Xlib − C Language X Interface

MIT X Consortium Standard

X Version 11, Release 6

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Chapter 1

Introduction to Xlib

The X Window System is a network-transparent window system that was designed at MIT. X display servers run on computers with either monochrome or color bitmap display hardware. The server distributes user input to and accepts output requests from various client programs located either on the same machine or elsewhere in the network. Xlib is a C subroutine library that application programs (clients) use to interface with the window system by means of a stream connection. Although a client usually runs on the same machine as the X server it is talking to, this need not be the case.

Xlib − C Language X Interface is a reference guide to the low-level C language interface to the X Window System protocol. It is neither a tutorial nor a user's guide to programming the X Window System. Rather, it provides a detailed description of each function in the library as well as a discussion of the related background information. *Xlib − C Language X Interface* assumes a basic understanding of a graphics window system and of the C programming language. Other higher-level abstractions (for example, those provided by the toolkits for X) are built on top of the Xlib library. For further information about these higher-level libraries, see the appropriate toolkit documentation. The *X Window System Protocol* provides the definitive word on the behavior of X. Although additional information appears here, the protocol document is the ruling document.

To provide an introduction to X programming, this chapter discusses:

- Overview of the X Window System
- Errors
- Standard header files
- Naming and argument conventions
- Programming considerations
- Formatting conventions

1.1. Overview of the X Window System

Some of the terms used in this book are unique to X, and other terms that are common to other window systems have different meanings in X. You may find it helpful to refer to the glossary, which is located at the end of the book.

The X Window System supports one or more screens containing overlapping windows or subwindows. A screen is a physical monitor and hardware, which can be either color, grayscale, or monochrome. There can be multiple screens for each display or workstation. A single X server can provide display services for any number of screens. A set of screens for a single user with one keyboard and one pointer (usually a mouse) is called a display.

All the windows in an X server are arranged in strict hierarchies. At the top of each hierarchy is a root window, which covers each of the display screens. Each root window is partially or completely covered by child windows. All windows, except for root windows, have parents. There is usually at least one window for each application program. Child windows may in turn have their own children. In this way, an application program can create an arbitrarily deep tree on each screen. X provides graphics, text, and raster operations for windows.

A child window can be larger than its parent. That is, part or all of the child window can extend beyond the boundaries of the parent, but all output to a window is clipped by its parent. If several children of a window have overlapping locations, one of the children is considered to be on top of or raised over the others thus obscuring them. Output to areas covered by other windows is suppressed by the window system unless the window has backing store. If a window is obscured by a second window, the second window obscures only those ancestors of the second window, which are also ancestors of the first window.

A window has a border zero or more pixels in width, which can be any pattern (pixmap) or solid color you like. A window usually but not always has a background pattern, which will be repainted by the window system when uncovered. Child windows obscure their parents, and graphic operations in the parent window usually are clipped by the children.

Each window and pixmap has its own coordinate system. The coordinate system has the X axis horizontal and the Y axis vertical with the origin [0, 0] at the upper-left corner. Coordinates are integral, in terms of pixels, and coincide with pixel centers. For a window, the origin is inside the border at the inside, upper-left corner.

X does not guarantee to preserve the contents of windows. When part or all of a window is hidden and then brought back onto the screen, its contents may be lost. The server then sends the client program an **Expose** event to notify it that part or all of the window needs to be repainted. Programs must be prepared to regenerate the contents of windows on demand.

X also provides off-screen storage of graphics objects, called pixmaps. Single plane (depth 1) pixmaps are sometimes referred to as bitmaps. Pixmaps can be used in most graphics functions interchangeably with windows and are used in various graphics operations to define patterns or tiles. Windows and pixmaps together are referred to as drawables.

Most of the functions in Xlib just add requests to an output buffer. These requests later execute asynchronously on the X server. Functions that return values of information stored in the server do not return (that is, they block) until an explicit reply is received or an error occurs. You can provide an error handler, which will be called when the error is reported.

If a client does not want a request to execute asynchronously, it can follow the request with a call to **XSync**, which blocks until all previously buffered asynchronous events have been sent and acted on. As an important side effect, the output buffer in Xlib is always flushed by a call to any function that returns a value from the server or waits for input.

Many Xlib functions will return an integer resource ID, which allows you to refer to objects stored on the X server. These can be of type **Window**, **Font**, **Pixmap**, **Colormap**, **Cursor**, and **GContext**, as defined in the file **<X11/X.h>**. These resources are created by requests and are destroyed (or freed) by requests or when connections are closed. Most of these resources are potentially sharable between applications, and in fact, windows are manipulated explicitly by window manager programs. Fonts and cursors are shared automatically across multiple screens. Fonts are loaded and unloaded as needed and are shared by multiple clients. Fonts are often cached in the server. Xlib provides no support for sharing graphics contexts between applications.

Client programs are informed of events. Events may either be side effects of a request (for example, restacking windows generates **Expose** events) or completely asynchronous (for example, from the keyboard). A client program asks to be informed of events. Because other applications can send events to your application, programs must be prepared to handle (or ignore) events of all types.

Input events (for example, a key pressed or the pointer moved) arrive asynchronously from the server and are queued until they are requested by an explicit call (for example, **XNextEvent** or **XWindowEvent**). In addition, some library functions (for example, **XRaiseWindow**) generate

Expose and **ConfigureRequest** events. These events also arrive asynchronously, but the client may wish to explicitly wait for them by calling **XSync** after calling a function that can cause the server to generate events.

1.2. Errors

Some functions return **Status**, an integer error indication. If the function fails, it returns a zero. If the function returns a status of zero, it has not updated the return arguments. Because C does not provide multiple return values, many functions must return their results by writing into client-passed storage. By default, errors are handled either by a standard library function or by one that you provide. Functions that return pointers to strings return NULL pointers if the string does not exist.

The X server reports protocol errors at the time that it detects them. If more than one error could be generated for a given request, the server can report any of them.

Because Xlib usually does not transmit requests to the server immediately (that is, it buffers them), errors can be reported much later than they actually occur. For debugging purposes, however, Xlib provides a mechanism for forcing synchronous behavior (see section 11.8.1). When synchronization is enabled, errors are reported as they are generated.

When Xlib detects an error, it calls an error handler, which your program can provide. If you do not provide an error handler, the error is printed, and your program terminates.

1.3. Standard Header Files

The following include files are part of the Xlib standard:

- **<X11/Xlib.h>**

  This is the main header file for Xlib. The majority of all Xlib symbols are declared by including this file. This file also contains the preprocessor symbol **XlibSpecificationRelease**. This symbol is defined to have the 6 in this release of the standard. (Release 5 of Xlib was the first release to have this symbol.)

- **<X11/X.h>**

  This file declares types and constants for the X protocol that are to be used by applications. It is included automatically from **<X11/Xlib.h>**, so application code should never need to reference this file directly.

- **<X11/Xcms.h>**

  This file contains symbols for much of the color management facilities described in chapter 6. All functions, types, and symbols with the prefix “Xcms”, plus the Color Conversion Contexts macros, are declared in this file. **<X11/Xlib.h>** must be included before including this file.

- **<X11/Xutil.h>**

  This file declares various functions, types, and symbols used for inter-client communication and application utility functions, which are described in chapters 14 and 16. **<X11/Xlib.h>** must be included before including this file.

- **<X11/Xresource.h>**

  This file declares all functions, types, and symbols for the resource manager facilities, which are described in chapter 15. **<X11/Xlib.h>** must be included before including this file.

- **<X11/Xatom.h>**

This file declares all predefined atoms, which are symbols with the prefix “XA_”.

- **<X11/cursorfont.h>**

  This file declares the cursor symbols for the standard cursor font, which are listed in appendix B. All cursor symbols have the prefix “XC_”.

- **<X11/keysymdef.h>**

  This file declares all standard KeySym values, which are symbols with the prefix “XK_”. The KeySyms are arranged in groups, and a preprocessor symbol controls inclusion of each group. The preprocessor symbol must be defined prior to inclusion of the file to obtain the associated values. The preprocessor symbols are XK_MISCELLANY, XK_LATIN1, XK_LATIN2, XK_LATIN3, XK_LATIN4, XK_KATAKANA, XK_ARABIC, XK_CYRILLIC, XK_GREEK, XK_TECHNICAL, XK_SPECIAL, XK_PUBLISHING, XK_APL, XK_HEBREW, XK_THAI, and XK_KOREAN.

- **<X11/keysym.h>**

  This file defines the preprocessor symbols XK_MISCELLANY, XK_LATIN1, XK_LATIN2, XK_LATIN3, XK_LATIN4, and XK_GREEK and then includes **<X11/keysymdef.h>**.

- **<X11/Xlibint.h>**

  This file declares all the functions, types, and symbols used for extensions, which are described in appendix C. This file automatically includes **<X11/Xlib.h>**.

- **<X11/Xproto.h>**

  This file declares types and symbols for the basic X protocol, for use in implementing extensions. It is included automatically from **<X11/Xlibint.h>**, so application and extension code should never need to reference this file directly.

- **<X11/Xprotostr.h>**

  This file declares types and symbols for the basic X protocol, for use in implementing extensions. It is included automatically from **<X11/Xproto.h>**, so application and extension code should never need to reference this file directly.

- **<X11/X10.h>**

  This file declares all the functions, types, and symbols used for the X10 compatibility functions, which are described in appendix D.

1.4. Generic Values and Types

The following symbols are defined by Xlib and used throughout the manual:

- Xlib defines the type **Bool** and the Boolean values **True** and **False**.
- **None** is the universal null resource ID or atom.
- The type **XID** is used for generic resource IDs.
- The type **XPointer** is defined to be char* and is used as a generic opaque pointer to data.

1.5. Naming and Argument Conventions within Xlib

Xlib follows a number of conventions for the naming and syntax of the functions. Given that you remember what information the function requires, these conventions are intended to make the syntax of the functions more predictable.

