]]
   RETURNS [window: Handle];
CreateBody: --StarWindowShell-- PROCEDURE [
   sws: Handle, repaintProc: PROCEDURE [Window.Handle] ^ NIL,
   bodyNotifyProc: TIP.NotifyProc ^ NIL, box: Window.Box ^ xxx]
   RETURNS [Window.Handle];
CreateCharTable: --TIP-- PROCEDURE [
   z: UNCOUNTED ZONE ^ LOOPHOLE[0], buffered: BOOLEAN ^ TRUE]
   RETURNS [table: Table];
CreateDesktop: --StarDesktop-- PROCEDURE [name: XString.Reader]
   RETURNS [fh: NSFile.Handle];
CreateField: --SimpleTextEdit-- PROCEDURE [
   clientData: LONG POINTER, context: FieldContext, dims: Window.Dims,
   initString: XString.Reader ^ NIL,
   flushness: SimpleTextDisplay.Flushness ^ fromFirstChar,
   streakSuccession: SimpleTextDisplay.StreakSuccession ^ fromFirstChar,
   readOnly: BOOLEAN ^ FALSE, password: BOOLEAN ^ FALSE,
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fixedHeight: BOOLEAN ^ FALSE, font: SimpleTextFont.MappedFontHandle ^ NIL,
backingWriter: XString.Writer ^ NIL,
SPECIALKeyboard: BlackKeys.Keyboard ^ NIL] RETURNS [f: Field];
CreateFieldContext: --*SimpleTextEdit*-- PROCEDURE [
z: UNCOUNTED ZONE, window: Window.Handle, changeSizeProc: ChangeSizeProc]
RETURNS [fc: FieldContext];
CreateFile: --*Catalog*-- PROCEDURE [
catalogType: NSFile.Type ^ 10476B, name: XString.Reader, type: NSFile.Type,
isDirectory: BOOLEAN ^ FALSE, size: LONG CARDINAL ^ 0,
session: NSFile.Session ^ LOOPHOLE[0]] RETURNS [file: NSFile.Handle];
CreateItem: --*MenuData*-- PROCEDURE [
zone: UNCOUNTED ZONE, name: XString.Reader, proc: MenuProc,
itemData: LONG UNSPECIFIED ^ 0] RETURNS [ItemHandle];
CreateLinked: --*PropertySheet*-- PROCEDURE [
formWindowItems: FormWindow MakeItemsProc, menuItemProc: MenuItemProc,
size: Window.Dims, menuItems: MenuItems ^ propertySheetDefaultMenu,
title: XString.Reader ^ NIL, placeToDisplay: Window.Place ^ nullPlace,
formWindowItemsLayout: FormWindow.LayoutProc ^ NIL,
windowAttachedTo: StarWindowShell.Handle ^ LOOPHOLE[0],
globalChangeProc: FormWindow.GlobalChangeProc ^ NIL, display: BOOLEAN ^ TRUE,
linkWindowItems: FormWindow.MakeItemsProc,
linkWindowItemsLayout: FormWindow.LayoutProc ^ NIL,
clientData: LONG POINTER ^ NIL, afterTakenDownProc: MenuItemProc ^ NIL,
zone: UNCOUNTED ZONE ^ LOOPHOLE[0]] RETURNS [shell: StarWindowShell.Handle];
CreateMenu: --*MenuData*-- PROCEDURE [
zone: UNCOUNTED ZONE, title: ItemHandle, array: ArrayHandle,
copyItemsIntoMenusZone: BOOLEAN ^ FALSE] RETURNS [MenuHandle];
CreatePeriodicNotify: --*TIP*-- PROCEDURE [
window: Window.Handle ^ NIL, results: Results, milliSeconds: CARDINAL,
notifyProc: NotifyProc ^ NIL] RETURNS [PeriodicNotify];
CreatePlaceHolderTable: --*TIP*-- PROCEDURE [z: UNCOUNTED ZONE ^ LOOPHOLE[0]]
RETURNS [table: Table];
CreateProcType: --*Context*-- TYPE = PROCEDURE RETURNS [Data, DestroyProcType];
CreateTable: --*TIP*-- PROCEDURE [
file: XString.Reader, z: UNCOUNTED ZONE ^ LOOPHOLE[0],
contents: XString.Reader ^ NIL] RETURNS [table: Table];
Current: --*XTime*-- PROCEDURE RETURNS [time: System.GreenwichMeanTime];
DashCnt: --*Display*-- CARDINAL = 6;
Data: --*Containee*-- TYPE = RECORD [reference: NSFile.Reference ^ xxx];
Data: --*Context*-- TYPE = LONG POINTER;
DataHandle: --*Containee*-- TYPE = LONG POINTER TO Data;
Date: --*XFormat*-- PROCEDURE [
h: Handle ^ NIL, time: System.GreenwichMeanTime ^ LOOPHOLE[17601311200B],
format: DateFormat ^ dateAndTime];
dateAndTime: --*XTime*-- XString.Reader;
DateColumn: --*FileContainerSource*-- PROCEDURE
RETURNS [multipleAttributes ColumnContentsInfo];
DateFormat: --*XFormat*-- TYPE = {dateOnly, timeOnly, dateAndTime};
dateOnly: --*XTime*-- XString.Reader;
DaysOfWeek: --*XComSoftMessage* TYPE = Keys [monday..sunday];
Decase: --*XChar*-- PROCEDURE [c: Character] RETURNS [Character];
Decimal: --*XFormat*-- PROCEDURE [h: Handle ^ NIL, n: LONG INTEGER];
Decimal: --*XToken*-- PROCEDURE [h: Handle, signalOnError: BOOLEAN ^ TRUE]
RETURNS [i: LONG INTEGER];
DecimalFormat: --*XFormat*-- NumberFormat;

Decompose: --*XMessage*-- PROCEDURE [source: XString.Reader]
  RETURNS [args: StringArray];
DefaultFileConvertProc: --*Containee*-- Selection.ConvertProc;
defaultGeometry: --*KeyboardWindow*-- BlackKeys.GeometryTable;
DefaultLayout: --*FormWindow*-- LayoutProc;
defaultPicture: --*KeyboardWindow*-- BlackKeys.Picture;
DefaultPictureProc: --*KeyboardWindow*-- BlackKeys.PictureProc;
defaultTabStops: --*FormWindow*-- TabStops;
defaultTime: --*XTime*-- System.GreenwichMeanTime;
Defined: --*Cursor*-- TYPE = Type [blank. column];
DeleteAll: --*Undo*-- PROCEDURE;
DeleteAndShowNextPrevious: --*ContainerWindow*-- PROCEDURE [
  window: Window.Handle, item: ContainerSource.ItemIndex, direction: Direction];
DeleteAndShowNextPrevious: --*ContainerWindowExtra2*-- PROCEDURE [
  window: Window.Handle, item: ContainerSource.ItemIndex,
  direction: ContainerWindow.Direction]
  RETURNS [newOpenShell: StarWindowShell.Handle];
DeleteItems: --*ContainerSource*-- DeleteItemsProc;
DeleteItemsProc: --*ContainerSource*-- TYPE = PROCEDURE [
  source: Handle, itemIndex: ItemIndex, n: CARDINAL ^ 1,
  changeProc: ChangeProc ^ NIL, changeProcData: LONG POINTER ^ NIL];
DeleteNItems: --*ContainerCache*-- PROCEDURE [
  cache: Handle, item: CARDINAL, nitems: CARDINAL ^ 1];
Delimited: --*XToken*-- FilterProcType;
Dependency: --*Event*-- TYPE [2];
Dereference: --*XString*-- PROCEDURE [r: Reader] RETURNS [rb: ReaderBody];
DescribeOption: --*ProductFactoring*-- PROCEDURE [
  option: Option, desc: XString.Reader,
  prerequisite: Prerequisite ^ nullPrerequisite];
DescribeProduct: --*ProductFactoring*-- PROCEDURE [
  product: Product, desc: XString.Reader];
DescribeReader: --*XString*-- Courier.Description;
DescribeReaderBody: --*XString*-- Courier.Description;
desktop: --*BWSFileTypes*-- NSFile.Type = 10400B;
desktopCatalog: --*BWSFileTypes*-- NSFile.Type = 10400B;
DesktopProc: --*IdleControl*-- TYPE = PROCEDURE;
desktopWindowAvailable: --*StarDesktop*-- Atom.ATOM;
DestallBody: --*StarWindowShell*-- PROCEDURE [body: Window.Handle];
Destroy: --*ContainerWindow*-- PROCEDURE [Window.Handle];
Destroy: --*Context*-- PROCEDURE [type: Type, window: Window.Handle];
Destroy: --*FormWindow*-- PROCEDURE [window: Window.Handle];
Destroy: --*MessageWindow*-- PROCEDURE [Window.Handle];
Destroy: --*StarWindowShell*-- PROCEDURE [sws: Handle];
DestroyAll: --*Context*-- PROCEDURE [window: Window.Handle];
DestroyBody: --*StarWindowShell*-- PROCEDURE [body: Window.Handle];
DestroyField: --*SimpleTextEdit*-- PROCEDURE [f: Field];
DestroyFieldContext: --*SimpleTextEdit*-- PROCEDURE [fc: FieldContext];
END.

DestroyItem: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, item: ItemKey, repaint: BOOLEAN ^ TRUE];
DestroyItem: --*MenuData*-- PROCEDURE [zone: UNCOUNTED ZONE, item: ItemHandle];
DestroyItems: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, item: LONG DESCRIPTOR FOR ARRAY CARDINAL OF ItemKey,
  repaint: BOOLEAN ^ TRUE];

DestroyMenu: --*MenuData*-- PROCEDURE [zone: UNCOUNTED ZONE, menu: MenuHandle];

DestroyMessages: --*XMessage*-- PROCEDURE [h: Handle];

DestroyMsgsProc: --*XMessage*-- TYPE = PROCEDURE [clientData: ClientData];

DestroyProcType: --*Context*-- TYPE = PROCEDURE [Data, Window.Handle];

DestroyTable: --*TIP*-- PROCEDURE [LONG POINTER TO Table];

DFonts: --*ProductFactoringProducts*-- Product = 3;

Difficulty: --*Selection*-- TYPE = {easy, moderate, hard, impossible};

Digit: --*XLReal*-- TYPE = [0..9];

Digits: --*XLReal*-- TYPE = PACKED ARRAY [0..12] OF Digit;

Dims: --*Window*-- TYPE = RECORD [w: INTEGER, h: INTEGER];

Direction: --*ContainerWindow*-- TYPE = {next, previous};

Discard: --*Selection*-- PROCEDURE [saved: Saved, unmark: BOOLEAN ^ TRUE];

DisplayProc: --*Window*-- TYPE = PROCEDURE [window: Handle];

Divide: --*XLReal*-- PROCEDURE [a: Number, b: Number] RETURNS [Number];

DoAnUndo: --*Undo*-- PROCEDURE;

DoAnUnundo: --*Undo*-- PROCEDURE;

DoneLookingAtTextItemValue: --*FormWindow*-- PROCEDURE [
window: Window.Handle, item: ItemKey];

DoneWithString: --*AtomicProfile*-- PROCEDURE [string: XString.Reader];

dontTimeout: --*Attention*-- Process Ticks = 0;

DoTheGreeterProc: --*IdleControl*-- GreeterProc;

Double: --*XLReal*-- PROCEDURE [Number] RETURNS [Number];

DownUp: --*LevelIVKeys*-- TYPE = KeyStations.DownUp;

DownUp: --*TIP*-- TYPE = LevelIVKeys DownUp;

DstFunc: --*Display*-- TYPE = BitBlt.DstFunc;

E: --*XLReal*-- PROCEDURE RETURNS [Number];

EditInfo: --*ContainerSource*-- TYPE = RECORD [
afterItem: ItemIndex, nItems: CARDINAL];

Ellipse: --*Display*-- PROCEDURE [
window: Handle, center: Window.Place, xRadius: INTEGER, yRadius: INTEGER,
lineStyle: LineStyle ^ NIL, bounds: Window.BoxHandle ^ NIL];

Empty: --*XString*-- PROCEDURE [r: Reader] RETURNS [BOOLEAN];

emptyContext: --*XString*-- Context;

Enabled: --*ProductFactoring*-- PROCEDURE [option: Option]
RETURNS [enabled: BOOLEAN];

EntireBox: --*Window*-- PROCEDURE [Handle] RETURNS [box: Box];

EntryEnumProc: --*OptionFile*-- TYPE = PROCEDURE [entry: XString.Reader]
RETURNS [stop: BOOLEAN ^ FALSE];

Enumerate: --*Catalog*-- PROCEDURE [proc: CatalogProc];

Enumerate: --*Selection*-- PROCEDURE [
proc: EnumerationProc, target: Target, data: RequestorData ^ NIL,
zone: UNCOUNTED ZONE ^ LOOPHOLE[0]] RETURNS [aborted: BOOLEAN];

EnumerateAllMenus: --*StarWindowShellExtra*-- PROCEDURE [
sws: StarWindowShell.Handle, proc: StarWindowShell.MenuEnumProc];

EnumerateDisplayed: --*StarWindowShell*-- PROCEDURE [proc: ShellEnumProc]
RETURNS [Handle ^ LOOPHOLE[0]];

EnumerateDisplayedOfType: --*StarWindowShell*-- PROCEDURE [
type: ShellType, proc: ShellEnumProc] RETURNS [Handle ^ LOOPHOLE[0]];

EnumerateEntries: --*OptionFile*-- PROCEDURE [
section: XString.Reader, callBack: EntryEnumProc,
file: NSFile.Reference ^ xxx];

EnumerateInvalidBoxes: --*Window*-- PROCEDURE [window: Handle, proc: BoxEnumProc];

EnumerateKeyboards: --*KeyboardKey*-- PROCEDURE [
class: KeyboardClass, enumProc: EnumerateProc];

EnumerateMyDisplayedParasites: --*StarWindowShell*-- PROCEDURE [
  sws: Handle, proc: ShellEnumProc] RETURNS [Handle ˆ LOOPHOLE[0]];
EnumeratePopupMenus: --*StarWindowShell*-- PROCEDURE [
  sws: Handle, proc: MenuEnumProc];
EnumerateProc: --*KeyboardKey*-- TYPE = PROCEDURE [
  keyboard: BlackKeys.Keyboard, class. KeyboardClass]
  RETURNS [stop: BOOLEAN ˆ FALSE];
EnumerateSections: --*OptionFile*-- PROCEDURE [
  callBack: SectionEnumProc, file: NSFile.Reference ˆ xxx];
EnumerateString: --*AtomicProfile*-- PROCEDURE [
  atom: Atom.ATOM, proc: PROCEDURE [XString.Reader]];
EnumerateTree: --*Window*-- PROCEDURE [
  root: Handle, proc: PROCEDURE [window: Handle]];
EnumerationProc: --*Selection*-- TYPE = PROCEDURE [
  element: Value, data: RequestorData] RETURNS [stop: BOOLEAN ˆ FALSE];
Equal: --*XLReal*-- PROCEDURE [a: Number, b: Number] RETURNS [BOOLEAN];
Equal: --*XString*-- PROCEDURE [r1: Reader, r2: Reader] RETURNS [BOOLEAN];
Equivalent: --*XString*-- PROCEDURE [r1: Reader, r2: Reader] RETURNS [BOOLEAN];
eraseFlags: --*Display*-- BitBltFlags;
Error: --*Containee*-- ERROR [
  msg: XString.Reader ˆ NIL, error: ERROR ˆ NIL, errorData: LONG POINTER ˆ NIL];
Error: --*ContainerSource*-- ERROR [
  code: ErrorCode, msg: XString.Reader ˆ NIL, error: ERROR ˆ NIL,
  errorData: LONG POINTER ˆ NIL];
Error: --*ContainerWindow*-- ERROR [code: ErrorCode];
Error: --*Context*-- ERROR [code: ErrorCode];
Error: --*FormWindow*-- ERROR [code: ErrorCode];
Error: --*KeyboardKey*-- ERROR [code: ErrorCode];
Error: --*OptionFile*-- ERROR [code: ErrorCode];
Error: --*ProductFactoring*-- ERROR [type: ErrorType];
Error: --*PropertySheet*-- ERROR [code: ErrorCode];
Error: --*Selection*-- ERROR [code: ErrorCode];
Error: --*SimpleTextEdit*-- ERROR [type: ErrorType];
Error: --*StarWindowShell*-- ERROR [code: ErrorCode];
Error: --*TIP*-- ERROR [code: ErrorCode];
Error: --*Window*-- ERROR [code: ErrorCode];
Error: --*XFormat*-- ERROR [code: ErrorCode];
Error: --*XLReal*-- ERROR [code: ErrorCode];
Error: --*XMessage*-- ERROR [type: ErrorType];
Error: --*XString*-- ERROR [code: ErrorCode];
ErrorCode: --*ContainerSource*-- TYPE = MACHINE DEPENDENT{
  invalidParameters, accessError, fileError, noSuchItem, other, last(15)};
ErrorCode: --*ContainerWindow*-- TYPE = MACHINE DEPENDENT{
  notAContainerWindow, noSuchItem, last(7)};
ErrorCode: --*Context*-- TYPE = {duplicateType, windowIsNIL, tooManyTypes, other};
ErrorCode: --*FormWindow*-- TYPE = MACHINE DEPENDENT{
  notAFormWindow, wrongItemType, invalidChoiceNumber, noSuchLine,
  alreadyAFormWindow, invalidItemKey, itemNotOnLine, duplicateItemKey,
  incompatibleLayout, alreadyLaidOut, last(15)};
ErrorCode: --*KeyboardKey*-- TYPE = {
  alreadyInSystemKeyboards, notInSystemKeyboards, insufficientSpace};
ErrorCode: --*OptionFile*-- TYPE = {
  invalidParameters, inconsistentValue, notFound, syntaxError};
ErrorCode: --*PropertySheet*-- TYPE = {notAPropSheet};