The major naming conventions are:

- To differentiate the X symbols from the other symbols, the library uses mixed case for external symbols. It leaves lowercase for variables and all uppercase for user macros, as per existing convention.
- All Xlib functions begin with a capital X.
- The beginnings of all function names and symbols are capitalized.
- All user-visible data structures begin with a capital X. More generally, anything that a user might dereference begins with a capital X.
- Macros and other symbols do not begin with a capital X. To distinguish them from all user symbols, each word in the macro is capitalized.
- All elements of or variables in a data structure are in lowercase. Compound words, where needed, are constructed with underscores (_).
- The display argument, where used, is always first in the argument list.
- All resource objects, where used, occur at the beginning of the argument list immediately after the display argument.
- When a graphics context is present together with another type of resource (most commonly, a drawable), the graphics context occurs in the argument list after the other resource. Drawables outrank all other resources.
- Source arguments always precede the destination arguments in the argument list.
- The x argument always precedes the y argument in the argument list.
- The width argument always precedes the height argument in the argument list.
- Where the x, y, width, and height arguments are used together, the x and y arguments always precede the width and height arguments.
- Where a mask is accompanied with a structure, the mask always precedes the pointer to the structure in the argument list.

1.6. Programming Considerations

The major programming considerations are:

- Coordinates and sizes in X are actually 16-bit quantities. This decision was made to minimize the bandwidth required for a given level of performance. Coordinates usually are declared as an **int** in the interface. Values larger than 16 bits are truncated silently. Sizes (width and height) are declared as unsigned quantities.
- Keyboards are the greatest variable between different manufacturers' workstations. If you want your program to be portable, you should be particularly conservative here.
- Many display systems have limited amounts of off-screen memory. If you can, you should minimize use of pixmaps and backing store.
- The user should have control of his screen real estate. Therefore, you should write your applications to react to window management rather than presume control of the entire screen. What you do inside of your top-level window, however, is up to your application. For further information, see chapter 14 and the *Inter-Client Communication Conventions Manual*.

1.7. Character Sets and Encodings

Some of the Xlib functions make reference to specific character sets and character encodings. The following are the most common:

- X Portable Character Set

  A basic set of 97 characters, which are assumed to exist in all locales supported by Xlib. This set contains the following characters:

a..z A..Z 0..9 !"#$%&’()*+,-./:;<=>?@[\]^_‘{|}˜ <space>, <tab>, and <newline>

  This set is the left/lower half of the graphic character set of ISO8859-1 plus space, tab, and newline. It is also the set of graphic characters in 7-bit ASCII plus the same three control characters. The actual encoding of these characters on the host is system dependent.

- Host Portable Character Encoding

  The encoding of the X Portable Character Set on the host. The encoding itself is not defined by this standard, but the encoding must be the same in all locales supported by Xlib on the host. If a string is said to be in the Host Portable Character Encoding, then it only contains characters from the X Portable Character Set, in the host encoding.

- Latin-1

  The coded character set defined by the ISO8859-1 standard.

- Latin Portable Character Encoding

  The encoding of the X Portable Character Set using the Latin-1 codepoints plus ASCII control characters. If a string is said to be in the Latin Portable Character Encoding, then it only contains characters from the X Portable Character Set, not all of Latin-1.

- STRING Encoding

  Latin-1, plus tab and newline.

- POSIX Portable Filename Character Set

  The set of 65 characters, which can be used in naming files on a POSIX-compliant host, that are correctly processed in all locales. The set is:

  a..z A..Z 0..9 ._-

1.8. Formatting Conventions

Xlib − C Language X Interface uses the following conventions:

- Global symbols are printed in **this special font**. These can be either function names, symbols defined in include files, or structure names. When declared and defined, function arguments are printed in *italics*. In the explanatory text that follows, they usually are printed in regular type.
- Each function is introduced by a general discussion that distinguishes it from other functions. The function declaration itself follows, and each argument is specifically explained. Although ANSI C function prototype syntax is not used, Xlib header files normally declare functions using function prototypes in ANSI C environments. General discussion of the function, if any is required, follows the arguments. Where applicable, the last paragraph of the explanation lists the possible Xlib error codes that the function can generate. For a complete discussion of the Xlib error codes, see section 11.8.2.
- To eliminate any ambiguity between those arguments that you pass and those that a function returns to you, the explanations for all arguments that you pass start with the word *specifies* or, in the case of multiple arguments, the word *specify*. The explanations for all arguments that are returned to you start with the word *returns* or, in the case of multiple arguments, the word *return*. The explanations for all arguments that you can pass and are

returned start with the words *specifies and returns*.

- Any pointer to a structure that is used to return a value is designated as such by the *_return* suffix as part of its name. All other pointers passed to these functions are used for reading only. A few arguments use pointers to structures that are used for both input and output and are indicated by using the *_in_out* suffix.

Chapter 2

Display Functions

Before your program can use a display, you must establish a connection to the X server. Once you have established a connection, you then can use the Xlib macros and functions discussed in this chapter to return information about the display. This chapter discusses how to:

- Open (connect to) the display
- Obtain information about the display, image format, and screen
- Free client-created data
- Close (disconnect from) a display

The chapter concludes with a general discussion of what occurs when the connection to the X server is closed.

2.1. Opening the Display

To open a connection to the X server that controls a display, use **XOpenDisplay**.

Display *XOpenDisplay(*display_name*)
 char **display_name*;

display_name	Specifies the hardware display name, which determines the display and communications domain to be used. On a POSIX-conformant system, if the display_name is NULL, it defaults to the value of the DISPLAY environment variable.

The encoding and interpretation of the display name is implementation dependent. Strings in the Host Portable Character Encoding are supported; support for other characters is implementation dependent. On POSIX-conformant systems, the display name or DISPLAY environment variable can be a string in the format:

hostname:*number*.*screen_number*

hostname	Specifies the name of the host machine on which the display is physically attached. You follow the hostname with either a single colon (:) or a double colon (::).
number	Specifies the number of the display server on that host machine. You may optionally follow this display number with a period (.). A single CPU can have more than one display. Multiple displays are usually numbered starting with zero.
screen_number	Specifies the screen to be used on that server. Multiple screens can be controlled by a single X server. The screen_number sets an internal variable that can be accessed by using the **DefaultScreen** macro or the **XDefaultScreen** function if you are using languages other than C (see section 2.2.1).

For example, the following would specify screen 1 of display 0 on the machine named ‘‘dual-headed’’:

dual-headed:0.1

The **XOpenDisplay** function returns a **Display** structure that serves as the connection to the X server and that contains all the information about that X server. **XOpenDisplay** connects your application to the X server through TCP or DECnet communications protocols, or through some local inter-process communication protocol. If the hostname is a host machine name and a single colon (:) separates the hostname and display number, **XOpenDisplay** connects using TCP streams. If the hostname is not specified, Xlib uses whatever it believes is the fastest transport. If the hostname is a host machine name and a double colon (::) separates the hostname and display number, **XOpenDisplay** connects using DECnet. A single X server can support any or all of these transport mechanisms simultaneously. A particular Xlib implementation can support many more of these transport mechanisms.

If successful, **XOpenDisplay** returns a pointer to a **Display** structure, which is defined in **<X11/Xlib.h>**. If **XOpenDisplay** does not succeed, it returns NULL. After a successful call to **XOpenDisplay**, all of the screens in the display can be used by the client. The screen number specified in the display_name argument is returned by the **DefaultScreen** macro (or the **XDefaultScreen** function). You can access elements of the **Display** and **Screen** structures only by using the information macros or functions. For information about using macros and functions to obtain information from the **Display** structure, see section 2.2.1.

X servers may implement various types of access control mechanisms (see section 9.8).

2.2. Obtaining Information about the Display, Image Formats, or Screens

The Xlib library provides a number of useful macros and corresponding functions that return data from the **Display** structure. The macros are used for C programming, and their corresponding function equivalents are for other language bindings. This section discusses the:

- Display macros
- Image format macros
- Screen macros

All other members of the **Display** structure (that is, those for which no macros are defined) are private to Xlib and must not be used. Applications must never directly modify or inspect these private members of the **Display** structure.

Note

> The **XDisplayWidth**, **XDisplayHeight**, **XDisplayCells**, **XDisplayPlanes**, **XDisplayWidthMM**, and **XDisplayHeightMM** functions in the next sections are misnamed. These functions really should be named Screen*whatever* and XScreen*whatever*, not Display*whatever* or XDisplay*whatever*. Our apologies for the resulting confusion.

2.2.1. Display Macros

Applications should not directly modify any part of the **Display** and **Screen** structures. The members should be considered read-only, although they may change as the result of other operations on the display.

The following lists the C language macros, their corresponding function equivalents that are for other language bindings, and what data they both can return.

AllPlanes

unsigned long XAllPlanes()

Both return a value with all bits set to 1 suitable for use in a plane argument to a procedure.

Both **BlackPixel** and **WhitePixel** can be used in implementing a monochrome application. These pixel values are for permanently allocated entries in the default colormap. The actual RGB (red, green, and blue) values are settable on some screens and, in any case, may not actually be black or white. The names are intended to convey the expected relative intensity of the colors.

BlackPixel(*display*, *screen_number*)

unsigned long XBlackPixel(*display*, *screen_number*)
    Display **display*;
    int *screen_number*;

display Specifies the connection to the X server.

screen_number
Specifies the appropriate screen number on the host server.

Both return the black pixel value for the specified screen.

WhitePixel(*display*, *screen_number*)

unsigned long XWhitePixel(*display*, *screen_number*)
    Display **display*;
    int *screen_number*;

display	Specifies the connection to the X server.
screen_number	Specifies the appropriate screen number on the host server.

Both return the white pixel value for the specified screen.

ConnectionNumber(*display*)

int XConnectionNumber(*display*)
    Display **display*;

display	Specifies the connection to the X server.

Both return a connection number for the specified display. On a POSIX-conformant system, this is the file descriptor of the connection.

DefaultColormap(*display*, *screen_number*)

Colormap XDefaultColormap(*display*, *screen_number*)
    Display **display*;
    int *screen_number*;

display	Specifies the connection to the X server.
screen_number	Specifies the appropriate screen number on the host server.

Both return the default colormap ID for allocation on the specified screen. Most routine allocations of color should be made out of this colormap.

```
DefaultDepth(display, screen_number)

int XDefaultDepth(display, screen_number)
      Display *display;
      int screen_number;
```

display	Specifies the connection to the X server.
screen_number	Specifies the appropriate screen number on the host server.

Both return the depth (number of planes) of the default root window for the specified screen. Other depths may also be supported on this screen (see **XMatchVisualInfo**).

To determine the number of depths that are available on a given screen, use **XListDepths**.

```
int *XListDepths(display, screen_number, count_return)
      Display *display;
      int screen_number;
      int *count_return;
```

display	Specifies the connection to the X server.
screen_number	Specifies the appropriate screen number on the host server.
count_return	Returns the number of depths.

The **XListDepths** function returns the array of depths that are available on the specified screen. If the specified screen_number is valid and sufficient memory for the array can be allocated, **XListDepths** sets count_return to the number of available depths. Otherwise, it does not set count_return and returns NULL. To release the memory allocated for the array of depths, use **XFree**.

```
DefaultGC(display, screen_number)

GC XDefaultGC(display, screen_number)
      Display *display;
      int screen_number;
```

display	Specifies the connection to the X server.
screen_number	Specifies the appropriate screen number on the host server.

Both return the default graphics context for the root window of the specified screen. This GC is created for the convenience of simple applications and contains the default GC components with the foreground and background pixel values initialized to the black and white pixels for the screen, respectively. You can modify its contents freely because it is not used in any Xlib function. This GC should never be freed.

DefaultRootWindow(*display*)

Window XDefaultRootWindow(*display*)
   Display **display*;

display Specifies the connection to the X server.

Both return the root window for the default screen.

DefaultScreenOfDisplay(*display*)

Screen *XDefaultScreenOfDisplay(*display*)
   Display **display*;

display Specifies the connection to the X server.

Both return a pointer to the default screen.

ScreenOfDisplay(*display*, *screen_number*)

Screen *XScreenOfDisplay(*display*, *screen_number*)
   Display **display*;
   int *screen_number*;

display Specifies the connection to the X server.

screen_number
   Specifies the appropriate screen number on the host server.

Both return a pointer to the indicated screen.

DefaultScreen(*display*)

int XDefaultScreen(*display*)
   Display **display*;

display Specifies the connection to the X server.

Both return the default screen number referenced by the **XOpenDisplay** function. This macro or function should be used to retrieve the screen number in applications that will use only a single screen.

```
DefaultVisual(display, screen_number)

Visual *XDefaultVisual(display, screen_number)
      Display *display;
      int screen_number;
```

display	Specifies the connection to the X server.
screen_number	Specifies the appropriate screen number on the host server.

Both return the default visual type for the specified screen. For further information about visual types, see section 3.1.

```
DisplayCells(display, screen_number)

int XDisplayCells(display, screen_number)
      Display *display;
      int screen_number;
```

display	Specifies the connection to the X server.
screen_number	Specifies the appropriate screen number on the host server.

Both return the number of entries in the default colormap.

```
DisplayPlanes(display, screen_number)

int XDisplayPlanes(display, screen_number)
      Display *display;
      int screen_number;
```

display	Specifies the connection to the X server.
screen_number	Specifies the appropriate screen number on the host server.

Both return the depth of the root window of the specified screen. For an explanation of depth, see the glossary.

DisplayString(*display*)

char *XDisplayString(*display*)
    Display **display*;

display Specifies the connection to the X server.

Both return the string that was passed to **XOpenDisplay** when the current display was opened. On POSIX-conformant systems, if the passed string was NULL, these return the value of the DISPLAY environment variable when the current display was opened. These are useful to applications that invoke the **fork** system call and want to open a new connection to the same display from the child process as well as for printing error messages.

long XExtendedMaxRequestSize(*display*)
        Display **display*;

display Specifies the connection to the X server.

The **XExtendedMaxRequestSize** function returns zero if the specified display does not support an extended-length protocol encoding; otherwise, it returns the maximum request size (in 4-byte units) supported by the server using the extended-length encoding. The Xlib functions **XDrawLines**, **XDrawArcs**, **XFillPolygon**, **XChangeProperty**, **XSetClipRectangles**, and **XSetRegion** will use the extended-length encoding as necessary, if supported by the server. Use of the extended-length encoding in other Xlib functions (for example, **XDrawPoints**, **XDrawRectangles**, **XDrawSegments**, **XFillArcs**, **XFillRectangles**, **XPutImage**) is permitted but not required; an Xlib implementation may choose to split the data across multiple smaller requests instead.

long XMaxRequestSize(*display*)
        Display **display*;

display Specifies the connection to the X server.

The **XMaxRequestSize** function returns the maximum request size (in 4-byte units) supported by the server without using an extended-length protocol encoding. Single protocol requests to the server can be no larger than this size unless an extended-length protocol encoding is supported by the server. The protocol guarantees the size to be no smaller than 4096 units (16384 bytes). Xlib automatically breaks data up into multiple protocol requests as necessary for the following functions: **XDrawPoints**, **XDrawRectangles**, **XDrawSegments**, **XFillArcs**, **XFillRectangles**, and **XPutImage**.

LastKnownRequestProcessed(*display*)

unsigned long XLastKnownRequestProcessed(*display*)
 Display **display*;

display Specifies the connection to the X server.

Both extract the full serial number of the last request known by Xlib to have been processed by the X server. Xlib automatically sets this number when replies, events, and errors are received.

NextRequest(*display*)

unsigned long XNextRequest(*display*)
 Display **display*;

display Specifies the connection to the X server.

Both extract the full serial number that is to be used for the next request. Serial numbers are maintained separately for each display connection.

ProtocolVersion(*display*)

int XProtocolVersion(*display*)
 Display **display*;

display Specifies the connection to the X server.

Both return the major version number (11) of the X protocol associated with the connected display.

ProtocolRevision(*display*)

int XProtocolRevision(*display*)
 Display **display*;

display Specifies the connection to the X server.

Both return the minor protocol revision number of the X server.

QLength(*display*)

int XQLength(*display*)
Display **display*;

display Specifies the connection to the X server.

Both return the length of the event queue for the connected display. Note that there may be more events that have not been read into the queue yet (see **XEventsQueued**).

RootWindow(*display*, *screen_number*)

Window XRootWindow(*display*, *screen_number*)
Display **display*;
int *screen_number*;

display Specifies the connection to the X server.

screen_number
Specifies the appropriate screen number on the host server.

Both return the root window. These are useful with functions that need a drawable of a particular screen and for creating top-level windows.

ScreenCount(*display*)

int XScreenCount(*display*)
Display **display*;

display Specifies the connection to the X server.

Both return the number of available screens.

ServerVendor(*display*)

char *XServerVendor(*display*)
Display **display*;

display Specifies the connection to the X server.

Both return a pointer to a null-terminated string that provides some identification of the owner of the X server implementation. If the data returned by the server is in the Latin Portable Character Encoding, then the string is in the Host Portable Character Encoding. Otherwise, the contents of the string are implementation dependent.

VendorRelease(*display*)

int XVendorRelease(*display*)
Display **display*;

display Specifies the connection to the X server.

Both return a number related to a vendor's release of the X server.

2.2.2. Image Format Functions and Macros

Applications are required to present data to the X server in a format that the server demands. To help simplify applications, most of the work required to convert the data is provided by Xlib (see sections 8.7 and 16.8).

The **XPixmapFormatValues** structure provides an interface to the pixmap format information that is returned at the time of a connection setup. It contains:

```
typedef struct {
        int depth;
        int bits_per_pixel;
        int scanline_pad;
} XPixmapFormatValues;
```

To obtain the pixmap format information for a given display, use **XListPixmapFormats**.

XPixmapFormatValues *XListPixmapFormats(*display*, *count_return*)
Display **display*;
int **count_return*;

display	Specifies the connection to the X server.
count_return	Returns the number of pixmap formats that are supported by the display.

The **XListPixmapFormats** function returns an array of **XPixmapFormatValues** structures that describe the types of Z format images supported by the specified display. If insufficient memory is available, **XListPixmapFormats** returns NULL. To free the allocated storage for the **XPixmapFormatValues** structures, use **XFree**.

The following lists the C language macros, their corresponding function equivalents that are for other language bindings, and what data they both return for the specified server and screen. These are often used by toolkits as well as by simple applications.

ImageByteOrder(*display*)

int XImageByteOrder(*display*)
    Display **display*;

display Specifies the connection to the X server.

Both specify the required byte order for images for each scanline unit in XY format (bitmap) or for each pixel value in Z format. The macro or function can return either **LSBFirst** or **MSBFirst**.

BitmapUnit(*display*)

int XBitmapUnit(*display*)
    Display **display*;

display Specifies the connection to the X server.

Both return the size of a bitmap's scanline unit in bits. The scanline is calculated in multiples of this value.

BitmapBitOrder(*display*)

int XBitmapBitOrder(*display*)
    Display **display*;

display Specifies the connection to the X server.

Within each bitmap unit, the left-most bit in the bitmap as displayed on the screen is either the least-significant or most-significant bit in the unit. This macro or function can return **LSBFirst** or **MSBFirst**.

BitmapPad(*display*)

int XBitmapPad(*display*)
    Display **display*;

display Specifies the connection to the X server.

Each scanline must be padded to a multiple of bits returned by this macro or function.

```
DisplayHeight(display, screen_number)

int XDisplayHeight(display, screen_number)
      Display *display;
      int screen_number;
```

display	Specifies the connection to the X server.
screen_number	Specifies the appropriate screen number on the host server.

Both return an integer that describes the height of the screen in pixels.

```
DisplayHeightMM(display, screen_number)

int XDisplayHeightMM(display, screen_number)
      Display *display;
      int screen_number;
```

display	Specifies the connection to the X server.
screen_number	Specifies the appropriate screen number on the host server.

Both return the height of the specified screen in millimeters.

```
DisplayWidth(display, screen_number)

int XDisplayWidth(display, screen_number)
      Display *display;
      int screen_number;
```

display	Specifies the connection to the X server.
screen_number	Specifies the appropriate screen number on the host server.

Both return the width of the screen in pixels.

DisplayWidthMM(*display*, *screen_number*)

int XDisplayWidthMM(*display*, *screen_number*)
  Display **display*;
  int *screen_number*;

display	Specifies the connection to the X server.
screen_number	Specifies the appropriate screen number on the host server.

Both return the width of the specified screen in millimeters.

2.2.3. Screen Information Macros

The following lists the C language macros, their corresponding function equivalents that are for other language bindings, and what data they both can return. These macros or functions all take a pointer to the appropriate screen structure.