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ErrorCode: --Selection-- TYPE = {
   tooManyActions, tooManyTargets, invalidOperation, operationFailed, didntAbort,
   didntClear};
ErrorCode: --StarWindowShell-- TYPE = {
   desktopNotUp, notASWS, notStarStyle, tooManyWindows};
ErrorCode: --TIP-- TYPE = {noSuchPeriodicNotifier, other};
ErrorCode: --Window-- TYPE = {
   illegalBitmap, illegalFloat, windowNotChildOfParent, whosSlidingRoot,
   noSuchSibling, noUnderVariant, windowInTree, sizingWithBitmapUnder,
   illegalStack, invalidParameters};
ErrorCode: --XFormat-- TYPE = {invalidFormat, nilData};
ErrorCode: --XLReal-- TYPE = {
   bug, divideByZero, invalidOperation, notANumber, overflow, underflow,
   unimplemented};
ErrorCode: --XString-- TYPE = {
   invalidOperation, multipleCharSets, tooManyBytes, invalidParameter};
ErrorType: --ProductFactoring-- TYPE = {
   dataNotFound, notStarted, illegalProduct, illegalOption, missingProduct,
   missingOption};
ErrorType: --SimpleTextEdit-- TYPE = {
   fieldIsNoplace, noRoomInWriter, lastCharGTfirstChar};
ErrorType: --XMessage-- TYPE = {
   arrayMismatch, invalidMsgKeyList, invalidStringArray, invalidString,
   notEnoughArguments};
EventData: --ApplicationFolder-- TYPE = RECORD [
   applicationFolder: NSFile.Reference, internalName: XString.Reader];
EventType: --Event-- TYPE = Atom.ATOM;
Exp: --XLReal - PROCEDURE [Number] RETURNS [Number];
ExpandWriter: --XString-- PROCEDURE [w: Writer, extra: CARDINAL];
Fetch: --Cursor-- PROCEDURE [h: Handle];
FetchFromType: --Cursor-- PROCEDURE [h: Handle, type: Defined];
Field: --SimpleTextEdit-- TYPE = LONG POINTER TO FieldObject;
FieldContext: --SimpleTextEdit-- TYPE = LONG POINTER TO FieldContextObject;
FieldContextObject: --SimpleTextEdit-- TYPE;
FieldObject: --SimpleTextEdit-- TYPE;
fiftyPercent: --Display-- Brick;
filedrawerReference: --BWSAttributeTypes-- NSFile.ExtendedAttributeType =
   10407B;
FillProc: --ContainerCache-- TYPE = PROCEDURE [cache: Handle]
   RETURNS [errored: BOOLEAN ˆ FALSE];
FillResolveBuffer: --SimpleTextDisplay-- PROCEDURE [
   string: XString.Reader, lineWidth: CARDINAL ˆ 177777B,
   wordBreak: BOOLEAN ˆ TRUE, streakSuccession: StreakSuccession ˆ fromFirstChar,
   resolve: ResolveBuffer, font: SimpleTextFont.MappedFontHandle ˆ NIL]
   RETURNS [width: CARDINAL, result: Result, rest: XString.ReaderBody];
Filtered: --XToken-- PROCEDURE [
   h: Handle, data: FilterState, filter: FilterProcType,
   skip: SkipMode ˆ whiteSpace, temporary: BOOLEAN ˆ TRUE]
   RETURNS [value: XString.ReaderBody];
FilterProcType: --XToken-- TYPE = PROCEDURE [
   c: XChar.Character, data: FilterState] RETURNS [inClass: BOOLEAN];
FilterState: --XToken-- TYPE = LONG POINTER TO StandardFilterState;
Find: --Context-- PROCEDURE [type: Type, window: Window.Handle] RETURNS [Data];
Find: --Prototype-- PROCEDURE [
   type: NSFile.Type, version: Version, subtype: Subtype ˆ 0,
   session: NSFile.Session ˆ LOOPHOLE[0]] RETURNS [reference: NSFile.Reference];
```

FindDescriptionFile: --*ApplicationFolder*-- PROCEDURE [
  applicationFolder: NSFile.Handle] RETURNS [descriptionFile: NSFile.Reference];
FindOrCreate: --*Context*-- PROCEDURE [
  type: Type, window: Window.Handle, createProc: CreateProcType] RETURNS [Data];
First: --*XString*-- PROCEDURE [r: Reader] RETURNS [c: Character];
firstAvailableApplicationType: --*BWSAttributeTypes*--
  NSFile.ExtendedAttributeType = 10505B;
firstBWSType: --*BWSAttributeTypes*-- NSFile.ExtendedAttributeType = 10400B;
firstOldApplicationSpecific: --*BWSAttributeTypes*--
  NSFile.ExtendedAttributeType = 10414B;
firstSpareBWSType: --*BWSAttributeTypes*-- NSFile.ExtendedAttributeType = 10461B;
firstStarType: --*BWSFileTypes*-- NSFile.Type = 10400B;
Fix: --*XLReal*-- PROCEDURE [Number] RETURNS [LONG INTEGER];
FixdPtNum: --*Display*-- TYPE = MACHINE DEPENDENT RECORD [
  SELECT OVERLAID * FROM
  wholeThing = > [li(0:0..31): LONG INTEGER],
  parts = > [frac(0:0..15): CARDINAL, int(1:0..15): INTEGER],
  ENDCASE];
Float: --*Window*-- PROCEDURE [window: Handle, temp: Handle, proc: FloatProc];
Float: --*XLReal*-- PROCEDURE [LONG INTEGER] RETURNS [Number];
FloatProc: --*Window*-- TYPE = PROCEDURE [window: Handle]
  RETURNS [place: Place, done: BOOLEAN];
Flushness: --*FormWindow*-- TYPE = SimpleTextDisplay.Flushness;
Flushness: --*SimpleTextDisplay*-- TYPE = {flushLeft, flushRight, fromFirstChar};
FlushUserInput: --*TIP*-- PROCEDURE;
FocusTakesInput: --*TIP*-- PROCEDURE RETURNS [BOOLEAN];
FontNotFound: --*SimpleTextFont*-- SIGNAL [name: XString.Reader];
Format: --*XTime*-- PROCEDURE [
  xfh: XFormat.Handle ˆ NIL, time: System.GreenwichMeanTime ˆ defaultTime,
  template: XString.Reader ˆ dateAndTime, ltp: LTP ˆ useSystem];
formatHandle: --*Attention*-- XFormat.Handle;
FormatProc: --*XFormat*-- TYPE = PROCEDURE [r: XString.Reader, h: Handle];
FormatReal: --*XLReal*-- PROCEDURE [
  h: XFormat.Handle ˆ NIL, r: Number, width: NATURAL];
FractionPart: --*XLReal*-- PROCEDURE [Number] RETURNS [Number],
Free: --*Selection*-- PROCEDURE [v: ValueHandle];
Free: --*Window*-- PROCEDURE [window: Handle, zone: UNCOUNTED ZONE ˆ LOOPHOLE[0]];
FreeBadPhosphorList: --*Window*-- PROCEDURE [window: Handle];
FreeCache: --*ContainerCache*-- PROCEDURE [Handle];
FreeChoiceHintsProc: --*FormWindow*-- TYPE = PROCEDURE [
  window: Window.Handle, item: ItemKey,
  hints: LONG DESCRIPTOR FOR ARRAY CARDINAL OF ChoiceIndex];
FreeChoiceItems: --*FormWindowMessageParse*-- PROCEDURE [
  choiceItems: FormWindow.ChoiceItems, zone: UNCOUNTED ZONE];
FreeContext: --*Selection*-- PROCEDURE [v: ValueHandle, zone: UNCOUNTED ZONE];
FreeDataProcedure: --*Event*-- TYPE = PROCEDURE [myData: LONG POINTER];
FreeMark: --*ContainerCache*-- PROCEDURE [mark: Mark];
FreeMsgDomainsStorage: --*XMessage*-- PROCEDURE [msgDomains: MsgDomains];
FreeReaderBytes: --*XString*-- PROCEDURE [r: Reader, z: UNCOUNTED ZONE];
FreeReaderHandle: --*XToken*-- PROCEDURE [h: Handle] RETURNS [nil: Handle];
FreeResolveBuffer: --*SimpleTextDisplay*-- PROCEDURE [ResolveBuffer];
FreeStd: --*Selection*-- ValueFreeProc;
FreeStreamHandle: --*XToken*-- PROCEDURE [h: Handle] RETURNS [s: Stream.Handle];

FreeTextHintsProc: --*FormWindow*-- TYPE = PROCEDURE [
  window: Window.Handle, item: ItemKey,
  hints: LONG DESCRIPTOR FOR ARRAY CARDINAL OF XString.ReaderBody];
FreeTokenString: --*XToken*-- PROCEDURE [r: XString.Reader]
  RETURNS [nil: XString.Reader ˜ NIL];
FreeTree: --*Window*-- PROCEDURE [
  window: Handle, zone: UNCOUNTED ZONE ˜ LOOPHOLE[0]];
FreeWriterBytes: --*XString*-- PROCEDURE [w: Writer];
FromBlock: --*XString*-- PROCEDURE [
  block: Environment.Block, context: Context ˜ vanillaContext]
  RETURNS [ReaderBody];
FromChar: --*XString*-- PROCEDURE [char: LONG POINTER TO Character]
  RETURNS [ReaderBody];
FromName: --*ApplicationFolder*-- PROCEDURE [internalName: XString.Reader]
  RETURNS [applicationFolder: NSFile.Reference];
FromNSString: --*XString*-- PROCEDURE [
  s: NSString.String, homogeneous: BOOLEAN ˜ FALSE] RETURNS [ReaderBody];
FromSTRING: --*XString*-- PROCEDURE [s: LONG STRING, homogeneous: BOOLEAN ˜ FALSE]
  RETURNS [ReaderBody];
fullUserName: --*StarDesktop*-- Atom.ATOM;
GenericProc: --*Containee*-- TYPE = PROCEDURE [
  atom: Atom.ATOM, data: DataHandle, changeProc: ChangeProc ˜ NIL,
  changeProcData: LONG POINTER ˜ NIL] RETURNS [LONG UNSPECIFIED];
GeometryTable: --*BlackKeys*-- TYPE = LONG POINTER;
GeometryTableEntry: --*KeyboardWindow*-- TYPE = RECORD [
  box: Box, key: KeyStations, shift: ShiftState];
Get: --*XMessage*-- PROCEDURE [h: Handle, msgKey: MsgKey]
  RETURNS [msg: XString.ReaderBody];
GetAdjustProc: --*StarWindowShell*-- PROCEDURE [sws: Handle] RETURNS [AdjustProc];
GetAvailableBodyWindowDims: --*StarWindowShell*-- PROCEDURE [sws: Handle]
  RETURNS [Window.Dims];
GetBitmapUnder: --*Window*-- PROCEDURE [window: Handle] RETURNS [LONG POINTER];
GetBody: --*StarWindowShell*-- PROCEDURE [sws: Handle] RETURNS [Window Handle];
GetBodyWindowJustFits: --*StarWindowShell*-- PROCEDURE [sws: Handle]
  RETURNS [BOOLEAN];
GetBOOLEAN: --*AtomicProfile*-- PROCEDURE [atom: Atom.ATOM] RETURNS [BOOLEAN];
GetBooleanItemValue: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, item: ItemKey] RETURNS [value: BOOLEAN];
GetBooleanValue: --*OptionFile*-- PROCEDURE [
  section: XString.Reader, entry: XString.Reader, file: NSFile Reference ˜ xxx]
  RETURNS [value: BOOLEAN];
GetBox: --*SimpleTextEdit*-- PROCEDURE [f: Field] RETURNS [box: Window.Box];
GetBox: --*Window*-- PROCEDURE [Handle] RETURNS [box: Box];
GetCachedName: --*Containee*-- PROCEDURE [data: DataHandle]
  RETURNS [name: XString.ReaderBody, ticket: Ticket];
GetCachedType: --*Containee*-- PROCEDURE [data: DataHandle]
  RETURNS [type: NSFile.Type];
GetCaretPlace: --*SimpleTextEdit*-- PROCEDURE [context: FieldContext]
  RETURNS [place: Window.Place];
GetCharProcType: --*XToken*-- TYPE = PROCEDURE [h: Handle]
  RETURNS [c: XChar.Character];
GetCharTranslator: --*TIP*-- PROCEDURE [table: Table] RETURNS [o: CharTranslator];
GetCharWidth: --*SimpleTextDisplay*-- PROCEDURE [
  char: XChar.Character, font: SimpleTextFont.MappedFontHandle ˜ NIL]
  RETURNS [width: CARDINAL];
GetChild: --*Window*-- PROCEDURE [Handle] RETURNS [Handle];

GetChoiceItemValue: --*FormWindow*-- PROCEDURE [
 window: Window.Handle, item: ItemKey] RETURNS [value: ChoiceIndex];
GetClearingRequired: --*Window*-- PROCEDURE [Handle] RETURNS [BOOLEAN];
GetClientData: --*FormWindow*-- PROCEDURE [window: Window.Handle]
 RETURNS [clientData: LONG POINTER];
GetClientData: --*SimpleTextEdit*-- PROCEDURE [f: Field]
 RETURNS [clientData: LONG POINTER];
GetContainee: --*StarWindowShell*-- PROCEDURE [sws: Handle]
 RETURNS [Containee.Data];
GetContainerSource: --*FileContainerShell*-- PROCEDURE [
 shell: StarWindowShell.Handle] RETURNS [source: ContainerSource.Handle];
GetContainerWindow: --*FileContainerShell*-- PROCEDURE [
 shell: StarWindowShell.Handle] RETURNS [window: Window.Handle];
GetCurrentDesktopFile: --*StarDesktop*-- PROCEDURE RETURNS [NSFile.Reference];
GetCurrentKeyboard: --*BlackKeys*-- PROCEDURE RETURNS [current: Keyboard];
GetDecimalItemValue: --*FormWindow*-- PROCEDURE [
 window: Window.Handle, item: ItemKey] RETURNS [value: XLReal.Number];
GetDefaultImplementation: --*Containee*-- PROCEDURE RETURNS [Implementation];
GetDesktopProc: --*IdleControl*-- PROCEDURE [atom: Atom.ATOM]
 RETURNS [DesktopProc];
GetDims: --*Window*-- PROCEDURE [Handle] RETURNS [dims: Dims];
GetDisplayProc: --*Window*-- PROCEDURE [Handle] RETURNS [DisplayProc];
GetDisplayWindow: --*KeyboardWindow*-- PROCEDURE RETURNS [Window.Handle];
GetFieldContext: --*SimpleTextEdit*-- PROCEDURE [f: Field] RETURNS [FieldContext];
GetFile: --*Catalog*-- PROCEDURE [
 catalogType: NSFile.Type ^ 10476B, name: XString.Reader,
 readonly: BOOLEAN ^ FALSE, session: NSFile.Session ^ LOOPHOLE[0]]
 RETURNS [file: NSFile.Handle];
GetFlushness: --*FormWindow*-- PROCEDURE [window: Window.Handle, item: ItemKey]
 RETURNS [old: Flushness];
GetFlushness: --*SimpleTextEdit*-- PROCEDURE [f: Field]
 RETURNS [SimpleTextDisplay.Flushness];
GetFont: --*SimpleTextEdit*-- PROCEDURE [f: Field]
 RETURNS [SimpleTextFont.MappedFontHandle];
GetFormWindows: --*PropertySheet*-- PROCEDURE [shell: StarWindowShell.Handle]
 RETURNS [form: Window.Handle, link: Window.Handle];
GetGlobalChangeProc: --*FormWindow*-- PROCEDURE [window: Window.Handle]
 RETURNS [proc: GlobalChangeProc];
GetGreeterProc: --*IdleControl*-- PROCEDURE RETURNS [GreeterProc];
GetHandle: --*XComSoftMessage*-- PROCEDURE RETURNS [h: XMessage.Handle];
GetHost: --*StarWindowShell*-- PROCEDURE [sws: Handle] RETURNS [Handle];
GetImplementation: --*Containee*-- PROCEDURE [NSFile.Type]
 RETURNS [Implementation];
GetImplementation: --*Undo*-- PROCEDURE RETURNS [Implementation];
GetInfo: --*Cursor*-- PROCEDURE RETURNS [info: Info];
GetInputFocus: --*SimpleTextEdit*-- PROCEDURE [fc: FieldContext] RETURNS [Field];
GetInputFocus: --*TIP*-- PROCEDURE RETURNS [Window.Handle];
GetIntegerItemValue: --*FormWindow*-- PROCEDURE [
 window: Window.Handle, item: ItemKey] RETURNS [value: LONG INTEGER];
GetIntegerValue: --*OptionFile*-- PROCEDURE [
 section: XString.Reader, entry: XString.Reader, index: CARDINAL ^ 0,
 file: NSFile.Reference ^ xxx] RETURNS [value: LONG INTEGER];
GetIsCloseLegalProc: --*StarWindowShell*-- PROCEDURE [sws: Handle]
 RETURNS [IsCloseLegalProc];

GetItemInfo: --*FileContainerSource*- PROCEDURE [
  source: ContainerSource.Handle, itemIndex: ContainerSource.ItemIndex]
  RETURNS [file: NSFile.Reference, type: NSFile.Type];
GetJoinDirection: --*XChar*-- PROCEDURE [Character] RETURNS [JoinDirection];
GetLength: --*ContainerCacheExtra*- PROCEDURE [cache: ContainerCache.Handle]
  RETURNS [cacheLength: CARDINAL],
GetLength: --*ContainerSource*-- GetLengthProc;