BlackPixelOfScreen(*screen*)

unsigned long XBlackPixelOfScreen(*screen*)
  Screen **screen*;

screen	Specifies the appropriate **Screen** structure.

Both return the black pixel value of the specified screen.

WhitePixelOfScreen(*screen*)

unsigned long XWhitePixelOfScreen(*screen*)
  Screen **screen*;

screen	Specifies the appropriate **Screen** structure.

Both return the white pixel value of the specified screen.

CellsOfScreen(*screen*)

int XCellsOfScreen(*screen*)
  Screen **screen*;

screen	Specifies the appropriate **Screen** structure.

Both return the number of colormap cells in the default colormap of the specified screen.

DefaultColormapOfScreen(*screen*)

Colormap XDefaultColormapOfScreen(*screen*)
    Screen **screen*;

screen Specifies the appropriate **Screen** structure.

Both return the default colormap of the specified screen.

DefaultDepthOfScreen(*screen*)

int XDefaultDepthOfScreen(*screen*)
    Screen **screen*;

screen Specifies the appropriate **Screen** structure.

Both return the depth of the root window.

DefaultGCOfScreen(*screen*)

GC XDefaultGCOfScreen(*screen*)
    Screen **screen*;

screen Specifies the appropriate **Screen** structure.

Both return a default graphics context (GC) of the specified screen, which has the same depth as the root window of the screen. The GC must never be freed.

DefaultVisualOfScreen(*screen*)

Visual *XDefaultVisualOfScreen(*screen*)
    Screen **screen*;

screen Specifies the appropriate **Screen** structure.

Both return the default visual of the specified screen. For information on visual types, see section 3.1.

```
DoesBackingStore(screen)

int XDoesBackingStore(screen)
      Screen *screen;
```

screen Specifies the appropriate **Screen** structure.

Both return a value indicating whether the screen supports backing stores. The value returned can be one of **WhenMapped**, **NotUseful**, or **Always** (see section 3.2.4).

```
DoesSaveUnders(screen)

Bool XDoesSaveUnders(screen)
      Screen *screen;
```

screen Specifies the appropriate **Screen** structure.

Both return a Boolean value indicating whether the screen supports save unders. If **True**, the screen supports save unders. If **False**, the screen does not support save unders (see section 3.2.5).

```
DisplayOfScreen(screen)

Display *XDisplayOfScreen(screen)
      Screen *screen;
```

screen Specifies the appropriate **Screen** structure.

Both return the display of the specified screen.

```
int XScreenNumberOfScreen(screen)
      Screen *screen;
```

screen Specifies the appropriate **Screen** structure.

The **XScreenNumberOfScreen** function returns the screen index number of the specified screen.

```
EventMaskOfScreen(screen)

long XEventMaskOfScreen(screen)
      Screen *screen;
```

screen Specifies the appropriate **Screen** structure.

Both return the event mask of the root window for the specified screen at connection setup time.

WidthOfScreen(*screen*)

```
int XWidthOfScreen(screen)
      Screen *screen;
```

screen Specifies the appropriate **Screen** structure.

Both return the width of the specified screen in pixels.

HeightOfScreen(*screen*)

```
int XHeightOfScreen(screen)
      Screen *screen;
```

screen Specifies the appropriate **Screen** structure.

Both return the height of the specified screen in pixels.

WidthMMOfScreen(*screen*)

```
int XWidthMMOfScreen(screen)
      Screen *screen;
```

screen Specifies the appropriate **Screen** structure.

Both return the width of the specified screen in millimeters.

HeightMMOfScreen(*screen*)

```
int XHeightMMOfScreen(screen)
      Screen *screen;
```

screen Specifies the appropriate **Screen** structure.

Both return the height of the specified screen in millimeters.

MaxCmapsOfScreen(*screen*)

```
int XMaxCmapsOfScreen(screen)
      Screen *screen;
```

screen Specifies the appropriate **Screen** structure.

Both return the maximum number of installed colormaps supported by the specified screen (see section 9.3).

MinCmapsOfScreen(*screen*)

int XMinCmapsOfScreen(*screen*)
    Screen **screen*;

screen Specifies the appropriate **Screen** structure.

Both return the minimum number of installed colormaps supported by the specified screen (see section 9.3).

PlanesOfScreen(*screen*)

int XPlanesOfScreen(*screen*)
    Screen **screen*;

screen Specifies the appropriate **Screen** structure.

Both return the depth of the root window.

RootWindowOfScreen(*screen*)

Window XRootWindowOfScreen(*screen*)
    Screen **screen*;

screen Specifies the appropriate **Screen** structure.

Both return the root window of the specified screen.

2.3. Generating a NoOperation Protocol Request

To execute a **NoOperation** protocol request, use **XNoOp**.

XNoOp(*display*)
    Display **display*;

display Specifies the connection to the X server.

The **XNoOp** function sends a **NoOperation** protocol request to the X server, thereby exercising the connection.

2.4. Freeing Client-Created Data

To free in-memory data that was created by an Xlib function, use **XFree**.

XFree(*data*)
  void **data*;

data Specifies the data that is to be freed.

The **XFree** function is a general-purpose Xlib routine that frees the specified data. You must use it to free any objects that were allocated by Xlib, unless an alternate function is explicitly specified for the object. A NULL pointer cannot be passed to this function.

2.5. Closing the Display

To close a display or disconnect from the X server, use **XCloseDisplay**.

XCloseDisplay(*display*)
  Display **display*;

display Specifies the connection to the X server.

The **XCloseDisplay** function closes the connection to the X server for the display specified in the **Display** structure and destroys all windows, resource IDs (**Window**, **Font**, **Pixmap**, **Colormap**, **Cursor**, and **GContext**), or other resources that the client has created on this display, unless the close-down mode of the resource has been changed (see **XSetCloseDownMode**). Therefore, these windows, resource IDs, and other resources should never be referenced again or an error will be generated. Before exiting, you should call **XCloseDisplay** explicitly so that any pending errors are reported as **XCloseDisplay** performs a final **XSync** operation.

XCloseDisplay can generate a **BadGC** error.

Xlib provides a function to permit the resources owned by a client to survive after the client's connection is closed. To change a client's close-down mode, use **XSetCloseDownMode**.

XSetCloseDownMode(*display*, *close_mode*)
  Display **display*;
  int *close_mode*;

display Specifies the connection to the X server.

close_mode Specifies the client close-down mode. You can pass **DestroyAll**, **RetainPermanent**, or **RetainTemporary**.

The **XSetCloseDownMode** defines what will happen to the client's resources at connection close. A connection starts in **DestroyAll** mode. For information on what happens to the client's resources when the close_mode argument is **RetainPermanent** or **RetainTemporary**, see section 2.6.

XSetCloseDownMode can generate a **BadValue** error.

2.6. X Server Connection Close Operations

When the X server's connection to a client is closed either by an explicit call to **XCloseDisplay** or by a process that exits, the X server performs the following automatic operations:

- It disowns all selections owned by the client (see **XSetSelectionOwner**).
- It performs an **XUngrabPointer** and **XUngrabKeyboard** if the client has actively grabbed the pointer or the keyboard.
- It performs an **XUngrabServer** if the client has grabbed the server.
- It releases all passive grabs made by the client.
- It marks all resources (including colormap entries) allocated by the client either as permanent or temporary, depending on whether the close-down mode is **RetainPermanent** or **RetainTemporary**. However, this does not prevent other client applications from explicitly destroying the resources (see **XSetCloseDownMode**).

When the close-down mode is **DestroyAll**, the X server destroys all of a client's resources as follows:

- It examines each window in the client's save-set to determine if it is an inferior (subwindow) of a window created by the client. (The save-set is a list of other clients' windows, which are referred to as save-set windows.) If so, the X server reparents the save-set window to the closest ancestor so that the save-set window is not an inferior of a window created by the client. The reparenting leaves unchanged the absolute coordinates (with respect to the root window) of the upper-left outer corner of the save-set window.
- It performs a **MapWindow** request on the save-set window if the save-set window is unmapped. The X server does this even if the save-set window was not an inferior of a window created by the client.
- It destroys all windows created by the client.
- It performs the appropriate free request on each nonwindow resource created by the client in the server (for example, **Font**, **Pixmap**, **Cursor**, **Colormap**, and **GContext**).
- It frees all colors and colormap entries allocated by a client application.

Additional processing occurs when the last connection to the X server closes. An X server goes through a cycle of having no connections and having some connections. When the last connection to the X server closes as a result of a connection closing with the close_mode of **DestroyAll**, the X server does the following:

- It resets its state as if it had just been started. The X server begins by destroying all lingering resources from clients that have terminated in **RetainPermanent** or **RetainTemporary** mode.
- It deletes all but the predefined atom identifiers.
- It deletes all properties on all root windows (see section 4.3).
- It resets all device maps and attributes (for example, key click, bell volume, and acceleration) as well as the access control list.
- It restores the standard root tiles and cursors.
- It restores the default font path.
- It restores the input focus to state **PointerRoot**.

However, the X server does not reset if you close a connection with a close-down mode set to **RetainPermanent** or **RetainTemporary**.

2.7. Using Xlib With Threads

On systems that have threads, support may be provided to permit multiple threads to use Xlib concurrently.

To initialize support for concurrent threads, use **XInitThreads**.

Status XInitThreads( );

The **XInitThreads** function initializes Xlib support for concurrent threads. This function must be the first Xlib function a multi-threaded program calls, and it must complete before any other Xlib call is made. This function returns a nonzero status if initialization was successful; otherwise, it returns zero. On systems that do not support threads, this function always returns zero.

It is only necessary to call this function if multiple threads might use Xlib concurrently. If all calls to Xlib functions are protected by some other access mechanism (for example, a mutual exclusion lock in a toolkit or through explicit client programming), Xlib thread initialization is not required. It is recommended that single-threaded programs not call this function.

To lock a display across several Xlib calls, use **XLockDisplay**.

void XLockDisplay(*display*)
Display **display*;

display	Specifies the connection to the X server.

The **XLockDisplay** function locks out all other threads from using the specified display. Other threads attempting to use the display will block until the display is unlocked by this thread. Nested calls to **XLockDisplay** work correctly; the display will not actually be unlocked until **XUnlockDisplay** has been called the same number of times as **XLockDisplay**. This function has no effect unless Xlib was successfully initialized for threads using **XInitThreads**.