GetLengthProc: --*ContainerSource*-- TYPE = PROCEDURE [source: Handle]
  RETURNS [length: CARDINAL, totalOrPartial: TotalOrPartial ^ total];
GetLimitProc: --*StarWindowShell*-- PROCEDURE [sws: Handle] RETURNS [LimitProc];
GetList: --*XMessage*-- PROCEDURE [
  h: Handle, msgKeys: MsgKeyList, msgs: StringArray];
GetLONGINTEGER: --*AtomicProfile*-- PROCEDURE [atom: Atom.ATOM]
  RETURNS [LONG INTEGER];
GetManager: --*TIP*-- PROCEDURE RETURNS [current: Manager];
GetMode: --*TIPStar*-- PROCEDURE RETURNS [mode: Mode];
GetMultipleChoiceItemValue: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, item: ItemKey, zone: UNCOUNTED ZONE]
  RETURNS [value: LONG DESCRIPTOR FOR ARRAY CARDINAL OF ChoiceIndex];
GetNextAvailableKey: --*FormWindow*-- PROCEDURE [window: Window.Handle]
  RETURNS [key: ItemKey];
GetNextOutOfProc: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, item: ItemKey] RETURNS [NextOutOfProc];
GetNextUnobscuredBox: --*StarDesktop*-- PROCEDURE [height: INTEGER]
  RETURNS [Window.Box];
GetNotifyProc: --*TIP*-- PROCEDURE [window: Window.Handle] RETURNS [NotifyProc];
GetNotifyProcFromTable: --*TIP*-- PROCEDURE [table: Table] RETURNS [NotifyProc];
GetNthItem: --*ContainerCache*-- PROCEDURE [cache: Handle, n: CARDINAL]
  RETURNS [ItemHandle];
GetOpenItem: --*ContainerWindow*-- PROCEDURE [window: Window.Handle]
  RETURNS [item: ContainerSource.ItemIndex ^ 177777B];
GetPane: --*Window*-- PROCEDURE [Handle] RETURNS [BOOLEAN];
GetParent: --*Window*-- PROCEDURE [Handle] RETURNS [Handle];
GetPlace: --*TIP*-- PROCEDURE [window: Window.Handle] RETURNS [Window.Place];
GetPlaceFromReference: --*StarDesktop*-- PROCEDURE [ref: NSFile.Reference]
  RETURNS [Window.Place];
GetPName: --*Atom*-- PROCEDURE [atom: ATOM] RETURNS [pName: XString.Reader];
GetProp: --*Atom*-- PROCEDURE [onto: ATOM, prop: ATOM] RETURNS [pair: RefPair];
GetPusheeCommands: --*StarWindowShell*- PROCEDURE [sws: Handle]
  RETURNS [
    bottom: MenuData.MenuHandle, middle: MenuData.MenuHandle,
    top: MenuData.MenuHandle];
GetReadOnly: --*FormWindow*-- PROCEDURE [window: Window.Handle, item: ItemKey]
  RETURNS [readOnly: BOOLEAN];
GetReadOnly: --*SimpleTextEdit*-- PROCEDURE [f: Field]
  RETURNS [readOnly: BOOLEAN];
GetReadonly: --*StarWindowShell*- PROCEDURE [sws: Handle] RETURNS [BOOLEAN];
GetRegularCommands: --*StarWindowShell*-- PROCEDURE [sws: Handle]
    RETURNS [MenuData.MenuHandle];
GetResults: --*TIPX*-- PROCEDURE [
    window: Window.Handle, resultsWanted: ResultsWanted ^ NIL]
    RETURNS [results: TIP.Results];
GetScrollData: --*StarWindowShell*-- PROCEDURE [sws: Handle]
    RETURNS [scrollData: ScrollData]

GetSelection: --*ContainerWindow*-- PROCEDURE [window: Window.Handle] RETURNS [
first: ContainerSource.ItemIndex, lastPlusOne: ContainerSource.ItemIndex];
GetShellFromReference: --*StarDesktop*-- PROCEDURE [ref: NSFile.Reference] RETURNS [sws: StarWindowShell.Handle];
GetShowKeyboardProc: --*KeyboardKey*-- PROCEDURE RETURNS [ShowKeyboardProc];
GetSibling: --*Window*-- PROCEDURE [Handle] RETURNS [Handle];
GetSleeps: --*StarWindowShell*-- PROCEDURE [sws: Handle] RETURNS [BOOLEAN];
GetSource: --*ContainerWindow*-- PROCEDURE [window: Window.Handle] RETURNS [source: ContainerSource.Handle];
GetState: --*StarWindowShell*-- PROCEDURE [sws: Handle] RETURNS [State];
GetStreakNature: --*XChar*-- PROCEDURE [Character] RETURNS [StreakNature];
GetStreakSuccession: --*FormWindow*-- PROCEDURE [
window: Window.Handle, item: ItemKey] RETURNS [old: StreakSuccession];
GetStreakSuccession: --*SimpleTextEdit*-- PROCEDURE [f: Field] RETURNS [SimpleTextDisplay.StreakSuccession];
GetString: --*AtomicProfile*-- PROCEDURE [atom: Atom.ATOM] RETURNS [XString.Reader];
GetStringValue: --*OptionFile*-- PROCEDURE [
section: XString.Reader, entry: XString.Reader,
callBack: PROCEDURE [value: XString.Reader], index: CARDINAL ˆ 0,
file: NSFile.Reference ˆ xxx];
GetTable: --*TIP*-- PROCEDURE [window: Window.Handle] RETURNS [Table];
GetTable: --*TIPStar*-- PROCEDURE [Placeholder] RETURNS [TIP.Table];
GetTableLink: --*TIP*-- PROCEDURE [from: Table] RETURNS [to: Table];
GetTableOpacity: --*TIP*-- PROCEDURE [table: Table] RETURNS [BOOLEAN];
GetTabStops: --*FormWindow*-- PROCEDURE [window: Window.Handle] RETURNS [tabStops: TabStops];
GetTag: --*FormWindow*-- PROCEDURE [window: Window.Handle, item: ItemKey] RETURNS [tag: XString.ReaderBody];
GetTextItemValue: --*FormWindow*-- PROCEDURE [
window: Window.Handle, item: ItemKey, zone: UNCOUNTED ZONE]
RETURNS [value: XString.ReaderBody];
GetTransitionProc: --*StarWindowShell*-- PROCEDURE [sws: Handle] RETURNS [TransitionProc];
GetType: --*StarWindowShell*-- PROCEDURE [sws: Handle] RETURNS [ShellType];
GetUseBadPhosphor: --*Window*-- PROCEDURE [Handle] RETURNS [BOOLEAN];
GetUserProfile: --*OptionFile*-- PROCEDURE RETURNS [file: NSFile.Reference];
GetValue: --*SimpleTextEdit*-- PROCEDURE [f: Field] RETURNS [XString.ReaderBody];
GetVisibility: --*FormWindow*-- PROCEDURE [window: Window.Handle, item: ItemKey] RETURNS [visibility: Visibility];
GetWindow: --*SimpleTextEdit*-- PROCEDURE [fc: FieldContext] RETURNS [window: Window.Handle];
GetWindow: --*StarDesktop*-- PROCEDURE RETURNS [Window.Handle];
GetWindowItemValue: --*FormWindow*-- PROCEDURE [
window: Window.Handle, item: ItemKey] RETURNS [value: Window.Handle];
GetWorkstationProfile: --*OptionFile*-- PROCEDURE RETURNS [file: NSFile.Reference];
GetZone: --*FormWindow*-- PROCEDURE [window: Window.Handle] RETURNS [zone: UNCOUNTED ZONE];
GetZone: --*SimpleTextEdit*-- PROCEDURE [fc: FieldContext] RETURNS [UNCOUNTED ZONE];
GetZone: --*StarWindowShell*-- PROCEDURE [sws: Handle] RETURNS [UNCOUNTED ZONE];

GlobalChangeProc: --*FormWindow*-- TYPE = PROCEDURE [
window: Window.Handle, item: ItemKey, calledBecauseOf: ChangeReason,
clientData: LONG POINTER];
Gravity: --*Window*-- TYPE = {nil, nw, n, ne, e, se, s, sw, w, c, xxx};
Gray: --*Display*-- PROCEDURE [
window: Handle, box: Window.Box, gray: Brick ˆ fiftyPercent,
dstFunc: DstFunc ˆ null, bounds: Window.BoxHandle ˆ NIL];
GrayTrapezoid: --*Display*-- PROCEDURE [
window: Handle, t: Trapezoid, gray: Brick ˆ fiftyPercent,
dstFunc: DstFunc ˆ null, bounds: Window.BoxHandle ˆ NIL];
Greater: --*XLReal*-- PROCEDURE [a: Number, b: Number] RETURNS [BOOLEAN];
GreaterEq: --*XLReal*-- PROCEDURE [a: Number, b: Number] RETURNS [BOOLEAN];
GreeterProc: --*IdleControl*-- TYPE = PROCEDURE RETURNS [Atom.ATOM];
Half: --*XLReal*-- PROCEDURE [Number] RETURNS [Number];
Handle: --*ContainerCache*-- TYPE = LONG POINTER TO Object;
Handle: --*ContainerSource*-- TYPE = LONG POINTER TO Procedures;
Handle: --*Cursor*-- TYPE = LONG POINTER TO Object;
Handle: --*Display*-- TYPE = Window.Handle;
Handle: --*StarWindowShell*-- TYPE = RECORD [Window.Handle];
Handle: --*Window*-- TYPE = LONG POINTER TO Object;
Handle: --*XFormat*-- TYPE = LONG POINTER TO Object;
Handle: --*XMessage*-- TYPE = LONG POINTER TO Object;
Handle: --*XToken*-- TYPE = LONG POINTER TO Object;
HasAnyBeenChanged: --*FormWindow*-- PROCEDURE [window: Window.Handle]
RETURNS [yes: BOOLEAN];
HasBeenChanged: --*FormWindow*-- PROCEDURE [window: Window.Handle, item: ItemKey]
RETURNS [yes: BOOLEAN];
HaveDisplayedParasite: --*StarWindowShell*-- PROCEDURE [sws: Handle]
RETURNS [BOOLEAN];
Hex: --*XFormat*-- PROCEDURE [h: Handle ˆ NIL, n: LONG CARDINAL];
HexFormat: --*XFormat*-- NumberFormat;
HighlightThisKey: --*SoftKeys*-- PROCEDURE [
window: Window.Handle, key: CARDINAL ˆ nullKey];
HostNumber: --*XFormat*-- PROCEDURE [
h: Handle ˆ NIL, hostNumber: System.HostNumber, format: NetFormat];
HowHard: --*Selection*-- PROCEDURE [target: Target, enumeration: BOOLEAN ˆ FALSE]
RETURNS [difficulty: Difficulty];
IconColumn: --*FileContainerSource*-- PROCEDURE
RETURNS [attribute ColumnContentsInfo];
Idle: --*IdleControl*-- PROCEDURE;
ignoreType: --*Containee*-- NSFile.Type = 37777777777B;
Implementation: --*Containee*-- TYPE = RECORD [
implementors: LONG POINTER ˆ NIL,
name: XString.ReaderBody ˆ xxx,
smallPictureProc: SmallPictureProc ˆ NIL,
pictureProc: PictureProc ˆ NIL,
convertProc: Selection.ConvertProc ˆ NIL,
genericProc: GenericProc ˆ NIL];
Implementation: --*Undo*-- TYPE = RECORD [
opportunity: Proc,
roadblock: PROCEDURE [XString.Reader],
doAnUndo: PROCEDURE,
doAnUnundo: PROCEDURE,
deleteAll: PROCEDURE];

IndexFromMark: --*ContainerCache*-- PROCEDURE [mark: Mark]
RETURNS [index: CARDINAL];
Info: --*Cursor*-- TYPE = RECORD [type: Type, hotX: [0..15], hotY: [0..15]];
Info: --*FileContainerSource*-- PROCEDURE [source: ContainerSource.Handle]
RETURNS [
file: NSFile.Reference, columns: ColumnContents, scope: NSFile.Scope,
options: Options];
Info: --*SoftKeys*-- PROCEDURE [window: Window.Handle]
RETURNS [
table: TIP.Table, notifyProc: TIP.NotifyProc, labels: Labels,
highlightedKey: CARDINAL, outlinedKey: CARDINAL];
InitBreakTable: --*XString*-- PROCEDURE [
r: Reader, stopOrNot: StopOrNot, otherSets: StopOrNot]
RETURNS [break: BreakTableObject];
Initialize: --*Window*-- PROCEDURE [
window: Handle, display: DisplayProc, box: Box, parent: Handle ^ rootWindow,
sibling: Handle ^ NIL, child: Handle ^ NIL, clearingRequired: BOOLEAN ^ TRUE,
windowPane: BOOLEAN ^ FALSE, under: BOOLEAN ^ FALSE, cookie: BOOLEAN ^ FALSE,
color: BOOLEAN ^ FALSE];
InitializeWindow: --*Window*-- PROCEDURE [
window: Handle, display: DisplayProc, box: Box, parent: Handle ^ rootWindow,
sibling: Handle ^ NIL, child: Handle ^ NIL, clearingRequired: BOOLEAN ^ TRUE,
windowPane: BOOLEAN ^ FALSE, under: BOOLEAN ^ FALSE, cookie: BOOLEAN ^ FALSE,
color: BOOLEAN ^ FALSE];
InsertIntoTree: --*Window*-- PROCEDURE [window: Handle];
InsertItem: --*ContainerCache*-- PROCEDURE [
cache: Handle, before: CARDINAL, addData: AddData]
RETURNS [handle: ItemHandle];
InsertItem: --*FormWindow*-- PROCEDURE [
window: Window.Handle, item: ItemKey, line: Line, beforeItem: ItemKey,
preMargin: CARDINAL ^ 0, tabStop: CARDINAL ^ nextTabStop,
repaint: BOOLEAN ^ TRUE];
InsertLine: --*FormWindow*-- PROCEDURE [
window: Window.Handle, before: Line, spaceAboveLine: CARDINAL ^ 0]
RETURNS [line: Line];
InstallBody: --*StarWindowShell*-- PROCEDURE [sws: Handle, body: Window.Handle];
InstallFormWindow: --*PropertySheet*-- PROCEDURE [
shell: StarWindowShell.Handle, menuItemProc: MenuItemProc,
menuItems: MenuItems ^ propertySheetDefaultMenu, title: XString.Reader ^ NIL,
formWindow: Window.Handle, afterTakenDownProc: MenuItemProc ^ NIL];
InsufficientRoom: --*XString*-- SIGNAL [
needsMoreRoom: Writer, amountNeeded: CARDINAL];
IntegerPart: --*XLReal*-- PROCEDURE [Number] RETURNS [Number];
Interpolator: --*Display*-- TYPE = RECORD [val: FixdPtNum, dVal: FixdPtNum];
IntersectBoxes: --*Window*-- PROCEDURE [b1: Box, b2: Box] RETURNS [box: Box];
Invalid: --*XTime*-- ERROR;
InvalidateBox: --*Window*-- PROCEDURE [
window: Handle, box: Box, clarity: Clarity ^ isDirty];
InvalidateCache: --*Containee*-- PROCEDURE [data: DataHandle];
InvalidateWholeCache: --*Containee*-- PROCEDURE;
InvalidEncoding: --*XString*-- ERROR [
invalidReader: Reader, firstBadByteOffset: CARDINAL];
InvalidHandle: --*BlackKeys*-- ERROR;
InvalidHandle: --*SoftKeys*-- ERROR;
InvalidNumber: --*XString*-- SIGNAL;
InvalidTable: --*TIP*-- SIGNAL [type: TableError, message: XString.Reader];

Invert: --*Cursor*-- PROCEDURE RETURNS [BOOLEAN];
Invert: --*Display*-- PROCEDURE [
  window: Handle, box: Window.Box, bounds: Window.BoxHandle ˆ NIL];
IsBitmapUnderVariant: --*Window*-- PROCEDURE [Handle] RETURNS [BOOLEAN];
IsBodyWindowOutOfInterior: --*StarWindowShell*-- PROCEDURE [body: Window.Handle]
  RETURNS [BOOLEAN];
IsCloseLegal: --*StarWindowShell*-- PROCEDURE [
  sws: Handle, closeAll: BOOLEAN ˆ FALSE] RETURNS [BOOLEAN];
IsCloseLegalProc: --*StarWindowShell*-- TYPE = PROCEDURE [
  sws: Handle, closeAll: BOOLEAN ˆ FALSE] RETURNS [BOOLEAN];
IsCloseLegalProcReturnsFalse: --*StarWindowShell*-- IsCloseLegalProc;
IsColorVariant: --*Window*-- PROCEDURE [Handle] RETURNS [BOOLEAN];
IsCookieVariant: --*Window*-- PROCEDURE [Handle] RETURNS [BOOLEAN];
IsDescendantOfRoot: --*Window*-- PROCEDURE [Handle] RETURNS [BOOLEAN];
IsIt: --*ContainerWindow*-- PROCEDURE [window: Window.Handle]
  RETURNS [yes: BOOLEAN];
IsIt: --*FileContainerSource*-- PROCEDURE [source: ContainerSource.Handle]
  RETURNS [BOOLEAN];
IsIt: --*FormWindow*-- PROCEDURE [window: Window.Handle] RETURNS [yes: BOOLEAN];
IsIt: --*MessageWindow*-- PROCEDURE [Window.Handle] RETURNS [yes: BOOLEAN];
IsPlaceInBox: --*Window*-- PROCEDURE [place: Place, box: Box] RETURNS [BOOLEAN];
IsSpecial: --*XLReal*-- PROCEDURE [Number]
  RETURNS [yes: BOOLEAN, index: SpecialIndex];
Item: --*MenuData*-- TYPE = PrivateItem;
Item: --*XToken*-- PROCEDURE [h: Handle, temporary: BOOLEAN ˆ TRUE]
  RETURNS [value: XString.ReaderBody];
ItemClients: --*ContainerCache*-- PROCEDURE [item: ItemHandle]