To unlock a display, use **XUnlockDisplay**.

void XUnlockDisplay(*display*)
Display **display*;

display	Specifies the connection to the X server.

The **XUnlockDisplay** function allows other threads to use the specified display again. Any threads that have blocked on the display are allowed to continue. Nested locking works correctly; if **XLockDisplay** has been called multiple times by a thread, then **XUnlockDisplay** must be called an equal number of times before the display is actually unlocked. This function has no effect unless Xlib was successfully initialized for threads using **XInitThreads**.

2.8. Internal Connections

In addition to the connection to the X server, an Xlib implementation may require connections to other kinds of servers (for example, to input method servers as described in chapter 13). Toolkits and clients that use multiple displays, or that use displays in combination with other inputs, need to obtain these additional connections to correctly block until input is available and need to process that input when it is available. Simple clients that use a single display and block for input in an Xlib event function do not need to use these facilities.

To track internal connections for a display, use **XAddConnectionWatch**.

```
typedef void (*XConnectionWatchProc)(display, client_data, fd, opening, watch_data)
      Display *display;
      XPointer client_data;
      int fd;
      Bool opening;
      XPointer *watch_data;

Status XAddConnectionWatch(display, procedure, client_data)
      Display *display;
      XWatchProc procedure;
      XPointer client_data;
```

display	Specifies the connection to the X server.
procedure	Specifies the procedure to be called.
client_data	Specifies the additional client data.

The **XAddConnectionWatch** function registers a procedure to be called each time Xlib opens or closes an internal connection for the specified display. The procedure is passed the display, the specified client_data, the file descriptor for the connection, a Boolean indicating whether the connection is being opened or closed, and a pointer to a location for private watch data. If opening is **True**, the procedure can store a pointer to private data in the location pointed to by watch_data; when the procedure is later called for this same connection and opening is **False**, the location pointed to by watch_data will hold this same private data pointer.

This function can be called at any time after a display is opened. If internal connections already exist, the registered procedure will immediately be called for each of them, before **XAddConnectionWatch** returns. **XAddConnectionWatch** returns a nonzero status if the procedure is successfully registered; otherwise, it returns zero.

The registered procedure should not call any Xlib functions. If the procedure directly or indirectly causes the state of internal connections or watch procedures to change, the result is not defined. If Xlib has been initialized for threads, the procedure is called with the display locked and the result of a call by the procedure to any Xlib function that locks the display is not defined unless the executing thread has externally locked the display using **XLockDisplay**.

To stop tracking internal connections for a display, use **XRemoveConnectionWatch**.

```
Status XRemoveConnectionWatch(display, procedure, client_data)
      Display *display;
      XWatchProc procedure;
      XPointer client_data;
```

display	Specifies the connection to the X server.
procedure	Specifies the procedure to be called.
client_data	Specifies the additional client data.

The **XRemoveConnectionWatch** function removes a previously registered connection watch procedure. The client_data must match the client_data used when the procedure was initially registered.

To process input on an internal connection, use **XProcessInternalConnection**.

void XProcessInternalConnection(*display*, *fd*)
  Display **display*;
  int *fd*;

display	Specifies the connection to the X server.
fd	Specifies the file descriptor.

The **XProcessInternalConnection** function processes input available on an internal connection. This function should be called for an internal connection only after an operating system facility (for example, **select** or **poll**) has indicated that input is available; otherwise, the effect is not defined.

To obtain all of the current internal connections for a display, use **XInternalConnectionNumbers**.

Status XInternalConnectionNumbers(*display*, *fd_return*, *count_return*)
  Display **display*;
  int ***fd_return*;
  int **count_return*;

display	Specifies the connection to the X server.
fd_return	Returns the file descriptors.
count_return	Returns the number of file descriptors.

The **XInternalConnectionNumbers** function returns a list of the file descriptors for all internal connections currently open for the specified display. When the allocated list is no longer needed, free it by using **XFree**. This functions returns a nonzero status if the list is successfully allocated; otherwise, it returns zero.

Chapter 3

Window Functions

In the X Window System, a window is a rectangular area on the screen that lets you view graphic output. Client applications can display overlapping and nested windows on one or more screens that are driven by X servers on one or more machines. Clients who want to create windows must first connect their program to the X server by calling **XOpenDisplay**. This chapter begins with a discussion of visual types and window attributes. The chapter continues with a discussion of the Xlib functions you can use to:

- Create windows
- Destroy windows
- Map windows
- Unmap windows
- Configure windows
- Change the stacking order
- Change window attributes

This chapter also identifies the window actions that may generate events.

Note that it is vital that your application conform to the established conventions for communicating with window managers for it to work well with the various window managers in use (see section 14.1). Toolkits generally adhere to these conventions for you, relieving you of the burden. Toolkits also often supersede many functions in this chapter with versions of their own. Refer to the documentation for the toolkit you are using for more information.

3.1. Visual Types

On some display hardware, it may be possible to deal with color resources in more than one way. For example, you may be able to deal with a screen of either 12-bit depth with arbitrary mapping of pixel to color (pseudo-color) or 24-bit depth with 8 bits of the pixel dedicated to each of red, green, and blue. These different ways of dealing with the visual aspects of the screen are called visuals. For each screen of the display, there may be a list of valid visual types supported at different depths of the screen. Because default windows and visual types are defined for each screen, most simple applications need not deal with this complexity. Xlib provides macros and functions that return the default root window, the default depth of the default root window, and the default visual type (see sections 2.2.1 and 16.7).

Xlib uses an opaque **Visual** structure that contains information about the possible color mapping. The visual utility functions (see section 16.7) use an **XVisualInfo** structure to return this information to an application. The members of this structure pertinent to this discussion are class, red_mask, green_mask, blue_mask, bits_per_rgb, and colormap_size. The class member specifies one of the possible visual classes of the screen and can be **StaticGray**, **StaticColor**, **TrueColor**, **GrayScale**, **PseudoColor**, or **DirectColor**.

The following concepts may serve to make the explanation of visual types clearer. The screen can be color or grayscale, can have a colormap that is writable or read-only, and can also have a colormap whose indices are decomposed into separate RGB pieces, provided one is not on a grayscale screen. This leads to the following diagram:

	Color		Gray-scale	
	R/O	R/W	R/O	R/W
Undecomposed Colormap	Static Color	Pseudo Color	Static Gray	Gray Scale
Decomposed Colormap	True Color	Direct Color		

Conceptually, as each pixel is read out of video memory for display on the screen, it goes through a look-up stage by indexing into a colormap. Colormaps can be manipulated arbitrarily on some hardware, in limited ways on other hardware, and not at all on other hardware. The visual types affect the colormap and the RGB values in the following ways:

- For **PseudoColor**, a pixel value indexes a colormap to produce independent RGB values, and the RGB values can be changed dynamically.
- **GrayScale** is treated the same way as **PseudoColor** except that the primary that drives the screen is undefined. Thus, the client should always store the same value for red, green, and blue in the colormaps.
- For **DirectColor**, a pixel value is decomposed into separate RGB subfields, and each subfield separately indexes the colormap for the corresponding value. The RGB values can be changed dynamically.
- **TrueColor** is treated the same way as **DirectColor** except that the colormap has predefined, read-only RGB values. These RGB values are server-dependent but provide linear or near-linear ramps in each primary.
- **StaticColor** is treated the same way as **PseudoColor** except that the colormap has predefined, read-only, server-dependent RGB values.
- **StaticGray** is treated the same way as **StaticColor** except that the RGB values are equal for any single pixel value, thus resulting in shades of gray. **StaticGray** with a two-entry colormap can be thought of as monochrome.

The red_mask, green_mask, and blue_mask members are only defined for **DirectColor** and **TrueColor**. Each has one contiguous set of bits with no intersections. The bits_per_rgb member specifies the log base 2 of the number of distinct color values (individually) of red, green, and blue. Actual RGB values are unsigned 16-bit numbers. The colormap_size member defines the number of available colormap entries in a newly created colormap. For **DirectColor** and **TrueColor**, this is the size of an individual pixel subfield.

To obtain the visual ID from a **Visual**, use **XVisualIDFromVisual**.

```
VisualID XVisualIDFromVisual(visual)
      Visual *visual;
```

visual Specifies the visual type.

The **XVisualIDFromVisual** function returns the visual ID for the specified visual type.

3.2. Window Attributes

All **InputOutput** windows have a border width of zero or more pixels, an optional background, an event suppression mask (which suppresses propagation of events from children), and a property list (see section 4.3). The window border and background can be a solid color or a pattern, called a tile. All windows except the root have a parent and are clipped by their parent. If a window is stacked on top of another window, it obscures that other window for the purpose of input. If a window has a background (almost all do), it obscures the other window for purposes of output. Attempts to output to the obscured area do nothing, and no input events (for example, pointer motion) are generated for the obscured area.

Windows also have associated property lists (see section 4.3).

Both **InputOutput** and **InputOnly** windows have the following common attributes, which are the only attributes of an **InputOnly** window:

- win-gravity
- event-mask
- do-not-propagate-mask
- override-redirect
- cursor

If you specify any other attributes for an **InputOnly** window, a **BadMatch** error results.

InputOnly windows are used for controlling input events in situations where **InputOutput** windows are unnecessary. **InputOnly** windows are invisible; can only be used to control such things as cursors, input event generation, and grabbing; and cannot be used in any graphics requests. Note that **InputOnly** windows cannot have **InputOutput** windows as inferiors.

Windows have borders of a programmable width and pattern as well as a background pattern or tile. Pixel values can be used for solid colors. The background and border pixmaps can be destroyed immediately after creating the window if no further explicit references to them are to be made. The pattern can either be relative to the parent or absolute. If **ParentRelative**, the parent's background is used.

When windows are first created, they are not visible (not mapped) on the screen. Any output to a window that is not visible on the screen and that does not have backing store will be discarded. An application may wish to create a window long before it is mapped to the screen. When a window is eventually mapped to the screen (using **XMapWindow**), the X server generates an **Expose** event for the window if backing store has not been maintained.

A window manager can override your choice of size, border width, and position for a top-level window. Your program must be prepared to use the actual size and position of the top window. It is not acceptable for a client application to resize itself unless in direct response to a human command to do so. Instead, either your program should use the space given to it, or if the space is too small for any useful work, your program might ask the user to resize the window. The border of your top-level window is considered fair game for window managers.

To set an attribute of a window, set the appropriate member of the **XSetWindowAttributes** structure and OR in the corresponding value bitmask in your subsequent calls to **XCreateWindow** and **XChangeWindowAttributes**, or use one of the other convenience functions that set the appropriate attribute. The symbols for the value mask bits and the **XSetWindowAttributes** structure are:

```
/* Window attribute value mask bits */

#define     CWBackPixmap                    (1L<<0)
#define     CWBackPixel                     (1L<<1)
#define     CWBorderPixmap                  (1L<<2)
#define     CWBorderPixel                   (1L<<3)
#define     CWBitGravity                    (1L<<4)
#define     CWWinGravity                    (1L<<5)
#define     CWBackingStore                  (1L<<6)
#define     CWBackingPlanes                 (1L<<7)
#define     CWBackingPixel                  (1L<<8)
#define     CWOverrideRedirect              (1L<<9)
#define     CWSaveUnder                     (1L<<10)
#define     CWEventMask                     (1L<<11)
#define     CWDontPropagate                 (1L<<12)
#define     CWColormap                      (1L<<13)
#define     CWCursor                        (1L<<14)

/* Values */

typedef struct {
        Pixmap background_pixmap;           /* background, None, or ParentRelative */
        unsigned long background_pixel;     /* background pixel */
        Pixmap border_pixmap;               /* border of the window or CopyFromParent */
        unsigned long border_pixel;         /* border pixel value */
        int bit_gravity;                    /* one of bit gravity values */
        int win_gravity;                    /* one of the window gravity values */
        int backing_store;                  /* NotUseful, WhenMapped, Always */
        unsigned long backing_planes;       /* planes to be preserved if possible */
        unsigned long backing_pixel;        /* value to use in restoring planes */
        Bool save_under;                    /* should bits under be saved? (popups) */
        long event_mask;                    /* set of events that should be saved */
        long do_not_propagate_mask;         /* set of events that should not propagate */
        Bool override_redirect;             /* boolean value for override_redirect */
        Colormap colormap;                  /* color map to be associated with window */
        Cursor cursor;                      /* cursor to be displayed (or None) */
} XSetWindowAttributes;
```

The following lists the defaults for each window attribute and indicates whether the attribute is applicable to **InputOutput** and **InputOnly** windows:

Attribute	Default	InputOutput	InputOnly
background-pixmap	**None**	Yes	No
background-pixel	Undefined	Yes	No
border-pixmap	**CopyFromParent**	Yes	No
border-pixel	Undefined	Yes	No
bit-gravity	**ForgetGravity**	Yes	No
win-gravity	**NorthWestGravity**	Yes	Yes

Attribute	Default	InputOutput	InputOnly
backing-store	**NotUseful**	Yes	No
backing-planes	All ones	Yes	No
backing-pixel	zero	Yes	No
save-under	**False**	Yes	No
event-mask	empty set	Yes	Yes
do-not-propagate-mask	empty set	Yes	Yes
override-redirect	**False**	Yes	Yes
colormap	**CopyFromParent**	Yes	No
cursor	**None**	Yes	Yes

3.2.1. Background Attribute

Only **InputOutput** windows can have a background. You can set the background of an **InputOutput** window by using a pixel or a pixmap.

The background-pixmap attribute of a window specifies the pixmap to be used for a window's background. This pixmap can be of any size, although some sizes may be faster than others. The background-pixel attribute of a window specifies a pixel value used to paint a window's background in a single color.

You can set the background-pixmap to a pixmap, **None** (default), or **ParentRelative**. You can set the background-pixel of a window to any pixel value (no default). If you specify a background-pixel, it overrides either the default background-pixmap or any value you may have set in the background-pixmap. A pixmap of an undefined size that is filled with the background-pixel is used for the background. Range checking is not performed on the background pixel; it simply is truncated to the appropriate number of bits.

If you set the background-pixmap, it overrides the default. The background-pixmap and the window must have the same depth, or a **BadMatch** error results. If you set background-pixmap to **None**, the window has no defined background. If you set the background-pixmap to **ParentRelative**:

- The parent window's background-pixmap is used. The child window, however, must have the same depth as its parent, or a **BadMatch** error results.
- If the parent window has a background-pixmap of **None**, the window also has a background-pixmap of **None**.
- A copy of the parent window's background-pixmap is not made. The parent's background-pixmap is examined each time the child window's background-pixmap is required.
- The background tile origin always aligns with the parent window's background tile origin. If the background-pixmap is not **ParentRelative**, the background tile origin is the child window's origin.

Setting a new background, whether by setting background-pixmap or background-pixel, overrides any previous background. The background-pixmap can be freed immediately if no further explicit reference is made to it (the X server will keep a copy to use when needed). If you later draw into the pixmap used for the background, what happens is undefined because the X implementation is free to make a copy of the pixmap or to use the same pixmap.

When no valid contents are available for regions of a window and either the regions are visible or the server is maintaining backing store, the server automatically tiles the regions with the window's background unless the window has a background of **None**. If the background is **None**, the previous screen contents from other windows of the same depth as the window are simply left in place as long as the contents come from the parent of the window or an inferior of the parent. Otherwise, the initial contents of the exposed regions are undefined. **Expose** events are then generated for the regions, even if the background-pixmap is **None** (see section 10.9).

3.2.2. Border Attribute

Only **InputOutput** windows can have a border. You can set the border of an **InputOutput** window by using a pixel or a pixmap.

The border-pixmap attribute of a window specifies the pixmap to be used for a window's border. The border-pixel attribute of a window specifies a pixmap of undefined size filled with that pixel be used for a window's border. Range checking is not performed on the background pixel; it simply is truncated to the appropriate number of bits. The border tile origin is always the same as the background tile origin.

You can also set the border-pixmap to a pixmap of any size (some may be faster than others) or to **CopyFromParent** (default). You can set the border-pixel to any pixel value (no default).

If you set a border-pixmap, it overrides the default. The border-pixmap and the window must have the same depth, or a **BadMatch** error results. If you set the border-pixmap to **CopyFromParent**, the parent window's border-pixmap is copied. Subsequent changes to the parent window's border attribute do not affect the child window. However, the child window must have the same depth as the parent window, or a **BadMatch** error results.

The border-pixmap can be freed immediately if no further explicit reference is made to it. If you later draw into the pixmap used for the border, what happens is undefined because the X implementation is free either to make a copy of the pixmap or to use the same pixmap. If you specify a border-pixel, it overrides either the default border-pixmap or any value you may have set in the border-pixmap. All pixels in the window's border will be set to the border-pixel. Setting a new border, whether by setting border-pixel or by setting border-pixmap, overrides any previous border.

Output to a window is always clipped to the inside of the window. Therefore, graphics operations never affect the window border.

3.2.3. Gravity Attributes

The bit gravity of a window defines which region of the window should be retained when an **InputOutput** window is resized. The default value for the bit-gravity attribute is **ForgetGravity**. The window gravity of a window allows you to define how the **InputOutput** or **InputOnly** window should be repositioned if its parent is resized. The default value for the win-gravity attribute is **NorthWestGravity**.

If the inside width or height of a window is not changed and if the window is moved or its border is changed, then the contents of the window are not lost but move with the window. Changing the inside width or height of the window causes its contents to be moved or lost (depending on the bit-gravity of the window) and causes children to be reconfigured (depending on their win-gravity). For a change of width and height, the (x, y) pairs are defined:

Gravity Direction	**Coordinates**
NorthWestGravity	(0, 0)
NorthGravity	(Width/2, 0)

NorthEastGravity	(Width, 0)
WestGravity	(0, Height/2)
CenterGravity	(Width/2, Height/2)
EastGravity	(Width, Height/2)
SouthWestGravity	(0, Height)
SouthGravity	(Width/2, Height)
SouthEastGravity	(Width, Height)

When a window with one of these bit-gravity values is resized, the corresponding pair defines the change in position of each pixel in the window. When a window with one of these win-gravities has its parent window resized, the corresponding pair defines the change in position of the window within the parent. When a window is so repositioned, a **GravityNotify** event is generated (see section 10.10.5).

A bit-gravity of **StaticGravity** indicates that the contents or origin should not move relative to the origin of the root window. If the change in size of the window is coupled with a change in position (x, y), then for bit-gravity the change in position of each pixel is (−x, −y), and for win-gravity the change in position of a child when its parent is so resized is (−x, −y). Note that **StaticGravity** still only takes effect when the width or height of the window is changed, not when the window is moved.

A bit-gravity of **ForgetGravity** indicates that the window's contents are always discarded after a size change, even if a backing store or save under has been requested. The window is tiled with its background and zero or more **Expose** events are generated. If no background is defined, the existing screen contents are not altered. Some X servers may also ignore the specified bit-gravity and always generate **Expose** events.

The contents and borders of inferiors are not affected by their parent's bit-gravity. A server is permitted to ignore the specified bit-gravity and use **Forget** instead.

A win-gravity of **UnmapGravity** is like **NorthWestGravity** (the window is not moved), except the child is also unmapped when the parent is resized, and an **UnmapNotify** event is generated.

3.2.4. Backing Store Attribute

Some implementations of the X server may choose to maintain the contents of **InputOutput** windows. If the X server maintains the contents of a window, the off-screen saved pixels are known as backing store. The backing store advises the X server on what to do with the contents of a window. The backing-store attribute can be set to **NotUseful** (default), **WhenMapped**, or **Always**.

A backing-store attribute of **NotUseful** advises the X server that maintaining contents is unnecessary, although some X implementations may still choose to maintain contents and, therefore, not generate **Expose** events. A backing-store attribute of **WhenMapped** advises the X server that maintaining contents of obscured regions when the window is mapped would be beneficial. In this case, the server may generate an **Expose** event when the window is created. A backing-store attribute of **Always** advises the X server that maintaining contents even when the window is unmapped would be beneficial. Even if the window is larger than its parent, this is a request to the X server to maintain complete contents, not just the region within the parent window boundaries. While the X server maintains the window's contents, **Expose** events normally are not generated, but the X server may stop maintaining contents at any time.

When the contents of obscured regions of a window are being maintained, regions obscured by noninferior windows are included in the destination of graphics requests (and source, when the window is the source). However, regions obscured by inferior windows are not included.