  RETURNS [clientData: LONG POINTER];
ItemClientsLength: --*ContainerCache*-- PROCEDURE [handle: ItemHandle]
  RETURNS [dataLength: CARDINAL];
ItemData: --*MenuData*-- PROCEDURE [item: ItemHandle] RETURNS [LONG UNSPECIFIED];
ItemGeneric: --*ContainerSource*-- ItemGenericProc;
ItemGenericProc: --*ContainerSource*-- TYPE = PROCEDURE [
  source: Handle, itemIndex: ItemIndex, atom: Atom.ATOM,
  changeProc: ChangeProc ˆ NIL, changeProcData: LONG POINTER ˆ NIL]
  RETURNS [LONG UNSPECIFIED];
ItemHandle: --*ContainerCache*-- TYPE = LONG POINTER TO ItemObject;
ItemHandle: --*MenuData*-- TYPE = LONG POINTER TO Item;
ItemIndex: --*ContainerCache*-- PROCEDURE [item: ItemHandle]
  RETURNS [index: CARDINAL];
ItemIndex: --*ContainerSource*-- TYPE = CARDINAL;
ItemKey: --*FormWindow*-- TYPE = CARDINAL;
ItemName: --*MenuData*-- PROCEDURE [item: ItemHandle]
  RETURNS [name: XString.ReaderBody];
ItemNameWidth: --*MenuData*-- PROCEDURE [item: ItemHandle] RETURNS [CARDINAL];
ItemNthString: --*ContainerCache*-- PROCEDURE [item: ItemHandle, n: CARDINAL]
  RETURNS [XString.ReaderBody];
ItemObject: --*ContainerCache*-- TYPE;
ItemProc: --*MenuData*-- PROCEDURE [item: ItemHandle] RETURNS [proc: MenuProc];
ItemStringCount: --*ContainerCache*-- PROCEDURE [item: ItemHandle]
  RETURNS [strings: CARDINAL];
ItemType: --*FormWindow*-- TYPE = MACHINE DEPENDENT{
  choice, multiplechoice, decimal, integer, boolean, text, command, tagonly,
  window, last(15)};
JoinDirection: --*XChar*- TYPE = {nextCharToRight, nextCharToLeft};

KeyBits: --*LevelIVKeys*-- TYPE = PACKED ARRAY KeyName OF DownUp;
KeyBits: --*TIP*-- TYPE = LevelIVKeys.KeyBits;
Keyboard: --*BlackKeys*-- TYPE = LONG POINTER TO KeyboardObject ^ NIL;
KeyboardClass: --*KeyboardKey*-- TYPE = {system, client, special, all, none};
KeyboardObject: --*BlackKeys*-- TYPE = RECORD [
  table: TIP.Table ^ NIL,
  charTranslator: TIP.CharTranslator ^ xxx,
  pictureProc: PictureProc ^ NIL,
  label: XString.ReaderBody ^ xxx,
  clientData: LONG POINTER ^ NIL];
KeyName: --*LevelIVKeys*-- TYPE = MACHINE DEPENDENT{
  notAKey, Keyset1(8), Keyset2, Keyset3, Keyset4, Keyset5, MouseLeft, MouseRight, MouseMiddle, Five, Four, Six, E, Seven, D, U, V, Zero, K, Minus, P, Slash, Font, Same, BS, Three, Two, W, Q, S, A, Nine, I, X, O, L, Comma, CloseQuote, RightBracket, Open, Keyboard, One, Tab, ParaTab, F, Props, C, J, B, Z, LeftShift, Period, SemiColon, NewPara, OpenQuote, Delete, Next, R, T, G, Y, H, Eight, N, M, Lock, Space, LeftBracket, Equal, RightShift, Stop, Move, Undo, Margins, R9, L10, L7, L4, L1, A9, R10, A8, Copy, Find, Again, Help, Expand, R4, D2, D1, Center, T1, Bold, Italics, Underline, Superscript, Subscript, Smaller, T10, R3, Key47, A10, Defaults, A11, A12};
KeyName: --*TIP*-- TYPE = LevelIVKeys.KeyName;
Keys: --*XComSoftMessage*-- TYPE = MACHINE DEPENDENT{
  time, date, dateAndTime, am, pm, january, february, march, april, may, june, july, august, september, october, november, december, monday, tuesday, wednesday, thursday, friday, saturday, sunday, decimalSeparator, thousandsSeparator};
KeyStations: --*KeyboardWindow*-- TYPE = MACHINE DEPENDENT{
  k1, k2, k3, k4, k5, k6, k7, k8, k9, k10, k11, k12, k13, k14, k15, k16, k17, k18, k19, k20, k21, k22, k23, k24, k25, k26, k27, k28, k29, k30, k31, k32, k33, k34, k35, k36, k37, k38, k39, k40, k41, k42, k43, k44, k45, k46, k47, k48, a1, a2, a3, a4, a5, a6, a7, a8, a9, a10, a11, a12, last(96)};
KeyToCharProc: --*TIP*-- TYPE = PROCEDURE [
  keys: LONG POINTER TO KeyBits, key: KeyName, downUp: DownUp,
  data: LONG POINTER, buffer: XString.Writer];
LabelRecord: --*SoftKeys*-- TYPE = RECORD [
  unshifted: XString.ReaderBody ^ xxx, shifted: XString.ReaderBody ^ xxx];
Labels: --*SoftKeys*-- TYPE = LONG DESCRIPTOR FOR ARRAY CARDINAL OF LabelRecord;
lasstOldApplicationSpecific: --*BWSAttributeTypes*--
  NSFile.ExtendedAttributeType = 10457B;
lastBWSType: --*BWSAttributeTypes*-- NSFile.ExtendedAttributeType = 10777B;
LayoutError: --*FormWindow*-- SIGNAL [code: LayoutErrorCode];
LayoutErrorCode: --*FormWindow*-- TYPE = {onTopOfAnotherItem, notEnufTabsDefined};
LayoutInfoFromItem: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, item: ItemKey]
  RETURNS [line: Line, margin: CARDINAL, tabStop: CARDINAL, box: Window.Box];
LayoutProc: --*FormWindow*-- TYPE = PROCEDURE [
  window: Window.Handle, clientData: LONG POINTER];
Less: --*XLReal*-- PROCEDURE [a: Number, b: Number] RETURNS [BOOLEAN];
LessEq: --*XLReal*-- PROCEDURE [a: Number, b: Number] RETURNS [BOOLEAN];
LimitProc: --*StarWindowShell*-- TYPE = PROCEDURE [sws: Handle, box: Window.Box]
  RETURNS [Window.Box];
Line: --*Display*-- PROCEDURE [
  window: Handle, start: Window.Place, stop: Window.Place,
  lineStyle: LineStyle ^ NIL, bounds: Window.BoxHandle ^ NIL];
Line: --*FormWindow*-- TYPE [2];

Line: --*XFormat*-- PROCEDURE [
  h: Handle ^ NIL, r: XString.Reader, n: CARDINAL ^ 1];
Line: --*XToken*-- FilterProcType;
LineStyle: --*Display*-- TYPE = LONG POINTER TO LineStyleObject;
LineStyleObject: --*Display*-- TYPE = RECORD [
  widths: ARRAY [0..5] OF CARDINAL, thickness: CARDINAL];
LineUpBoxes: --*FormWindow*-- PROCEDURE [
  window: Window.Handle,
  items: LONG DESCRIPTOR FOR ARRAY CARDINAL OF ItemKey ^ xxx];
Ln: --*XLReal*-- PROCEDURE [Number] RETURNS [Number];
Log: --*XLReal*-- PROCEDURE [base: Number, arg: Number] RETURNS [Number];
logoff: --*StarDesktop*-- Atom.ATOM;
logon: --*StarDesktop*-- Atom.ATOM;
LogonSession: --*BWSZone*-- PROCEDURE RETURNS [UNCOUNTED ZONE];
logonSession: --*BWSZone*-- UNCOUNTED ZONE;
LookAtTextItemValue: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, item: ItemKey] RETURNS [value: XString.ReaderBody];
Lop: --*XString*-- PROCEDURE [r: Reader] RETURNS [c: Character];
LosingFocusProc: --*TIP*-- TYPE = PROCEDURE [
  w: Window.Handle, data: LONG POINTER];
LowerCase: --*XChar*-- PROCEDURE [c: Character] RETURNS [Character];
LTP: --*XTime*-- TYPE = RECORD [
  r: SELECT t: * FROM
    useSystem = > NULL, useThese = > [ltp: System.LocalTimeParameters], ENDCASE];
mailStatus: --*BWSAttributeTypes*-- NSFile.ExtendedAttributeType = 10411B;
Make: --*Atom*-- PROCEDURE [pName: XString.Reader] RETURNS [atom: ATOM];
Make: --*XChar*-- PROCEDURE [set: Environment.Byte, code: Environment.Byte]
  RETURNS [Character];
Make: --*XCharSet0*-- PROCEDURE [code: Codes0] RETURNS [XChar.Character];
Make: --*XCharSet164*-- PROCEDURE [code: Codes164] RETURNS [XChar.Character];
Make: --*XCharSet356*-- PROCEDURE [code: Codes356] RETURNS [XChar.Character];
Make: --*XCharSet357*-- PROCEDURE [code: Codes357] RETURNS [XChar.Character];
Make: --*XCharSet360*-- PROCEDURE [code: Codes360] RETURNS [XChar.Character];
Make: --*XCharSet361*-- PROCEDURE [code: Codes361] RETURNS [XChar.Character];
Make: --*XCharSet41*-- PROCEDURE [code: Codes41] RETURNS [XChar.Character];
Make: --*XCharSet42*-- PROCEDURE [code: Codes42] RETURNS [XChar.Character];
Make: --*XCharSet43*-- PROCEDURE [code: Codes43] RETURNS [XChar.Character];
Make: --*XCharSet44*-- PROCEDURE [code: Codes44] RETURNS [XChar.Character];
Make: --*XCharSet45*-- PROCEDURE [code: Codes45] RETURNS [XChar.Character];
Make: --*XCharSet46*-- PROCEDURE [code: Codes46] RETURNS [XChar.Character];
Make: --*XCharSet47*-- PROCEDURE [code: Codes47] RETURNS [XChar.Character];
MakeAtom: --*Atom*-- PROCEDURE [pName: LONG STRING] RETURNS [atom: ATOM];
MakeBooleanItem: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, myKey: ItemKey, tag: XString.Reader ^ NIL,
  suffix: XString.Reader ^ NIL, visibility: Visibility ^ visible,
  boxed: BOOLEAN ^ TRUE, readOnly: BOOLEAN ^ FALSE,
  changeProc: BooleanChangeProc ^ NIL, label: BooleanItemLabel,
  initBoolean: BOOLEAN ^ TRUE];
MakeChoiceItem: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, myKey: ItemKey, tag: XString.Reader ^ NIL,
  suffix: XString.Reader ^ NIL, visibility: Visibility ^ visible,
  boxed: BOOLEAN ^ TRUE, readOnly: BOOLEAN ^ FALSE, values: ChoiceItems,
  initChoice: ChoiceIndex, fullyDisplayed: BOOLEAN ^ TRUE,
  verticallyDisplayed: BOOLEAN ^ FALSE, hintsProc: ChoiceHintsProc ^ NIL,
  changeProc: ChoiceChangeProc ^ NIL,
  outlineOrHighlight: OutlineOrHighlight ^ highlight];

MakeCommandItem: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, myKey: ItemKey, tag: XString.Reader ˆ NIL,
  suffix: XString.Reader ˆ NIL, visibility: Visibility ˆ visible,
  boxed: BOOLEAN ˆ TRUE, readOnly: BOOLEAN ˆ FALSE, commandProc: CommandProc,
  commandName: XString.Reader, clientData: LONG POINTER ˆ NIL];
MakeDecimalItem: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, myKey: ItemKey, tag: XString.Reader ˆ NIL,
  suffix: XString.Reader ˆ NIL, visibility: Visibility ˆ visible,
  boxed: BOOLEAN ˆ TRUE, readOnly: BOOLEAN ˆ FALSE, signed: BOOLEAN ˆ FALSE,
  width: CARDINAL, initDecimal: XLReal.Number ˆ xxx,
  wrapUnderTag: BOOLEAN ˆ FALSE, hintsProc: TextHintsProc ˆ NIL,
  nextOutOfProc: NextOutOfProc ˆ NIL, displayTemplate: XString.Reader ˆ NIL,
  SPECIALKeyboard: BlackKeys.Keyboard ˆ NIL];
MakeIntegerItem: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, myKey: ItemKey, tag: XString.Reader ˆ NIL,
  suffix: XString.Reader ˆ NIL, visibility: Visibility ˆ visible,
  boxed: BOOLEAN ˆ TRUE, readOnly: BOOLEAN ˆ FALSE, signed: BOOLEAN ˆ FALSE,
  width: CARDINAL, initInteger: LONG INTEGER ˆ 0, wrapUnderTag: BOOLEAN ˆ FALSE,
  hintsProc: TextHintsProc ˆ NIL, nextOutOfProc: NextOutOfProc ˆ NIL,
  SPECIALKeyboard: BlackKeys.Keyboard ˆ NIL];
MakeItemsProc: --*FormWindow*-- TYPE = PROCEDURE [
  window: Window.Handle, clientData: LONG POINTER];
MakeMenuItem: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, myKey: ItemKey, tag: XString.Reader ˆ NIL,
  suffix: XString.Reader ˆ NIL, visibility: Visibility ˆ visible,
  boxed: BOOLEAN ˆ TRUE, menu: MenuData.MenuHandle];
MakeMultipleChoiceItem: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, myKey: ItemKey, tag: XString.Reader ˆ NIL,
  suffix: XString.Reader ˆ NIL, visibility: Visibility ˆ visible,
  boxed: BOOLEAN ˆ TRUE, readOnly: BOOLEAN ˆ FALSE, values: ChoiceItems,
  initChoice: LONG DESCRIPTOR FOR ARRAY CARDINAL OF ChoiceIndex,
  fullyDisplayed: BOOLEAN ˆ TRUE, verticallyDisplayed: BOOLEAN ˆ FALSE,
  hintsProc: ChoiceHintsProc ˆ NIL, changeProc: MultipleChoiceChangeProc ˆ NIL,
  outlineOrHighlight: OutlineOrHighlight ˆ highlight];
MakeNegative: --*Cursor*-- PROCEDURE;
MakePositive: --*Cursor*-- PROCEDURE;
MakeSpecial: --*XLReal*-- PROCEDURE [index: SpecialIndex] RETURNS [Number];
MakeTagOnlyItem: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, myKey: ItemKey, tag: XString.Reader,
  visibility: Visibility ˆ visible];
MakeTextItem: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, myKey: ItemKey, tag: XString.Reader ˆ NIL,
  suffix: XString.Reader ˆ NIL, visibility: Visibility ˆ visible,
  boxed: BOOLEAN ˆ TRUE, readOnly: BOOLEAN ˆ FALSE, width: CARDINAL,
  initString: XString.Reader ˆ NIL, wrapUnderTag: BOOLEAN ˆ FALSE,
  passwordFeedback: BOOLEAN ˆ FALSE, hintsProc: TextHintsProc ˆ NIL,
  nextOutOfProc: NextOutOfProc ˆ NIL,
  SPECIALKeyboard: BlackKeys.Keyboard ˆ NIL];
MakeWindowItem: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, myKey: ItemKey, tag: XString.Reader ˆ NIL,
  visibility: Visibility ˆ visible, boxed: BOOLEAN ˆ TRUE, size: Window.Dims,
  nextIntoProc: NextIntoProc ˆ NIL] RETURNS [clientWindow: Window.Handle];
Manager: --*TIP*-- TYPE = RECORD [
  table: Table, window: Window.Handle, notify: NotifyProc];
ManagerData: --*Selection*- TYPE = LONG POINTER;

Map: --*XString*-- PROCEDURE [r: Reader, proc: MapCharProc]
RETURNS [c: Character];
MapAtomProc: --*Atom*-- TYPE = PROCEDURE [ATOM] RETURNS [BOOLEAN];
MapAtoms: --*Atom*-- PROCEDURE [proc: MapAtomProc] RETURNS [lastAtom: ATOM];
MapCharProc: --*XString*-- TYPE = PROCEDURE [c: Character]
RETURNS [stop: BOOLEAN];
MappedDefaultFont: --*SimpleTextFont*-- PROCEDURE RETURNS [MappedFontHandle];
MappedFont: --*SimpleTextFont*-- PROCEDURE [name: XString.Reader ^ NIL]
RETURNS [MappedFontHandle];
MappedFontDescriptor: --*SimpleTextFont*-- TYPE;
MappedFontHandle: --*SimpleTextFont*-- TYPE = LONG POINTER TO
MappedFontDescriptor;
MapPList: --*Atom*-- PROCEDURE [atom: ATOM, proc: MapPListProc]
RETURNS [lastPair: RefPair];
MapPListProc: --*Atom*-- TYPE = PROCEDURE [RefPair] RETURNS [BOOLEAN];
Mark: --*ContainerCache*-- TYPE = LONG POINTER TO MarkObject;
MarkObject: --*ContainerCache*-- TYPE;
Match: --*Selection*-- PROCEDURE [pointer: ManagerData] RETURNS [match: BOOLEAN];
maxStringLength: --*Selection*-- CARDINAL = 200;
MaybeQuoted: --*XToken*-- PROCEDURE [
h: Handle, data: FilterState, filter: FilterProcType ^ NonWhiteSpace,
isQuote: QuoteProcType ^ Quote, skip: SkipMode ^ whiteSpace,
temporary: BOOLEAN ^ TRUE] RETURNS [value: XString.ReaderBody];
MeasureString: --*SimpleTextDisplay*-- PROCEDURE [
string: XString.Reader, lineWidth: CARDINAL ^ 177777B,
wordBreak: BOOLEAN ^ TRUE, streakSuccession: StreakSuccession ^ fromFirstChar,
font: SimpleTextFont.MappedFontHandle ^ NIL]
RETURNS [width: CARDINAL, result: Result, rest: XString.ReaderBody];
MenuArray: --*MenuData*-- PROCEDURE [menu: MenuHandle]
RETURNS [array: ArrayHandle];
MenuEnumProc: --*StarWindowShell*-- TYPE = PROCEDURE [menu: MenuData.MenuHandle]
RETURNS [stop: BOOLEAN ^ FALSE];
MenuHandle: --*MenuData*-- TYPE = LONG POINTER TO MenuObject;
MenuItemProc: --*PropertySheet*-- TYPE = PROCEDURE [
shell: StarWindowShell.Handle, formWindow: Window.Handle,
menuItem: MenuItemType, clientData: LONG POINTER] RETURNS [ok: BOOLEAN];
MenuItems: --*PropertySheet*-- TYPE = PACKED ARRAY MenuItemType OF
BooleanFalseDefault;
MenuItemType: --*PropertySheet*-- TYPE = {
done, apply, cancel, defaults, start, reset};
MenuObject: --*MenuData*-- TYPE = PrivateMenu;
MenuProc: --*MenuData*-- TYPE = PROCEDURE [
window: Window.Handle, menu: MenuHandle, itemData: LONG UNSPECIFIED];
MenuTitle: --*MenuData*-- PROCEDURE [menu: MenuHandle]
RETURNS [title: ItemHandle];
Messages: --*XMessage*-- TYPE = LONG DESCRIPTOR FOR ARRAY CARDINAL OF MsgEntry;
MessagesFromFile: --*XMessage*-- PROCEDURE [
fileName: LONG STRING, clientData: ClientData, proc: DestroyMsgsProc]
RETURNS [msgDomains: MsgDomains];
MessagesFromReference: --*XMessage*-- PROCEDURE [
file: NSFile.Reference, clientData: ClientData, proc: DestroyMsgsProc]
RETURNS [msgDomains: MsgDomains];
MinDimsChangeProc: --*FormWindow*-- TYPE = PROCEDURE [
window: Window.Handle, old: Window.Dims, new: Window.Dims];
MinusLandBitmapUnder: --*Window*-- TYPE [6];

MinusLandColor: --*Window*-- TYPE [1];
MinusLandCookieCutter: --*Window*-- TYPE [2];
Mode: --*TIPStar*-- TYPE = {normal, copy, move, sameAs};
ModeChangeProc: --*TIPStar*-- TYPE = PROCEDURE [
  old: Mode, new: Mode, clientData: LONG POINTER];
ModifySource: --*ContainerWindow*-- PROCEDURE [
  window: Window.Handle, proc: SourceModifyProc];
Months: --*XComSoftMessage*-- TYPE = Keys [january..december];
MoreFlavor: --*StarWindowShell*-- TYPE = {before, after};
MoreScrollProc: --*StarWindowShell*-- TYPE = PROCEDURE [
  sws: Handle, vertical: BOOLEAN, flavor: MoreFlavor, amount: CARDINAL];
MouseTransformerProc: --*Window*-- TYPE = PROCEDURE [Handle, Place]
  RETURNS [Handle, Place];
Move: --*Selection*-- PROCEDURE [v: ValueHandle, data: LONG POINTER];
MoveIntoWindow: --*Cursor*-- PROCEDURE [
  window: Window.Handle, place: Window.Place];
MoveMark: --*ContainerCache*-- PROCEDURE [mark: Mark, newIndex: CARDINAL];
MsgDomain: --*XMessage*-- TYPE = RECORD [
  applicationName: XString.ReaderBody, handle: Handle];
MsgDomains: --*XMessage*-- TYPE = LONG DESCRIPTOR FOR ARRAY CARDINAL OF MsgDomain;
MsgEntry: --*XMessage*-- TYPE = RECORD [
  msgKey: MsgKey,
  msg: XString.ReaderBody,
  translationNote: LONG STRING ^ NIL,
  translatable: BOOLEAN ^ TRUE,
  type: MsgType ^ userMsg,
  id: MsgID];
MsgID: --*XMessage*-- TYPE = CARDINAL;
MsgKey: --*XMessage*-- TYPE = CARDINAL;
MsgKeyList: --*XMessage*-- TYPE = LONG DESCRIPTOR FOR ARRAY CARDINAL OF MsgKey;
MsgType: --*XMessage*-- TYPE = {
  userMsg, template, argList, menuItem, pSheetItem, commandItem, errorMsg,
  infoMsg, promptItem, windowMenuCommand, others};
MultiAttributeFormatProc: --*FileContainerSource*-- TYPE = PROCEDURE [
  containeeImpl: Containee.Implementation, containeeData: Containee.DataHandle,
  attrRecord: NSFile.Attributes, displayString: XString.Writer];
MultipleChoiceChangeProc: --*FormWindow*-- TYPE = PROCEDURE [
  window: Window.Handle, item: ItemKey, calledBecauseOf: ChangeReason,
  oldValue: LONG DESCRIPTOR FOR ARRAY CARDINAL OF ChoiceIndex,
  newValue: LONG DESCRIPTOR FOR ARRAY CARDINAL OF ChoiceIndex];
Multiply: --*XLReal*-- PROCEDURE [a: Number, b: Number] RETURNS [Number];
NameAndVersionColumn: --*FileContainerSourceExtra*-- PROCEDURE
  RETURNS [multipleAttributes FileContainerSource.ColumnContentsInfo];
NameColumn: --*FileContainerSource*-- PROCEDURE
  RETURNS [attribute ColumnContentsInfo];
NeededDims: --*FormWindow*-- PROCEDURE [window: Window.Handle]
  RETURNS [Window.Dims];
Negative: --*XLReal*-- PROCEDURE [Number] RETURNS [Number];
netAddr: --*BWSAttributeTypes*-- NSFile.ExtendedAttributeType = 10402B;
NetFormat: --*XFormat*-- TYPE = {octal, hex, productSoftware};
NetworkAddress: --*XFormat*-- PROCEDURE [
  h: Handle ^ NIL, networkAddress: System.NetworkAddress, format: NetFormat];
networkName: --*BWSAttributeTypes*-- NSFile.ExtendedAttributeType = 10404B;
NetworkNumber: --*XFormat*-- PROCEDURE [
  h: Handle ^ NIL, networkNumber: System.NetworkNumber, format: NetFormat];

New: --*Window*-- PROCEDURE [
  under: BOOLEAN ^ FALSE, cookie: BOOLEAN ^ FALSE, color: BOOLEAN ^ FALSE,
  zone: UNCOUNTED ZONE ^ LOOPHOLE[0]] RETURNS [Handle];
newIcon: --*StarDesktop*-- Atom.ATOM;
NewResolveBuffer: --*SimpleTextDisplay*-- PROCEDURE [words: CARDINAL]
  RETURNS [ResolveBuffer];
NewStandardCloseEverything: --*StarWindowShellExtra*-- PROCEDURE
  RETURNS [
    numberLeftOpen: CARDINAL ^ 0,
    lastNotClosed: StarWindowShell.Handle ^ LOOPHOLE[0]];
NewWriterBody: --*XString*-- PROCEDURE [maxLength: CARDINAL, z: UNCOUNTED ZONE]
  RETURNS [WriterBody];
NextIntoProc: --*FormWindow*-- TYPE = PROCEDURE [
  window: Window.Handle, item: ItemKey];
NextOutOfProc: --*FormWindow*-- TYPE = PROCEDURE [
  window: Window.Handle, item: ItemKey];
nextPlace: --*StarDesktop*-- Window.Place;
nextTabStop: --*FormWindow*-- CARDINAL = 177777B;
NilData: --*XToken*-- SIGNAL;
nonQuote: --*XToken*-- XChar.Character = 0;
NonWhiteSpace: --*XToken*-- FilterProcType;
NopDestroyProc: --*Context*-- DestroyProcType;
NopFree: --*Selection*-- ValueFreeProc;
nopFreeValueProcs: --*Selection*-- READONLY LONG POINTER TO ValueProcs;
NormalTable: --*TIPStar*-- PROCEDURE RETURNS [TIP.Table];
noScrollData: --*StarWindowShell*-- ScrollData;
NoSuchAtom: --*Atom*-- ERROR;
NoSuchDependency: --*Event*-- ERROR;
not: --*XChar*-- Character = 177777B;
noTabStop: --*FormWindow*-- CARDINAL = 177776B;
NotAProfileFile: --*OptionFile*-- SIGNAL;
NotEq: --*XLReal*-- PROCEDURE [a: Number, b: Number] RETURNS [BOOLEAN];
Notes: --*XTime*-- TYPE = {
  normal, nozone, zonedGuessed, noTime, timeAndZoneGuessed};
Notify: --*Event*-- PROCEDURE [event: EventType, eventData: LONG POINTER ^ NIL]
  RETURNS [veto: BOOLEAN];
NotifyProc: --*TIP*-- TYPE = PROCEDURE [window: Window.Handle, results: Results];
NSChar: --*XFormat*-- PROCEDURE [h: Handle ^ NIL, char: NSString Character];
NSLine: --*XFormat*-- PROCEDURE [
  h: Handle ^ NIL, s: NSString.String, n: CARDINAL ^ 1];
NSString: --*XFormat*-- PROCEDURE [h: Handle ^ NIL, s: NSString String];
NSStringFromReader: --*XString*-- PROCEDURE [r: Reader, z: UNCOUNTED ZONE]
    RETURNS [ns: NSString.String];
NSStringObject: --*XFormat*-- PROCEDURE [s: LONG POINTER TO NSString.String]
  RETURNS [Object];
SStringProc: --*XFormat*-- FormatProc;
NthCharacter: --*XString*-- PROCEDURE [r: Reader, n: CARDINAL]
  RETURNS [c: Character];
null: --*Atom*-- ATOM;
null: --*XChar*-- Character = 0;
nullBox: --*Window*-- Box;
nullData: --*Containee*-- Data;
nullHandle: --*StarWindowShell*-- Handle;

nullItem: --*ContainerSource*-- ItemIndex = 177777B;
nullItemKey: --*FormWindow*-- ItemKey = 177777B;
nullKey: --*SoftKeys*-- CARDINAL = 177777B;
nullManager: --*TIP*-- Manager;
nullOption: --*ProductFactoring*-- Option;
nullPeriodicNotify: --*TIP*-- PeriodicNotify;
nullPicture: --*BlackKeys*-- bitmap Picture;
nullPlace: --*PropertySheet*-- Window.Place;
nullPrerequisite: --*ProductFactoring*-- Prerequisite;
nullReaderBody: --*XString*-- ReaderBody;
nullValue: --*Selection*-- Value;
nullWriterBody: --*XString*-- WriterBody;
Number: --*XFormat*-- PROCEDURE [
h: Handle ˆ NIL, n: LONG UNSPECIFIED, format: NumberFormat];
Number: --*XLReal*-- TYPE [4];
Number: --*XToken*-- PROCEDURE [
h: Handle, radix: CARDINAL, signalOnError: BOOLEAN ˆ TRUE]
RETURNS [u: LONG UNSPECIFIED];
NumberFormat: --*XFormat*-- TYPE = RECORD [
base: [2..36] ˆ 12,
zerofill: BOOLEAN ˆ FALSE,
signed: BOOLEAN ˆ FALSE,
columns: [0..255] ˆ 0];
NumberOfItems: --*FormWindow*-- PROCEDURE [window: Window.Handle]
RETURNS [CARDINAL];
numberOfKeys: --*SoftKeys*-- CARDINAL = 8;.
NumberToPair: --*XLReal*-- PROCEDURE [n: Number, digits: [1..13]]
RETURNS [negative: BOOLEAN, exp: INTEGER, mantissa: Digits];
Numeric: --*XToken*-- FilterProcType;
Object: --*ContainerCache*-- TYPE;
Object: --*Cursor*-- TYPE = RECORD [info: Info, array: UserTerminal.CursorArray];
Object: --*Window*-- TYPE [19];
Object: --*XFormat*-- TYPE = RECORD [
   proc: FormatProc,
   context: XString.Context ˆ LOOPHOLE[0],
   data: ClientData ˆ NIL];
Object: --*XMessage*-- TYPE;
Object: --*XToken*-- TYPE = MACHINE DEPENDENT RECORD [
getChar(0:0..31): GetCharProcType, break(2:0..15): XChar.Character ˆ 0];
ObscuredBySibling: --*Window*-- PROCEDURE [Handle] RETURNS [BOOLEAN];
Octal: --*XFormat*-- PROCEDURE [h: Handle ˆ NIL, n: LONG UNSPECIFIED];
Octal: --*XToken*-- PROCEDURE [h: Handle, signalOnError: BOOLEAN ˆ TRUE]
   RETURNS [c: LONG CARDINAL];
OctalFormat: --*XFormat*-- NumberFormat;
oldDateSent: --*BWSAttributeTypes*-- NSFile.ExtendedAttributeType = 10413B;
Open: --*Catalog*-- PROCEDURE [
   catalogType: NSFile.Type, session: NSFile.Session ˆ LOOPHOLE[0]]
   RETURNS [catalog: NSFile.Handle];
Opportunity: --*Undo*-- Proc;
Option: --*ProductFactoring*-- TYPE = RECORD [
   product: Product, productOption: ProductOption];
Options: --*FileContainerSource*-- TYPE = RECORD [readOnly: BOOLEAN ˆ FALSE];
optionSheetDefaultMenu: --*PropertySheet*-- MenuItems;
outbasketPSData: --*BWSAttributeTypes*-- NSFile.ExtendedAttributeType = 10410B;
OutlineOrHighlight: --*FormWindow*-- TYPE = {outline, highlight};

OutlineThisKey: --*SoftKeys*-- PROCEDURE [
window: Window.Handle, key: CARDINAL ^ nullKey];
Overflow: --*XString*-- SIGNAL;
owner: --*BWSAttributeTypes*-- NSFile.ExtendedAttributeType = 10377B;
Pack: --*XTime*-- PROCEDURE [unpacked: Unpacked, useSystemLTP: BOOLEAN ^ TRUE]
RETURNS [time: System.GreenwichMeanTime];
Packed: --*XTime*-- TYPE = System.GreenwichMeanTime;
paintFlags: --*Display*-- BitBltFlags;
paintGrayFlags: --*Display*-- BitBltFlags;
Pair: --*Atom*-- TYPE = RECORD [prop: ATOM, value: RefAny];
PairToNumber: --*XLReal*-- PROCEDURE [
negative: BOOLEAN, exp: INTEGER, mantissa: Digits] RETURNS [n: Number];
Parallelogram: --*Display*-- TYPE = RECORD [
x: Interpolator, y: INTEGER, w: NATURAL, h: NATURAL];
ParseChoiceItemMessage: --*FormWindowMessageParse*-- PROCEDURE [
choiceItemMessage: XString.Reader, zone: UNCOUNTED ZONE]
RETURNS [choiceItems: FormWindow.ChoiceItems];
ParseReader: --*XTime*-- PROCEDURE [
r: XString.Reader, treatNumbersAs: TreatNumbersAs ^ dayMonthYear]
RETURNS [time: System.GreenwichMeanTime, notes: Notes, length: CARDINAL];
ParseWithTemplate: --*XTime*-- PROCEDURE [
r: XString.Reader, template: XString.Reader]
RETURNS [time: System.GreenwichMeanTime, notes: Notes, length: CARDINAL];
PeekForFlushness: --*SimpleTextDisplay*-- PROCEDURE [
requestedFlushness: Flushness, string: XString.Reader] RETURNS [Flushness];
PeekForStreakSuccession: --*SimpleTextDisplay*-- PROCEDURE [
requestedStreakSuccession: StreakSuccession, string: XString.Reader]
RETURNS [StreakSuccession];
PeriodicNotify: --*TIP*-- TYPE [1];
Permanent: --*BWSZone*-- PROCEDURE RETURNS [UNCOUNTED ZONE];
permanent: --*BWSZone*-- UNCOUNTED ZONE;
PFonts: --*ProductFactoringProducts*-- Product = 4;
Pi: --*XLReal*-- PROCEDURE RETURNS [Number];
Picture: --*BlackKeys*-- TYPE = RECORD [
variant: SELECT type: PictureType FROM
bitmap = > [bitmap: LONG POINTER], text = > [text: XString.Reader], ENDCASE];
PictureAction: --*BlackKeys*-- TYPE = {acquire, release};
PictureProc: --*BlackKeys*-- TYPE = PROCEDURE [
keyboard: Keyboard, action: PictureAction]
RETURNS [picture: Picture ^ nullPicture, geometry: GeometryTable ^ NIL];
PictureProc: --*Containee*-- TYPE = PROCEDURE [
data: DataHandle, window: Window.Handle, box: Window.Box, old: PictureState,
new: PictureState];
PictureReal: --*XLReal*-- PROCEDURE [
h: XFormat.Handle ^ NIL, r: Number, template: XString.Reader];
PictureState: --*Containee*-- TYPE = {
garbage, normal, highlighted, ghost, reference, referenceHighlighted};
PictureType: --*BlackKeys*-- TYPE = {bitmap, text};
Piece: --*XString*-- PROCEDURE [r: Reader, firstChar: CARDINAL, nChars: CARDINAL]
RETURNS [piece: ReaderBody, endContext: Context];
Place: --*Window*-- TYPE = UserTerminal.Coordinate;
Placeholder: --*TIPStar*-- TYPE = {
mouseActions, keyOverrides, softKeys, keyboardSpecific, blackKeys, sideKeys,
backstopSpecialFocus};
Point: --*Display*-- PROCEDURE [window: Handle, point: Window.Place];
Pop: --*StarWindowShell*-- PROCEDURE [popee: Handle] RETURNS [Handle];