3.2.5. Save Under Flag

Some server implementations may preserve contents of **InputOutput** windows under other **InputOutput** windows. This is not the same as preserving the contents of a window for you. You may get better visual appeal if transient windows (for example, pop-up menus) request that the system preserve the screen contents under them, so the temporarily obscured applications do not have to repaint.

You can set the save-under flag to **True** or **False** (default). If save-under is **True**, the X server is advised that, when this window is mapped, saving the contents of windows it obscures would be beneficial.

3.2.6. Backing Planes and Backing Pixel Attributes

You can set backing planes to indicate (with bits set to 1) which bit planes of an **InputOutput** window hold dynamic data that must be preserved in backing store and during save unders. The default value for the backing-planes attribute is all bits set to 1. You can set backing pixel to specify what bits to use in planes not covered by backing planes. The default value for the backing-pixel attribute is all bits set to 0. The X server is free to save only the specified bit planes in the backing store or the save under and is free to regenerate the remaining planes with the specified pixel value. Any extraneous bits in these values (that is, those bits beyond the specified depth of the window) may be simply ignored. If you request backing store or save unders, you should use these members to minimize the amount of off-screen memory required to store your window.

3.2.7. Event Mask and Do Not Propagate Mask Attributes

The event mask defines which events the client is interested in for this **InputOutput** or **InputOnly** window (or, for some event types, inferiors of this window). The event mask is the bitwise inclusive OR of zero or more of the valid event mask bits. You can specify that no maskable events are reported by setting **NoEventMask** (default).

The do-not-propagate-mask attribute defines which events should not be propagated to ancestor windows when no client has the event type selected in this **InputOutput** or **InputOnly** window. The do-not-propagate-mask is the bitwise inclusive OR of zero or more of the following masks: **KeyPress**, **KeyRelease**, **ButtonPress**, **ButtonRelease**, **PointerMotion**, **Button1Motion**, **Button2Motion**, **Button3Motion**, **Button4Motion**, **Button5Motion**, and **ButtonMotion**. You can specify that all events are propagated by setting **NoEventMask** (default).

3.2.8. Override Redirect Flag

To control window placement or to add decoration, a window manager often needs to intercept (redirect) any map or configure request. Pop-up windows, however, often need to be mapped without a window manager getting in the way. To control whether an **InputOutput** or **InputOnly** window is to ignore these structure control facilities, use the override-redirect flag.

The override-redirect flag specifies whether map and configure requests on this window should override a **SubstructureRedirectMask** on the parent. You can set the override-redirect flag to **True** or **False** (default). Window managers use this information to avoid tampering with pop-up windows (see also chapter 14).

3.2.9. Colormap Attribute

The colormap attribute specifies which colormap best reflects the true colors of the **InputOutput** window. The colormap must have the same visual type as the window, or a **BadMatch** error results. X servers capable of supporting multiple hardware colormaps can use this information, and window managers can use it for calls to **XInstallColormap**. You can set the colormap attribute to a colormap or to **CopyFromParent** (default).

If you set the colormap to **CopyFromParent**, the parent window's colormap is copied and used by its child. However, the child window must have the same visual type as the parent, or a **BadMatch** error results. The parent window must not have a colormap of **None**, or a **BadMatch** error results. The colormap is copied by sharing the colormap object between the child and parent, not by making a complete copy of the colormap contents. Subsequent changes to the parent window's colormap attribute do not affect the child window.

3.2.10. Cursor Attribute

The cursor attribute specifies which cursor is to be used when the pointer is in the **InputOutput** or **InputOnly** window. You can set the cursor to a cursor or **None** (default).

If you set the cursor to **None**, the parent's cursor is used when the pointer is in the **InputOutput** or **InputOnly** window, and any change in the parent's cursor will cause an immediate change in the displayed cursor. By calling **XFreeCursor**, the cursor can be freed immediately as long as no further explicit reference to it is made.

3.3. Creating Windows

Xlib provides basic ways for creating windows, and toolkits often supply higher-level functions specifically for creating and placing top-level windows, which are discussed in the appropriate toolkit documentation. If you do not use a toolkit, however, you must provide some standard information or hints for the window manager by using the Xlib inter-client communication functions (see chapter 14).

If you use Xlib to create your own top-level windows (direct children of the root window), you must observe the following rules so that all applications interact reasonably across the different styles of window management:

- You must never fight with the window manager for the size or placement of your top-level window.
- You must be able to deal with whatever size window you get, even if this means that your application just prints a message like ‘‘Please make me bigger’’ in its window.
- You should only attempt to resize or move top-level windows in direct response to a user request. If a request to change the size of a top-level window fails, you must be prepared to live with what you get. You are free to resize or move the children of top-level windows as necessary. (Toolkits often have facilities for automatic relayout.)
- If you do not use a toolkit that automatically sets standard window properties, you should set these properties for top-level windows before mapping them.

For further information, see chapter 14 and the *Inter-Client Communication Conventions Manual*.

XCreateWindow is the more general function that allows you to set specific window attributes when you create a window. **XCreateSimpleWindow** creates a window that inherits its attributes from its parent window.

The X server acts as if **InputOnly** windows do not exist for the purposes of graphics requests, exposure processing, and **VisibilityNotify** events. An **InputOnly** window cannot be used as a drawable (that is, as a source or destination for graphics requests). **InputOnly** and **InputOutput** windows act identically in other respects (properties, grabs, input control, and so on). Extension packages can define other classes of windows.

To create an unmapped window and set its window attributes, use **XCreateWindow**.

```
Window XCreateWindow(display, parent, x, y, width, height, border_width, depth,
                class, visual, valuemask, attributes)
    Display *display;
    Window parent;
    int x, y;
    unsigned int width, height;
    unsigned int border_width;
    int depth;
    unsigned int class;
    Visual *visual
    unsigned long valuemask;
    XSetWindowAttributes *attributes;
```

display	Specifies the connection to the X server.
parent	Specifies the parent window.
x	
y	Specify the x and y coordinates, which are the top-left outside corner of the created window's borders and are relative to the inside of the parent window's borders.
width	
height	Specify the width and height, which are the created window's inside dimensions and do not include the created window's borders. The dimensions must be nonzero, or a **BadValue** error results.
border_width	Specifies the width of the created window's border in pixels.
depth	Specifies the window's depth. A depth of **CopyFromParent** means the depth is taken from the parent.
class	Specifies the created window's class. You can pass **InputOutput**, **InputOnly**, or **CopyFromParent**. A class of **CopyFromParent** means the class is taken from the parent.
visual	Specifies the visual type. A visual of **CopyFromParent** means the visual type is taken from the parent.
valuemask	Specifies which window attributes are defined in the attributes argument. This mask is the bitwise inclusive OR of the valid attribute mask bits. If valuemask is zero, the attributes are ignored and are not referenced.
attributes	Specifies the structure from which the values (as specified by the value mask) are to be taken. The value mask should have the appropriate bits set to indicate which attributes have been set in the structure.

The **XCreateWindow** function creates an unmapped subwindow for a specified parent window, returns the window ID of the created window, and causes the X server to generate a **CreateNotify** event. The created window is placed on top in the stacking order with respect to siblings.

The coordinate system has the X axis horizontal and the Y axis vertical with the origin [0, 0] at the upper-left corner. Coordinates are integral, in terms of pixels, and coincide with pixel centers. Each window and pixmap has its own coordinate system. For a window, the origin is inside the border at the inside, upper-left corner.

The border_width for an **InputOnly** window must be zero, or a **BadMatch** error results. For class **InputOutput**, the visual type and depth must be a combination supported for the screen, or a **BadMatch** error results. The depth need not be the same as the parent, but the parent must not be a window of class **InputOnly**, or a **BadMatch** error results. For an **InputOnly** window, the depth must be zero, and the visual must be one supported by the screen. If either condition is not met, a **BadMatch** error results. The parent window, however, may have any depth and class. If you specify any invalid window attribute for a window, a **BadMatch** error results.

The created window is not yet displayed (mapped) on the user's display. To display the window, call **XMapWindow**. The new window initially uses the same cursor as its parent. A new cursor can be defined for the new window by calling **XDefineCursor**. The window will not be visible on the screen unless it and all of its ancestors are mapped and it is not obscured by any of its ancestors.

XCreateWindow can generate **BadAlloc**, **BadColor**, **BadCursor**, **BadMatch**, **BadPixmap**, **BadValue**, and **BadWindow** errors.

To create an unmapped **InputOutput** subwindow of a given parent window, use **XCreateSimpleWindow**.

```
Window XCreateSimpleWindow(display, parent, x, y, width, height, border_width,
                    border, background)
    Display *display;
    Window parent;
    int x, y;
    unsigned int width, height;
    unsigned int border_width;
    unsigned long border;
    unsigned long background;
```

display	Specifies the connection to the X server.
parent	Specifies the parent window.
x *y*	Specify the x and y coordinates, which are the top-left outside corner of the new window's borders and are relative to the inside of the parent window's borders.
width *height*	Specify the width and height, which are the created window's inside dimensions and do not include the created window's borders. The dimensions must be nonzero, or a **BadValue** error results.
border_width	Specifies the width of the created window's border in pixels.
border	Specifies the border pixel value of the window.
background	Specifies the background pixel value of the window.

The **XCreateSimpleWindow** function creates an unmapped **InputOutput** subwindow for a specified parent window, returns the window ID of the created window, and causes the X server to generate a **CreateNotify** event. The created window is placed on top in the stacking order with respect to siblings. Any part of the window that extends outside its parent window is clipped. The border_width for an **InputOnly** window must be zero, or a **BadMatch** error results.

XCreateSimpleWindow inherits its depth, class, and visual from its parent. All other window attributes, except background and border, have their default values.

XCreateSimpleWindow can generate **BadAlloc**, **BadMatch**, **BadValue**, and **BadWindow** errors.

3.4. Destroying Windows

Xlib provides functions that you can use to destroy a window or destroy all subwindows of a window.

To destroy a window and all of its subwindows, use **XDestroyWindow**.

```
XDestroyWindow(display, w)
    Display *display;
    Window w;
```

display	Specifies the connection to the X server.
w	Specifies the window.