```
PopOrSwap: --StarWindowShell-- TYPE = {pop, swap};
PoppedProc: --StarWindowShell-- TYPE = PROCEDURE [
   popped: Handle, newShell: Handle, popOrSwap: PopOrSwap ˆ pop];
PopTable: --TIPStar-- PROCEDURE [Placeholder, TIP.Table];
Popup: --PopupMenu-- PROCEDURE [
   menu: MenuData.MenuHandle, clients: Window.Handle, showTitle: BOOLEAN ˆ TRUE,
   place: Window.Place ˆ LOOPHOLE[37777777777B]];
Post: --Attention-- PROCEDURE [
   s: XString.Reader, clear: BOOLEAN ˆ TRUE, beep: BOOLEAN ˆ FALSE,
   blink: BOOLEAN ˆ FALSE];
Post: --MessageWindow-- PROCEDURE [
   window: Window.Handle, r: XString.Reader, clear: BOOLEAN ˆ TRUE];
PostAndConfirm: --Attention-- PROCEDURE [
   s: XString.Reader, clear: BOOLEAN ˆ TRUE,
   confirmChoices: ConfirmChoices ˆ xxx, timeout: Process.Ticks ˆ dontTimeout,
   beep: BOOLEAN ˆ FALSE, blink: BOOLEAN ˆ FALSE]
   RETURNS [confirmed: BOOLEAN, timedOut: BOOLEAN];
PostSticky: --Attention-- PROCEDURE [
   s: XString.Reader, clear: BOOLEAN ˆ TRUE, beep: BOOLEAN ˆ FALSE,
   blink: BOOLEAN ˆ FALSE];
PostSTRING: --MessageWindow-- PROCEDURE [
   window: Window.Handle, s: LONG STRING, clear: BOOLEAN ˆ TRUE];
Power: --XLReal-- PROCEDURE [base: Number, exponent: Number] RETURNS [Number];
Prerequisite: --ProductFactoring-- TYPE = RECORD [
   prerequisiteSpec: BOOLEAN ˆ FALSE, option: Option];
printingLigatures: --XCharSet360-- XCharSets.Sets = LOOPHOLE[240];
PrivateItem: --MenuData-- TYPE = PRIVATE RECORD [
   proc: MenuProc,
   nameWidth: NATURAL,
   nameBytes: NATURAL,
   body: SELECT hasItemData: BOOLEAN FROM
      FALSE => [name: PACKED SEQUENCE COMPUTED CARDINAL OF Environment.Byte],
      TRUE => [
         itemData: LONG UNSPECIFIED,
         name: PACKED SEQUENCE COMPUTED CARDINAL OF Environment.Byte],
      ENDCASE];
PrivateMenu: --MenuData-- TYPE = PRIVATE RECORD [
   zone: UNCOUNTED ZONE,
   swapItemProc: SwapItemProc,
   title: ItemHandle ˆ NIL,
   array: ArrayHandle ˆ xxx,
   arrayAllocatedItemHandles: NATURAL ˆ 0,
   itemsInMenusZone: BOOLEAN ˆ FALSE];
Problem: --SimpleTextFont-- SIGNAL [code: ProblemCode];
ProblemCode: --SimpleTextFont-- TYPE = {
   badFont, clientCharacterCodesExhausted, clientCharacterBitsExhausted};
Proc: --Undo-- TYPE = PROCEDURE [
   undoProc: PROCEDURE [LONG POINTER], destroyProc: PROCEDURE [LONG POINTER],
   data: LONG POINTER, size: CARDINAL ˆ 0];
Procedures: --ContainerSource-- TYPE = LONG POINTER TO ProceduresObject;
ProceduresObject: --ContainerSource-- TYPE = RECORD [
   actOn: ActOnProc,
   canYouTake: CanYouTakeProc,
   columnCount: ColumnCountProc,
   convertItem: ConvertItemProc,
   deleteItems: DeleteItemsProc,
   getLength: GetLengthProc,
   itemGeneric: ItemGenericProc,
   stringOfItem: StringOfItemProc,
   take: TakeProc];
Product: --ProductFactoring-- TYPE = CARDINAL [0..15];
Product: --ProductFactoringProducts-- TYPE = ProductFactoring.Product;
Product: --ProductFactoringProductsExtras-- TYPE = ProductFactoring.Product;
ProductOption: --ProductFactoring-- TYPE = CARDINAL [0..27];
propertySheetDefaultMenu: --PropertySheet-- MenuItems;
prototypeCatalog: --BWSFileTypes-- NSFile.Type = 1;
PublicZone: --MenuData-- PROCEDURE RETURNS [UNCOUNTED ZONE];
PurgeOldVersions: --Prototype-- PROCEDURE [
   type: NSFile.Type, current: Version, subtype: Subtype ^ 0];
Push: --BlackKeys-- PROCEDURE [keyboard: Keyboard];
Push: --SoftKeys-- PROCEDURE [
   table: TIP.Table ^ NIL, notifyProc: TIP.NotifyProc ^ NIL,
   labels: Labels ^ xxx, highlightedKey: CARDINAL ^ nullKey,
   outlinedKey: CARDINAL ^ nullKey] RETURNS [window: Window.Handle];
Push: --StarWindowShell-- PROCEDURE [
   newShell: Handle, topOfStack: Handle ^ LOOPHOLE[0],
   poppedProc: PoppedProc ^ NIL];
PushedMe: --StarWindowShellExtra-- PROCEDURE [pushee: StarWindowShell.Handle]
   RETURNS [pusher: StarWindowShell.Handle];
PushedOnMe: --StarWindowShellExtra-- PROCEDURE [pusher: StarWindowShell.Handle]
   RETURNS [pushee: StarWindowShell.Handle];
PushTable: --TIPStar-- PROCEDURE [Placeholder, TIP.Table];
PutProp: --Atom-- PROCEDURE [onto: ATOM, pair: Pair];
Query: --Selection-- PROCEDURE [
   targets: LONG DESCRIPTOR FOR ARRAY CARDINAL OF QueryElement];
QueryElement: --Selection-- TYPE = RECORD [
   target: Target, enumeration: BOOLEAN ^ FALSE, difficulty: Difficulty ^ NULL];
Quote: --XToken-- QuoteProcType;
QuoteProcType: --XToken-- TYPE = PROCEDURE [c: XChar.Character]
   RETURNS [closing: XChar.Character];
Reader: --XFormat-- PROCEDURE [h: Handle ^ NIL, r: XString.Reader];
Reader: --XString-- TYPE = LONG POINTER TO ReaderBody;
ReaderBody: --XFormat-- PROCEDURE [h: Handle ^ NIL, rb: XString.ReaderBody];
ReaderBody: --XString-- TYPE = PRIVATE MACHINE DEPENDENT RECORD [
   context(0:0..15): Context,
   limit(1:0..15): CARDINAL,
   offset(2:0..15): CARDINAL,
   bytes(3:0..31): ReadOnlyBytes];
ReaderFromWriter: --XString-- PROCEDURE [w: Writer] RETURNS [Reader];
ReaderInfo: --XString-- PROCEDURE [r: Reader]
   RETURNS [context: Context, startsWith377B: BOOLEAN];
ReaderToHandle: --XToken-- PROCEDURE [r: XString.Reader] RETURNS [h: Handle];
ReaderToNumber: --XLReal-- PROCEDURE [r: XString.Reader] RETURNS [Number];
ReaderToNumber: --XString-- PROCEDURE [
   r: Reader, radix: CARDINAL ^ 10, signed: BOOLEAN ^ FALSE]
   RETURNS [LONG INTEGER];
ReadNumber: --XLReal-- PROCEDURE [
   get: PROCEDURE RETURNS [XChar.Character],
   putback: PROCEDURE [XChar.Character]] RETURNS [Number];
ReadOnlyBytes: --XString-- TYPE = LONG POINTER TO READONLY ByteSequence;
```

RebuildItem: --*FileContainerSourceExtra2*-- PROCEDURE [
  source: ContainerSource.Handle, item: ContainerSource.ItemIndex];
Reconversion: --*Selection*-- SIGNAL [target: Target, zone: UNCOUNTED ZONE]
  RETURNS [Value];
ReconvertDuringEnumerate: --*Selection*-- PROCEDURE [
  target: Target, zone: UNCOUNTED ZONE ^ LOOPHOLE[0]] RETURNS [Value];
RefAny: --*Atom*-- TYPE = LONG POINTER;
referencedType: --*BWSAttributeTypes*-- NSFile.ExtendedAttributeType = 10401B;
RefPair: --*Atom*-- TYPE = LONG POINTER TO READONLY Pair;
refParentID: --*BWSAttributeTypes*-- NSFile.ExtendedAttributeType = 10403B;
refparentTime: --*BWSAttributeTypes*-- NSFile.ExtendedAttributeType = 10405B;
RegisterClientKeyboards: --*KeyboardKey*-- PROCEDURE [
  wantSystemKeyboards: BOOLEAN ^ TRUE,
  SPECIALKeyboard: BlackKeys.Keyboard ^ NIL,
  keyboards: LONG DESCRIPTOR FOR ARRAY CARDINAL OF BlackKeys.KeyboardObject ^
    xxx];
RegisterMessages: --*XMessage*-- PROCEDURE [
  h: Handle, messages: Messages, stringBodiesAreReal: BOOLEAN];
Relation: --*XString*-- TYPE = {less, equal, greater};
Release: --*Context*-- PROCEDURE [type: Type, window: Window.Handle];
Remainder: --*XLReal*-- PROCEDURE [a: Number, b: Number] RETURNS [Number];
remoteName: --*BWSAttributeTypes*-- NSFile.ExtendedAttributeType = 10406B;
Remove: --*BlackKeys*-- PROCEDURE [keyboard: Keyboard];
Remove: --*SoftKeys*-- PROCEDURE [window: Window.Handle];
RemoveClientKeyboards: --*KeyboardKey*-- PROCEDURE;
RemoveDependency: --*Event*-- PROCEDURE [dependency: Dependency];
RemoveFromSystemKeyboards: --*KeyboardKey*-- PROCEDURE [
  keyboard: BlackKeys.Keyboard];
RemoveFromTree: --*Window*-- PROCEDURE [Handle];
RemoveItemFromLine: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, item: ItemKey, line: Line, repaint: BOOLEAN ^ TRUE];
RemoveMenuItem: --*Attention*-- PROCEDURE [item: MenuData.ItemHandle];
RemoveProp: --*Atom*-- PROCEDURE [onto: ATOM, prop: ATOM];
Repaint: --*FormWindow*-- PROCEDURE [window: Window.Handle];
RepaintField: --*SimpleTextEdit*-- PROCEDURE [f: Field];
Replace: --*StarWindowShellExtra*-- PROCEDURE [
  new: StarWindowShell.Handle, old: StarWindowShell.Handle];
ReplaceChars: --*SimpleTextEdit*-- PROCEDURE [
  f: Field, firstChar: CARDINAL, nChars: CARDINAL, r: XString.Reader,
  endContext: XString.Context ^ LOOPHOLE[255], repaint: BOOLEAN ^ TRUE];
replaceFlags: --*Display*-- BitBltFlags;
replaceGrayFlags: --*Display*-- BitBltFlags;
ReplaceItem: --*ContainerCache*-- PROCEDURE [
  cache: Handle, item: CARDINAL, addData: AddData] RETURNS [handle: ItemHandle];
ReplacePiece: --*XString*-- PROCEDURE [
  w: Writer, firstChar: CARDINAL, nChars: CARDINAL, r: Reader,
  endContext: Context ^ unknownContext];
RequestorData: --*Selection*-- TYPE = LONG POINTER;
ResetAllChanged: --*FormWindow*-- PROCEDURE [window: Window.Handle];
ResetCache: --*ContainerCache* - PROCEDURE [Handle];
ResetChanged: --*FormWindow*-- PROCEDURE [window: Window.Handle, item: ItemKey];
ResetUserAbort: --*TIP*-- PROCEDURE [Window.Handle];
ResolveBuffer: --*SimpleTextDisplay*-- TYPE = LONG DESCRIPTOR FOR ARRAY [0..0) OF
  CARDINAL;
Restore: --*FormWindow*-- PROCEDURE [window: Window.Handle];

```
Restore: --Selection-- PROCEDURE [
   saved: Saved, mark: BOOLEAN ^ TRUE, unmark: BOOLEAN ^ TRUE];
Result: --SimpleTextDisplay-- TYPE = {normal, margin, stop};
ResultObject: --TIP-- TYPE = RECORD [
   next: Results,
   body: SELECT type: * FROM
      atom = > [a: ATOM],
      bufferedChar = > NULL,
      coords = > [place: Window.Place],
      int = > [i: LONG INTEGER],
      key = > [key: KeyName, downUp: DownUp],
      nop = > NULL,
      string = > [rb: XString.ReaderBody],
      time = > [time: System.Pulses],
      ENDCASE];
Results: --TIP-- TYPE = LONG POINTER TO ResultObject;
ResultsWanted: --TIPX-- TYPE = PROCEDURE [
   window: Window.Handle, table: TIP.Table ^ NIL, results: TIP.Results]
   RETURNS [wanted: BOOLEAN];
ReturnTicket: --Containee-- PROCEDURE [ticket: Ticket];
ReturnToNotifier: --TIP-- ERROR [string: XString.Reader];
ReverseLop: --XString-- PROCEDURE [
   r: Reader, endContext: LONG POINTER TO Context,
   backScan: BackScanClosure ^ xxx] RETURNS [c: Character];
ReverseMap: --XString-- PROCEDURE [r: Reader, proc: MapCharProc]
   RETURNS [c: Character];
Roadblock: --Undo-- PROCEDURE [XString.Reader];
root: --BWSFileTypes-- NSFile.Type = 10477B;
Root: --Window-- PROCEDURE RETURNS [Handle];
Root: --XLReal-- PROCEDURE [index: Number, arg: Number] RETURNS [Number];
rootWindow: --Window-- READONLY Handle;
Run: --XString-- PROCEDURE [r: Reader] RETURNS [run: ReaderBody];
Save: --FormWindow-- PROCEDURE [window: Window.Handle];
SaveAndSet: --Selection-- PROCEDURE [
   pointer: ManagerData, conversion: ConvertProc, actOn: ActOnProc,
   unmark: BOOLEAN ^ TRUE] RETURNS [old: Saved];
Saved: --Selection-- TYPE [6];
Scan: --XString-- PROCEDURE [
   r: Reader, break: BreakTable, option: BreakCharOption]
   RETURNS [breakChar: Character, front: ReaderBody];
ScanForCharacter: --XString-- PROCEDURE [
   r: Reader, char: Character, option: BreakCharOption]
   RETURNS [breakChar: Character, front: ReaderBody];
ScrollData: --StarWindowShell-- TYPE = RECORD [
   displayHorizontal: BOOLEAN ^ FALSE,
   displayVertical: BOOLEAN ^ FALSE,
   arrowScroll: ArrowScrollProc ^ NIL,
   thumbScroll: ThumbScrollProc ^ NIL,
   moreScroll: MoreScrollProc ^ NIL];
SectionEnumProc: --OptionFile-- TYPE = PROCEDURE [section: XString.Reader]
   RETURNS [stop: BOOLEAN ^ FALSE];
SelectItem: --ContainerWindow-- PROCEDURE [
   window: Window.Handle, item: ContainerSource.ItemIndex];
SelectReference: --StarDesktop-- PROCEDURE [reference: NSFile.Reference]
   RETURNS [ok: BOOLEAN];
SemiPermanent: --BWSZone-- PROCEDURE RETURNS [UNCOUNTED ZONE];
```

semiPermanent: --*BWSZone*-- UNCOUNTED ZONE;
Services2: --*ProductFactoringProductsExtras*-- Product = 8;
Services: --*ProductFactoringProducts*-- Product = 1;
Set: --*Context*-- PROCEDURE [type: Type, data: Data, window: Window.Handle];
Set: --*Cursor*-- PROCEDURE [type: Defined];
Set: --*Selection*-- PROCEDURE [
  pointer: ManagerData, conversion: ConvertProc, actOn: ActOnProc];
Set: --*XChar*-- PROCEDURE [c: Character] RETURNS [set: Environment.Byte];
SetAdjustProc: --*StarWindowShell*-- PROCEDURE [sws: Handle, proc: AdjustProc]
  RETURNS [old: AdjustProc];
SetAllChanged: --*FormWindow*-- PROCEDURE [window: Window.Handle];
SetAttention: --*TIP*-- PROCEDURE [
  window: Window.Handle, attention: AttentionProc];
SetBackStopInputFocus: --*TIP*-- PROCEDURE [window: Window.Handle];
SetBitmapUnder: --*Window*-- PROCEDURE [
  window: Handle, pointer: LONG POINTER ˆ NIL,
  underChanged: UnderChangedProc ˆ NIL,
  mouseTransformer: MouseTransformerProc ˆ NIL] RETURNS [LONG POINTER];
SetBodyWindowJustFits: --*StarWindowShell*-- PROCEDURE [
  sws: Handle, yes: BOOLEAN];
SetBOOLEAN: --*AtomicProfile*-- PROCEDURE [atom: Atom.ATOM, boolean: BOOLEAN];
SetBooleanItemValue: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, item: ItemKey, newValue: BOOLEAN,
  repaint: BOOLEAN ˆ TRUE];
SetBottomPusheeCommands: --*StarWindowShell*-- PROCEDURE [
  sws: Handle, commands: MenuData.MenuHandle];
SetCachedName: --*Containee*-- PROCEDURE [
  data: DataHandle, newName: XString.Reader];
SetCachedType: --*Containee*-- PROCEDURE [data: DataHandle, newType: NSFile.Type];
SetChanged: --*FormWindow*-- PROCEDURE [window: Window.Handle, item: ItemKey];
SetCharTranslator: --*TIP*-- PROCEDURE [table: Table, new: CharTranslator]
  RETURNS [old: CharTranslator];
SetChild: --*Window*-- PROCEDURE [window: Handle, newChild: Handle]
  RETURNS [oldChild: Handle];
SetChoiceItemValue: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, item: ItemKey, newValue: ChoiceIndex,
  repaint: BOOLEAN ˆ TRUE];
SetClearingRequired: --*Window*-- PROCEDURE [window: Handle, required: BOOLEAN]
  RETURNS [old: BOOLEAN];
SetContainee: --*StarWindowShell*-- PROCEDURE [
  sws: Handle, file: Containee.DataHandle];
SetDecimalItemValue: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, item: ItemKey, newValue: XLReal.Number,
  repaint: BOOLEAN ˆ TRUE];
SetDefaultImplementation: --*Containee*-- PROCEDURE [Implementation]
  RETURNS [Implementation];
SetDefaultOutputSink: --*XFormat*-- PROCEDURE [new: Object] RETURNS [old: Object];
SetDesktopProc: --*IdleControl*-- PROCEDURE [
  atom: Atom.ATOM, desktop: DesktopProc];
SetDims: --*SimpleTextEdit*-- PROCEDURE [f: Field, dims: Window.Dims];
SetDisplayBackgroundProc: --*StarDesktop*-- PROCEDURE [PROCEDURE [Window.Handle]];
SetDisplayProc: --*Window*-- PROCEDURE [Handle, DisplayProc]
  RETURNS [DisplayProc];
SetFixedHeight: --*SimpleTextEdit*-- PROCEDURE [f: Field, fixedHeight: BOOLEAN];

SetFlushness: --*FormWindow*-- PROCEDURE [
window: Window.Handle, item: ItemKey, new: Flushness]
RETURNS [old: Flushness];

SetFlushness: --*SimpleTextEdit*-- PROCEDURE [
f: Field, new: SimpleTextDisplay.Flushness]
RETURNS [old: SimpleTextDisplay.Flushness];

SetFont: --*SimpleTextEdit*-- PROCEDURE [
f: Field, font: SimpleTextFont.MappedFontHandle ^ NIL];

SetGlobalChangeProc: --*FormWindow*-- PROCEDURE [
window: Window.Handle, proc: GlobalChangeProc]
RETURNS [old: GlobalChangeProc];

SetGreeterProc: --*IdleControl*-- PROCEDURE [new: GreeterProc]
RETURNS [old: GreeterProc];

SetHost: --*StarWindowShell*-- PROCEDURE [sws: Handle, host: Handle]
RETURNS [old: Handle];

SetImplementation: --*Containee*-- PROCEDURE [NSFile.Type, Implementation]
RETURNS [Implementation];

SetImplementation: --*Undo*-- PROCEDURE [Implementation] RETURNS [Implementation];

SetInputFocus: --*FormWindow*-- PROCEDURE [
window: Window.Handle, item: ItemKey, beforeChar: CARDINAL ` 177777B];

SetInputFocus: --*SimpleTextEdit*-- PROCEDURE [
f: Field, beforeChar: CARDINAL ` 177777B];

SetInputFocus: --*TIP*-- PROCEDURE [
w: Window.Handle, takesInput: BOOLEAN, newInputFocus: LosingFocusProc ^ NIL,
clientData: LONG POINTER ^ NIL];

SetIntegerItemValue: --*FormWindow*-- PROCEDURE [
window: Window.Handle, item: ItemKey, newValue: LONG INTEGER,
repaint: BOOLEAN ^ TRUE];

SetIsCloseLegalProc: --*StarWindowShell*-- PROCEDURE [
sws: Handle, proc: IsCloseLegalProc];

SetItemBox: --*FormWindow*-- PROCEDURE [
window: Window.Handle, item: ItemKey, box: Window.Box];

SetItemNameWidth: --*MenuData*-- PROCEDURE [item: ItemHandle, width: CARDINAL];

SetItemWidth: --*FormWindow*-- PROCEDURE [
window: Window.Handle, item: ItemKey, width: CARDINAL];

SetKeyboard: --*KeyboardKey*-- PROCEDURE [keyboard: BlackKeys.Keyboard];

SetLimitProc: --*StarWindowShell*-- PROCEDURE [sws: Handle, proc: LimitProc]
RETURNS [old: LimitProc];

SetLONGINTEGER: --*AtomicProfile*-- PROCEDURE [
atom: Atom.ATOM, int: LONG INTEGER];

SetManager: --*TIP*-- PROCEDURE [new: Manager] RETURNS [old: Manager];

SetMark: --*ContainerCache*-- PROCEDURE [cache: Handle, index: CARDINAL]
RETURNS [mark: Mark];

SetMiddlePusheeCommands: --*StarWindowShell*-- PROCEDURE [
sws: Handle, commands: MenuData.MenuHandle];

SetMode: --*TIPStar*-- PROCEDURE [
mode: Mode, modeChangeProc: ModeChangeProc ^ NIL,
clientData: LONG POINTER ` NIL] RETURNS [old: Mode];

SetMultipleChoiceItemValue: --*FormWindow*-- PROCEDURE [
window: Window.Handle, item: ItemKey,
newValues: LONG DESCRIPTOR FOR ARRAY CARDINAL OF ChoiceIndex,
repaint: BOOLEAN ^ TRUE];

SetName: --*StarWindowShell*-- PROCEDURE [sws: Handle, name: XString.Reader];

SetNamePicture: --*StarWindowShell*-- PROCEDURE [
sws: Handle, picture: XString.Character];

SetNextOutOfProc: --*FormWindow*-- PROCEDURE [
window: Window.Handle, item: ItemKey, nextOutOfProc: NextOutOfProc]
RETURNS [old: NextOutOfProc];
SetNotifyProc: --*TIP*-- PROCEDURE [window: Window.Handle, notify: NotifyProc]
RETURNS [oldNotify: NotifyProc];
SetNotifyProcForTable: --*TIP*-- PROCEDURE [table: Table, notify: NotifyProc]
RETURNS [oldNotify: NotifyProc];
SetParent: --*Window*-- PROCEDURE [window: Handle, newParent: Handle]
RETURNS [oldParent: Handle];
SetPlace: --*SimpleTextEdit*-- PROCEDURE [f: Field, place: Window.Place];
SetPreferredDims: --*StarWindowShell*-- PROCEDURE [
sws: Handle, dims: Window.Dims];
SetPreferredInteriorDims: --*StarWindowShellExtra2*-- PROCEDURE [
sws: StarWindowShell.Handle, dims: Window.Dims];
SetPreferredPlace: --*StarWindowShell*-- PROCEDURE [
sws: Handle, place: Window.Place];
SetReadOnly: --*FormWindow*-- PROCEDURE [
window: Window.Handle, item: ItemKey, readOnly: BOOLEAN]
RETURNS [old: BOOLEAN];
SetReadOnly: --*SimpleTextEdit*-- PROCEDURE [f: Field, readOnly: BOOLEAN]
RETURNS [old: BOOLEAN];
SetReadOnly: --*StarWindowShell*-- PROCEDURE [sws: Handle, yes: BOOLEAN];
SetRegularCommands: --*StarWindowShell*-- PROCEDURE [
sws: Handle, commands: MenuData.MenuHandle];
Sets: --*XCharSets*-- TYPE = MACHINE DEPENDENT{
latin, firstUnused1, lastUnused1(32), jisSymbol1, jisSymbol2, extendedLatin,
hiragana, katakana, greek, cyrillic, firstUserKanji1, lastUserKanji1(47),
firstLevel1Kanji, lastLevel1Kanji(79), firstLevel2Kanji, lastLevel2Kanji(115),
jSymbol3, firstUserKanji2, lastUserKanji2(126), firstUnused2,
lastUnused2(160), firstReserved1, lastReserved1(223), arabic, hebrew,
firstReserved2, lastReserved2(237), generalSymbols2, generalSymbols1,
firstRendering, lastRendering(253), userDefined, selectCode};
SetScrollData: --*StarWindowShell*-- PROCEDURE [sws: Handle, new: ScrollData]
RETURNS [old: ScrollData];
SetSelection: --*FormWindow*-- PROCEDURE [
window: Window.Handle, item: ItemKey, firstChar: CARDINAL ^ 0,
lastChar: CARDINAL ^ 177777B];
SetSelection: --*SimpleTextEdit*-- PROCEDURE [
f: Field, firstChar: CARDINAL ^ 0, lastChar: CARDINAL ^ 177777B];
SetShowKeyboardProc: --*KeyboardKey*-- PROCEDURE [ShowKeyboardProc];
SetSibling: --*Window*-- PROCEDURE [window: Handle, newSibling: Handle]
RETURNS [oldSibling: Handle];
SetSleeps: --*StarWindowShellExtra*-- PROCEDURE [
sws: StarWindowShell.Handle, sleeps: BOOLEAN] RETURNS [old: BOOLEAN];
SetSource: --*ContainerWindow*-- PROCEDURE [
window: Window.Handle, newSource: ContainerSource.Handle]
RETURNS [oldSource: ContainerSource.Handle];
SetState: --*StarWindowShell*-- PROCEDURE [sws: Handle, state: State];
SetStreakSuccession: --*FormWindow*-- PROCEDURE [
window: Window.Handle, item: ItemKey, new: StreakSuccession]
RETURNS [old: StreakSuccession];
SetStreakSuccession: --*SimpleTextEdit*-- PROCEDURE [
f: Field, new: SimpleTextDisplay.StreakSuccession]
RETURNS [old: SimpleTextDisplay.StreakSuccession];
SetString: --*AtomicProfile*-- PROCEDURE [
atom: Atom.ATOM, string: XString.Reader, immutable: BOOLEAN ^ FALSE];

SetSwapItemProc: --*MenuData*-- PROCEDURE [menu: MenuHandle, new: SwapItemProc]
  RETURNS [old: SwapItemProc];
SetTable: --*TIP*-- PROCEDURE [window: Window.Handle, table: Table]
  RETURNS [oldTable: Table];
SetTableAndNotifyProc: --*TIP*-- PROCEDURE [
  window: Window.Handle, table: Table ^ NIL, notify: NotifyProc ^ NIL];
SetTableLink: --*TIP*-- PROCEDURE [from: Table, to: Table] RETURNS [old: Table];
SetTableOpacity: --*TIP*-- PROCEDURE [table: Table, opaque: BOOLEAN]
  RETURNS [oldOpaque: BOOLEAN];
SetTabStops: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, tabStops: TabStops];
SetTextItemValue: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, item: ItemKey, newValue: XString.Reader,
  repaint: BOOLEAN ^ TRUE];
SetTopPusheeCommands: --*StarWindowShell*-- PROCEDURE [
  sws: Handle, commands: MenuData.MenuHandle];
SetTransitionProc: --*StarWindowShell*-- PROCEDURE [
  sws: Handle, new: TransitionProc] RETURNS [old: TransitionProc];
SetUseBadPhosphor: --*Window*-- PROCEDURE [Handle, BOOLEAN] RETURNS [BOOLEAN];
SetUserAbort: --*TIP*-- PROCEDURE [Window Handle];
SetValue: --*SimpleTextEdit*-- PROCEDURE [
  f: Field, string: XString.Reader, repaint: BOOLEAN ^ TRUE];
SetVisibility: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, item: ItemKey, visibility: Visibility,
  repaint: BOOLEAN ^ TRUE];
SetWindowItemSize: --*FormWindow*-- PROCEDURE [
  window: Window.Handle, windowItemKey: ItemKey, newSize: Window.Dims];
ShellEnumProc: --*StarWindowShell*-- TYPE = PROCEDURE [sws: Handle]
  RETURNS [stop: BOOLEAN ^ FALSE];
ShellFromChild: --*StarWindowShell*-- PROCEDURE [child: Window.Handle]
  RETURNS [Handle];
ShellType: --*StarWindowShell*-- TYPE = MACHINE DEPENDENT{
  regular, keyboard, psheet, attention, static, last(15)};
Shift: --*Display*-- PROCEDURE [
  window: Handle, box: Window.Box, newPlace: Window.Place];
ShiftState: --*KeyboardWindow*-- TYPE = {None, One, Two, Both};
ShortLifetime: --*BWSZone*-- PROCEDURE RETURNS [UNCOUNTED ZONE];
shortLifetime: --*BWSZone*-- UNCOUNTED ZONE;
ShowKeyboardProc: --*KeyboardKey*-- TYPE = PROCEDURE;
Signal: --*Containee*-- SIGNAL [
  msg: XString.Reader ^ NIL, error: ERROR ^ NIL, errorData: LONG POINTER ^ NIL];
Signal: --*ContainerSource*-- SIGNAL [
  code: ErrorCode, msg: XString.Reader ^ NIL, error: ERROR ^ NIL,
  errorData: LONG POINTER ^ NIL];
SimpleDestroyProc: --*Context*-- DestroyProcType;
Sin: --*XLReal*-- PROCEDURE [radians: Number] RETURNS [sin: Number];
SizeColumn: --*FileContainerSource*-- PROCEDURE
  RETURNS [multipleAttributes ColumnContentsInfo];
Skip: --*XToken*-- PROCEDURE [
  h: Handle, data: FilterState, filter: FilterProcType,
  skipInClass: BOOLEAN ^ TRUE];
SkipMode: --*XToken*-- TYPE = {none, whiteSpace, nonToken};
SleepOrDestroy: --*StarWindowShell*-- PROCEDURE [Handle] RETURNS [Handle];
Slide: --*Window*-- PROCEDURE [window: Handle, newPlace: Place];

SlideAndSize: --*Window*-- PROCEDURE [
  window: Handle, newBox: Box, gravity: Gravity ˆ nw];
SlideAndSizeAndStack: --*Window*-- PROCEDURE [
  window: Handle, newBox: Box, newSibling: Handle, newParent: Handle ˆ NIL,
  gravity: Gravity ˆ nw];
SlideAndStack: --*Window*-- PROCEDURE [
  window: Handle, newPlace: Place, newSibling: Handle, newParent: Handle ˆ NIL];
SmallPictureProc: --*Containee*-- TYPE = PROCEDURE [
  data: DataHandle ˆ NIL, type: NSFile.Type ˆ ignoreType,
  normalOrReference: PictureState] RETURNS [smallPicture: XString.Character];
SocketNumber: --*XFormat*-- PROCEDURE [
  h: Handle ˆ NIL, socketNumber: System.SocketNumber, format: NetFormat];
SortOrder: --*XString*-- TYPE = MACHINE DEPENDENT{
  standard, spanish, swedish, danish, firstFree, null(255)};
SourceModifyProc: --*ContainerWindow*-- TYPE = PROCEDURE [
  window: Window.Handle, source: ContainerSource.Handle]
  RETURNS [changeInfo: ContainerSource.ChangeInfo];
spares: --*BWSAttributeTypes*-- CARDINAL = 20;
SpecialIndex: --*XLReal*-- TYPE = NATURAL;
Spinnaker: --*ProductFactoringProducts*-- Product = 2;
SqRt: --*XLReal*-- PROCEDURE [Number] RETURNS [Number];
Stack: --*Window*-- PROCEDURE [
  window: Handle, newSibling: Handle, newParent: Handle ˆ NIL];
StandardClose: --*StarWindowShell*-- PROCEDURE [sws: Handle] RETURNS [Handle];
StandardCloseAll: --*StarWindowShell*-- PROCEDURE [sws: Handle] RETURNS [Handle];
StandardCloseEverything: --*StarWindowShell*-- PROCEDURE
  RETURNS [notClosed: Handle];
StandardFilterState: --*XToken*-- TYPE = ARRAY [0..1] OF UNSPECIFIED;
StandardLimitProc: --*StarWindowShell*-- LimitProc;
Star: --*ProductFactoringProducts*-- Product = 0;
State: --*StarWindowShell*-- TYPE = MACHINE DEPENDENT{
  awake, sleeping, dead, last(7)};
StatusOfFill: --*ContainerCache*-- PROCEDURE [cache: Handle]
  RETURNS [CacheFillStatus];
StopOrNot: --*XString*-- TYPE = {stop, not} ˆ not;
Store: --*Cursor*-- PROCEDURE [h: Handle];
StoreCharacter: --*Cursor*-- PROCEDURE [c: XChar.Character];
StoreNumber: --*Cursor*-- PROCEDURE [n: CARDINAL];
StoreTable: --*TIPStar*-- PROCEDURE [Placeholder, TIP.Table] RETURNS [TIP.Table];
StreakNature: --*XChar*-- TYPE = {leftToRight, rightToLeft};
StreakSuccession: --*FormWindow*-- TYPE = SimpleTextDisplay.StreakSuccession;
StreakSuccession: --*SimpleTextDisplay*-- TYPE = {
  leftToRight, rightToLeft, fromFirstChar};
StreamObject: --*XFormat*-- PROCEDURE [sH: Stream.Handle] RETURNS [Object];
StreamProc: --*XFormat*-- FormatProc;
StreamToHandle: --*XToken*-- PROCEDURE [s: Stream.Handle] RETURNS [h: Handle];
String: --*XFormat*-- PROCEDURE [h: Handle ˆ NIL, s: LONG STRING];
StringArray: --*XMessage*-- TYPE = LONG DESCRIPTOR FOR ARRAY CARDINAL OF
  XString.ReaderBody;
StringIntoBuffer: --*SimpleTextDisplay*-- PROCEDURE [
  string: XString.Reader, bufferProc: BufferProc, lineWidth: CARDINAL ˆ 177777B,
  wordBreak: BOOLEAN ˆ TRUE, streakSuccession: StreakSuccession ˆ fromFirstChar,
  font: SimpleTextFont.MappedFontHandle ˆ NIL]
  RETURNS [lastLineWidth: CARDINAL, result: Result, rest: XString.ReaderBody];
StringIntoWindow: --*SimpleTextDisplay*-- PROCEDURE [
  string: XString.Reader, window: Window.Handle, place: Window.Place,

lineWidth: CARDINAL ˆ 177777B, maxNumberOfLines: CARDINAL ˆ 1,
lineToLineDeltaY: CARDINAL ˆ 0, wordBreak: BOOLEAN ˆ TRUE,
flags: BitBlt.BitBltFlags ˆ LOOPHOLE[42000B]]
RETURNS [lines: CARDINAL, lastLineWidth: CARDINAL];
StringOfItem: --*ContainerSource*-- StringOfItemProc;
StringOfItemProc: --*ContainerSource*-- TYPE = PROCEDURE [
source: Handle, itemIndex: ItemIndex, stringIndex: CARDINAL]
RETURNS [XString.ReaderBody];
StuffCharacter: --*TIP*-- PROCEDURE [
window: Window.Handle, char: XString.Character] RETURNS [BOOLEAN];
StuffCurrentSelection: --*TIP*-- PROCEDURE [window: Window.Handle]
RETURNS [BOOLEAN];
StuffResults: --*TIP*-- PROCEDURE [window: Window.Handle, results: Results];
StuffSTRING: --*TIP*-- PROCEDURE [window: Window.Handle, string: LONG STRING]
RETURNS [BOOLEAN];
StuffString: --*TIP*-- PROCEDURE [window: Window.Handle, string: XString.Reader]
RETURNS [BOOLEAN];
StuffTrashBin: --*TIP*-- PROCEDURE [window: Window.Handle] RETURNS [BOOLEAN];
Subtract: --*XLReal*-- PROCEDURE [a: Number, b: Number] RETURNS [Number];
SubtractItem: --*MenuData*-- PROCEDURE [menu: MenuHandle, old: ItemHandle];
SubtractPopupMenu: --*StarWindowShell*-- PROCEDURE [
sws: Handle, menu: MenuData.MenuHandle];
Subtype: --*Prototype*-- TYPE = CARDINAL;
Swap: --*BlackKeys*-- PROCEDURE [old: Keyboard, new: Keyboard];
Swap: --*Cursor*-- PROCEDURE [old: Handle, new: Handle];
Swap: --*SoftKeys*-- PROCEDURE [
window: Window.Handle, table: TIP.Table ˆ NIL,
notifyProc: TIP.NotifyProc ˆ NIL, labels: Labels ˆ xxx,
highlightedKey: CARDINAL ˆ nullKey, outlinedKey: CARDINAL ˆ nullKey];
Swap: --*StarWindowShell*-- PROCEDURE [
new: Handle, old: Handle, poppedProc: PoppedProc ˆ NIL];
SwapExistingFormWindows: --*PropertySheet*-- PROCEDURE [
shell: StarWindowShell.Handle, new: Window.Handle, apply: BOOLEAN ˆ TRUE,
newMenuItemProc: MenuItemProc ˆ NIL, newMenuItems: MenuItems ˆ LOOPHOLE[0],
newTitle: XString.Reader ˆ NIL, newAfterTakenDownProc: MenuItemProc ˆ NIL]
RETURNS [old: Window.Handle];
SwapFormWindows: --*PropertySheet*-- PROCEDURE [
shell: StarWindowShell.Handle, newFormWindowItems:
FormWindow.MakeItemsProc,
newFormWindowItemsLayout: FormWindow.LayoutProc ˆ NIL, apply: BOOLEAN ˆ TRUE,
destroyOld: BOOLEAN ˆ TRUE, newMenuItemProc: MenuItemProc ˆ NIL,
newMenuItems: MenuItems ˆ LOOPHOLE[0], newTitle: XString.Reader ˆ NIL,
newGlobalChangeProc: FormWindow.GlobalChangeProc ˆ NIL,
newAfterTakenDownProc: MenuItemProc ˆ NIL] RETURNS [old: Window.Handle];
SwapItem: --*MenuData*-- PROCEDURE [
menu: MenuHandle, old: ItemHandle, new: ItemHandle];
SwapItemProc: --*MenuData*-- TYPE = PROCEDURE [
menu: MenuHandle, old: ItemHandle, new: ItemHandle];
SwapMenuItem: --*Attention*-- PROCEDURE [
old: MenuData.ItemHandle, new: MenuData.ItemHandle];
Switches: --*XToken*-- FilterProcType;
SyntaxError: --*XToken*-- SIGNAL [r: XString.Reader];
systemFileCatalog: --*BWSFileTypes*-- NSFile.Type = 10476B;
systemFontHeight: --*SimpleTextDisplay*-- READONLY CARDINAL;

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Table: --TIP-- TYPE = LONG POINTER TO TableObject;
TableError: --TIP-- TYPE = {fileNotFound, badSyntax};
TableObject: --TIP-- TYPE;
TabStops: --FormWindow-- TYPE = RECORD [
   variant: SELECT type: TabType FROM
      fixed => [interval: CARDINAL],
      vary => [list: LONG DESCRIPTOR FOR ARRAY CARDINAL OF CARDINAL],
      ENDCASE];
TabType: --FormWindow-- TYPE = {fixed, vary};
Take: --ContainerSource-- TakeProc;
TakeNEXTKey: --FormWindow-- PROCEDURE [window: Window.Handle, item: ItemKey];
TakeProc: --ContainerSource-- TYPE = PROCEDURE [
   source: Handle, copyOrMove: Selection.CopyOrMove,
   afterHint: ItemIndex ^ nullItem, withinSameSource: BOOLEAN ^ FALSE,
   changeProc: ChangeProc ^ NIL, changeProcData: LONG POINTER ^ NIL,
   selection: Selection.ConvertProc ^ NIL] RETURNS [ok: BOOLEAN];
Tan: --XLReal-- PROCEDURE [radians: Number] RETURNS [tan: Number];
Target: --Selection-- TYPE = MACHINE DEPENDENT{
   window, shell, subwindow, string, length, position, integer, interpressMaster,
   file, fileType, token, help, keyboard, interscriptScript, interscriptFragment,
   serializedFile, name, firstFree, last(1023)};
textFlags: --Display-- BitBltFlags;
TextHintAction: --FormWindow-- TYPE = {replace, append, nil};
TextHintsProc: --FormWindow-- TYPE = PROCEDURE [
   window: Window.Handle, item: ItemKey]
   RETURNS [
      hints: LONG DESCRIPTOR FOR ARRAY CARDINAL OF XString.ReaderBody,
      freeHints: FreeTextHintsProc, hintAction: TextHintAction ^ replace];
ThumbFlavor: --StarWindowShell TYPE = {downClick, track, upClick};
ThumbScrollProc: --StarWindowShell-- TYPE = PROCEDURE [
   sws: Handle, vertical: BOOLEAN, flavor: ThumbFlavor, m: INTEGER,
   outOfN: INTEGER];
Ticket: --Containee-- TYPE [2];
timeOnly: --XTime-- XString.Reader;
TIPResults: --SimpleTextEdit-- PROCEDURE [f: Field, results: TIP.Results]
   RETURNS [tookInputFocus: BOOLEAN, changed: BOOLEAN];
TotalOrPartial: --ContainerSource-- TYPE = {total, partial};
Trajectory: --Display-- PROCEDURE [
   window: Handle, box: Window.Box ^ xxx, proc: TrajectoryProc,
   source: LONG POINTER ^ NIL, bpl: CARDINAL ^ 16, height: CARDINAL ^ 16,
   flags: BitBltFlags ^ bitFlags, missesChildren: BOOLEAN ^ FALSE,
   brick: Brick ^ xxx];
TrajectoryProc: --Display-- TYPE = PROCEDURE [Handle]
   RETURNS [Window.Box, INTEGER];
TransitionProc: --StarWindowShell-- TYPE = PROCEDURE [
   sws: Handle, state: State];
Trapezoid: --Display-- TYPE = RECORD [
   x: Interpolator, y: INTEGER, w: Interpolator, h: NATURAL];
TreatNumbersAs: --XTime-- TYPE = {
   dayMonthYear, monthDayYear, yearMonthDay, yearDayMonth, dayYearMonth,
   monthYearDay};
TrimBoxStickouts: --Window-- PROCEDURE [window: Handle, box: Box] RETURNS [Box];
TTYObject: --XFormat-- PROCEDURE [h: TTY.Handle] RETURNS [Object];
TTYProc: --XFormat-- FormatProc;
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Type: --*Context*-- TYPE = MACHINE DEPENDENT{
all, first, lastAllocated(37737B), last(37777B)};
Type: --*Cursor*-- TYPE = MACHINE DEPENDENT{
blank, bullseye, confirm, ftpBoxes, hourGlass, lib, menu, mouseRed, pointDown,
pointLeft, pointRight, pointUp, questionMark, scrollDown, scrollLeft,
scrollLeftRight, scrollRight, scrollUp, scrollUpDown, textPointer,
groundedText, move, copy, sameAs, adjust, row, column, last(255)};
UnderChangedProc: --*Window*-- TYPE = PROCEDURE [Handle, Box];
Unintelligible: --*XTime*-- ERROR [vicinity: CARDINAL];
UniqueAction: --*Selection*-- PROCEDURE RETURNS [Action];
UniqueTarget: --*Selection*-- PROCEDURE RETURNS [Target];
UniqueType: --*Context*-- PROCEDURE RETURNS [type: Type];
UniqueType: --*Cursor*-- PROCEDURE RETURNS [Type];
Units: --*UnitConversion*-- TYPE = MACHINE DEPENDENT{
inch, mm, cm, mica, point, pixel, pica, didotPoint, cicero,
seventySecondOfAnInch, last(15)};
unknownContext: --*XString*-- Context;
UnmapFont: --*SimpleTextFontExtra*-- PROCEDURE [SimpleTextFont.MappedFontHandle];
Unpack: --*XTime*-- PROCEDURE [
time: System.GreenwichMeanTime ˆ defaultTime, ltp: LTP ˆ useSystem]
RETURNS [unpacked: Unpacked];
Unpacked: --*XTime*-- TYPE = RECORD [
year: [0..4070B],
month: [0..11],
day: [0..31],
hour: [0..23],
minute: [0..59],
second: [0..59],
weekday: [0..6],
dst: BOOLEAN,
zone: System.LocalTimeParameters];
UnpostedSwapItemProc: --*MenuData*-- SwapItemProc;
UnsignedDecimalFormat: --*XFormat*-- NumberFormat;
UnterminatedQuote: --*XToken*-- SIGNAL;
Update: --*ContainerWindow*-- PROCEDURE [window: Window.Handle];
UpperCase: --*XChar*-- PROCEDURE [c: Character] RETURNS [Character];
useGMT: --*XTime*-- useThese LTP;
UserAbort: --*TIP*-- PROCEDURE [Window.Handle] RETURNS [BOOLEAN];
userPassword: --*StarDesktop*-- Atom.ATOM;
useSystem: --*XTime*-- useSystem LTP;
Valid: --*Window*-- PROCEDURE [Handle] RETURNS [BOOLEAN];
Validate: --*Window*-- PROCEDURE [window: Handle];
ValidateReader: --*XString*-- PROCEDURE [r: Reader];
ValidateTree: --*Window*-- PROCEDURE [window: Handle ˆ rootWindow];
ValidExponent: --*XLReal*-- TYPE = [-512..511];
Value: --*Selection*-- TYPE = RECORD [
value: LONG POINTER,
ops: LONG POINTER TO ValueProcs ˆ NIL,
context: LONG UNSPECIFIED ˆ 0];
ValueCopyMoveProc: --*Selection*-- TYPE = PROCEDURE [
v: ValueHandle, op: CopyOrMove, data: LONG POINTER];
ValueFreeProc: --*Selection*-- TYPE = PROCEDURE [v: ValueHandle];
ValueHandle: --*Selection*-- TYPE = LONG POINTER TO Value;
ValueProcs: --*Selection*-- TYPE = RECORD [
free: ValueFreeProc ˆ NIL, copyMove: ValueCopyMoveProc ˆ NIL];

VanillaArrowScroll: --*StarWindowShell*-- ArrowScrollProc;
vanillaContext: --*XString*-- Context;
vanillaScrollData: --*StarWindowShell*-- ScrollData;
VanillaThumbScroll: --*StarWindowShell*-- ThumbScrollProc;
version: --*BWSAttributeTypes*-- NSFile.ExtendedAttributeType = 10460B;
Version: --*Prototype*-- TYPE = CARDINAL;
VersionColumn: --*FileContainerSourceExtra*-- PROCEDURE
RETURNS [attribute FileContainerSource.ColumnContentsInfo];
ViewPoint: --*ProductFactoringProducts*-- Product = 5;
ViewPointApps: --*ProductFactoringProducts*-- Product = 6;
Visibility: --*FormWindow*-- TYPE = {visible, invisible, invisibleGhost};
WaitSeconds: --*TIP*-- PROCEDURE [seconds: CARDINAL];
When: --*StarWindowShell*-- TYPE = {before, after};
White: --*Display*-- PROCEDURE [
window: Handle, box: Window.Box, bounds: Window.BoxHandle ^ NIL];
WhiteSpace: --*XToken*-- FilterProcType;
WordsForBitmapUnder: --*Window*-- PROCEDURE [window: Handle] RETURNS [CARDINAL];
Writer: --*XString*-- TYPE = LONG POINTER TO WriterBody;
WriterBody: --*XString*-- TYPE = PRIVATE MACHINE DEPENDENT RECORD [
context(0:0..15): Context,
limit(1:0..15): CARDINAL,
offset(2:0..15): CARDINAL,
bytes(3:0..31): Bytes,
maxLimit(5:0..15): CARDINAL,
endContext(6:0..15): Context,
zone(7:0..31): UNCOUNTED ZONE];
WriterBodyFromBlock: --*XString*-- PROCEDURE [
block: Environment.Block, inUse: CARDINAL ^ 0] RETURNS [WriterBody];
WriterBodyFromNSString: --*XString*-- PROCEDURE [
s: NSString.String, homogeneous: BOOLEAN ^ FALSE] RETURNS [WriterBody];
WriterBodyFromSTRING: --*XString*-- PROCEDURE [
s: LONG STRING, homogeneous: BOOLEAN ^ FALSE] RETURNS [WriterBody];
WriterInfo: --*XString*-- PROCEDURE [w: Writer]
RETURNS [unused: CARDINAL, endContext: Context, zone: UNCOUNTED ZONE];
WriterObject: --*XFormat*-- PROCEDURE [w: XString.Writer] RETURNS [Object];
WriterProc: --*XFormat*-- FormatProc;
XFormatObject: --*MessageWindow*-- PROCEDURE [window: Window.Handle]
RETURNS [o: XFormat.Object];
xorBoxFlags: --*Display*-- BitBltFlags;
xorFlags: --*Display*-- BitBltFlags;
xorGrayFlags: --*Display*-- BitBltFlags;
zero: --*XLReal*-- Number;
Zone: --*Undo*-- PROCEDURE RETURNS [UNCOUNTED ZONE];