The **XDestroyWindow** function destroys the specified window as well as all of its subwindows and causes the X server to generate a **DestroyNotify** event for each window. The window should never be referenced again. If the window specified by the w argument is mapped, it is unmapped automatically. The ordering of the **DestroyNotify** events is such that for any given window being destroyed, **DestroyNotify** is generated on any inferiors of the window before being generated on the window itself. The ordering among siblings and across subhierarchies is not otherwise constrained. If the window you specified is a root window, no windows are destroyed. Destroying a mapped window will generate **Expose** events on other windows that were obscured by the window being destroyed.

XDestroyWindow can generate a **BadWindow** error.

To destroy all subwindows of a specified window, use **XDestroySubwindows**.

```
XDestroySubwindows(display, w)
    Display *display;
    Window w;
```

display	Specifies the connection to the X server.
w	Specifies the window.

The **XDestroySubwindows** function destroys all inferior windows of the specified window, in bottom-to-top stacking order. It causes the X server to generate a **DestroyNotify** event for each window. If any mapped subwindows were actually destroyed, **XDestroySubwindows** causes the X server to generate **Expose** events on the specified window. This is much more efficient than deleting many windows one at a time because much of the work need be performed only once for all of the windows, rather than for each window. The subwindows should never be referenced again.

XDestroySubwindows can generate a **BadWindow** error.

3.5. Mapping Windows

A window is considered mapped if an **XMapWindow** call has been made on it. It may not be visible on the screen for one of the following reasons:

- It is obscured by another opaque window.
- One of its ancestors is not mapped.
- It is entirely clipped by an ancestor.

Expose events are generated for the window when part or all of it becomes visible on the screen. A client receives the **Expose** events only if it has asked for them. Windows retain their position in the stacking order when they are unmapped.

A window manager may want to control the placement of subwindows. If **SubstructureRedirectMask** has been selected by a window manager on a parent window (usually a root window), a map request initiated by other clients on a child window is not performed, and the window manager is sent a **MapRequest** event. However, if the override-redirect flag on the child had been set to **True** (usually only on pop-up menus), the map request is performed.

A tiling window manager might decide to reposition and resize other clients' windows and then decide to map the window to its final location. A window manager that wants to provide decoration might reparent the child into a frame first. For further information, see section 3.2.8 and section 10.10. Only a single client at a time can select for **SubstructureRedirectMask**.

Similarly, a single client can select for **ResizeRedirectMask** on a parent window. Then, any attempt to resize the window by another client is suppressed, and the client receives a **ResizeRequest** event.

To map a given window, use **XMapWindow**.

```
XMapWindow(display, w)
    Display *display;
    Window w;
```

display	Specifies the connection to the X server.
w	Specifies the window.

The **XMapWindow** function maps the window and all of its subwindows that have had map requests. Mapping a window that has an unmapped ancestor does not display the window but marks it as eligible for display when the ancestor becomes mapped. Such a window is called unviewable. When all its ancestors are mapped, the window becomes viewable and will be visible on the screen if it is not obscured by another window. This function has no effect if the window is already mapped.

If the override-redirect of the window is **False** and if some other client has selected **SubstructureRedirectMask** on the parent window, then the X server generates a **MapRequest** event, and the **XMapWindow** function does not map the window. Otherwise, the window is mapped, and the X server generates a **MapNotify** event.

If the window becomes viewable and no earlier contents for it are remembered, the X server tiles the window with its background. If the window's background is undefined, the existing screen contents are not altered, and the X server generates zero or more **Expose** events. If backing-store was maintained while the window was unmapped, no **Expose** events are generated. If backing-store will now be maintained, a full-window exposure is always generated. Otherwise, only visible regions may be reported. Similar tiling and exposure take place for any newly viewable inferiors.

If the window is an **InputOutput** window, **XMapWindow** generates **Expose** events on each **InputOutput** window that it causes to be displayed. If the client maps and paints the window and if the client begins processing events, the window is painted twice. To avoid this, first ask for **Expose** events and then map the window, so the client processes input events as usual. The event list will include **Expose** for each window that has appeared on the screen. The client's normal response to an **Expose** event should be to repaint the window. This method usually leads to simpler programs and to proper interaction with window managers.

XMapWindow can generate a **BadWindow** error.

To map and raise a window, use **XMapRaised**.

```
XMapRaised(display, w)
    Display *display;
    Window w;
```

display	Specifies the connection to the X server.
w	Specifies the window.

The **XMapRaised** function essentially is similar to **XMapWindow** in that it maps the window and all of its subwindows that have had map requests. However, it also raises the specified window to the top of the stack. For additional information, see **XMapWindow**.

XMapRaised can generate multiple **BadWindow** errors.

To map all subwindows for a specified window, use **XMapSubwindows**.

```
XMapSubwindows(display, w)
    Display *display;
    Window w;
```

display	Specifies the connection to the X server.
w	Specifies the window.

The **XMapSubwindows** function maps all subwindows for a specified window in top-to-bottom stacking order. The X server generates **Expose** events on each newly displayed window. This may be much more efficient than mapping many windows one at a time because the server needs to perform much of the work only once, for all of the windows, rather than for each window.

XMapSubwindows can generate a **BadWindow** error.

3.6. Unmapping Windows

Xlib provides functions that you can use to unmap a window or all subwindows.

To unmap a window, use **XUnmapWindow**.

XUnmapWindow(*display*, *w*)
  Display **display*;
  Window *w*;

display Specifies the connection to the X server.

w Specifies the window.

The **XUnmapWindow** function unmaps the specified window and causes the X server to generate an **UnmapNotify** event. If the specified window is already unmapped, **XUnmapWindow** has no effect. Normal exposure processing on formerly obscured windows is performed. Any child window will no longer be visible until another map call is made on the parent. In other words, the subwindows are still mapped but are not visible until the parent is mapped. Unmapping a window will generate **Expose** events on windows that were formerly obscured by it.

XUnmapWindow can generate a **BadWindow** error.

To unmap all subwindows for a specified window, use **XUnmapSubwindows**.

XUnmapSubwindows(*display*, *w*)
  Display **display*;
  Window *w*;

display Specifies the connection to the X server.

w Specifies the window.

The **XUnmapSubwindows** function unmaps all subwindows for the specified window in bottom-to-top stacking order. It causes the X server to generate an **UnmapNotify** event on each subwindow and **Expose** events on formerly obscured windows. Using this function is much more efficient than unmapping multiple windows one at a time because the server needs to perform much of the work only once, for all of the windows, rather than for each window.

XUnmapSubwindows can generate a **BadWindow** error.

3.7. Configuring Windows

Xlib provides functions that you can use to move a window, resize a window, move and resize a window, or change a window’s border width. To change one of these parameters, set the appropriate member of the **XWindowChanges** structure and OR in the corresponding value mask in subsequent calls to **XConfigureWindow**. The symbols for the value mask bits and the **XWindowChanges** structure are:

```
/* Configure window value mask bits */

#define     CWX                         (1<<0)
#define     CWY                         (1<<1)
#define     CWWidth                     (1<<2)
#define     CWHeight                    (1<<3)
#define     CWBorderWidth               (1<<4)
#define     CWSibling                   (1<<5)
#define     CWStackMode                 (1<<6)

/* Values */

typedef struct {
        int x, y;
        int width, height;
        int border_width;
        Window sibling;
        int stack_mode;
} XWindowChanges;
```

The x and y members are used to set the window's x and y coordinates, which are relative to the parent's origin and indicate the position of the upper-left outer corner of the window. The width and height members are used to set the inside size of the window, not including the border, and must be nonzero, or a **BadValue** error results. Attempts to configure a root window have no effect.

The border_width member is used to set the width of the border in pixels. Note that setting just the border width leaves the outer-left corner of the window in a fixed position but moves the absolute position of the window's origin. If you attempt to set the border-width attribute of an **InputOnly** window nonzero, a **BadMatch** error results.

The sibling member is used to set the sibling window for stacking operations. The stack_mode member is used to set how the window is to be restacked and can be set to **Above**, **Below**, **TopIf**, **BottomIf**, or **Opposite**.

If the override-redirect flag of the window is **False** and if some other client has selected **SubstructureRedirectMask** on the parent, the X server generates a **ConfigureRequest** event, and no further processing is performed. Otherwise, if some other client has selected **ResizeRedirectMask** on the window and the inside width or height of the window is being changed, a **ResizeRequest** event is generated, and the current inside width and height are used instead. Note that the override-redirect flag of the window has no effect on **ResizeRedirectMask** and that **SubstructureRedirectMask** on the parent has precedence over **ResizeRedirectMask** on the window.

When the geometry of the window is changed as specified, the window is restacked among siblings, and a **ConfigureNotify** event is generated if the state of the window actually changes. **GravityNotify** events are generated after **ConfigureNotify** events. If the inside width or height of the window has actually changed, children of the window are affected as specified.

If a window's size actually changes, the window's subwindows move according to their window gravity. Depending on the window's bit gravity, the contents of the window also may be moved (see section 3.2.3).

If regions of the window were obscured but now are not, exposure processing is performed on these formerly obscured windows, including the window itself and its inferiors. As a result of increasing the width or height, exposure processing is also performed on any new regions of the window and any regions where window contents are lost.

The restack check (specifically, the computation for **BottomIf**, **TopIf**, and **Opposite**) is performed with respect to the window's final size and position (as controlled by the other arguments of the request), not its initial position. If a sibling is specified without a stack_mode, a **BadMatch** error results.

If a sibling and a stack_mode are specified, the window is restacked as follows:

Above	The window is placed just above the sibling.
Below	The window is placed just below the sibling.
TopIf	If the sibling occludes the window, the window is placed at the top of the stack.
BottomIf	If the window occludes the sibling, the window is placed at the bottom of the stack.
Opposite	If the sibling occludes the window, the window is placed at the top of the stack. If the window occludes the sibling, the window is placed at the bottom of the stack.

If a stack_mode is specified but no sibling is specified, the window is restacked as follows:

Above	The window is placed at the top of the stack.
Below	The window is placed at the bottom of the stack.
TopIf	If any sibling occludes the window, the window is placed at the top of the stack.
BottomIf	If the window occludes any sibling, the window is placed at the bottom of the stack.
Opposite	If any sibling occludes the window, the window is placed at the top of the stack. If the window occludes any sibling, the window is placed at the bottom of the stack.

Attempts to configure a root window have no effect.

To configure a window's size, location, stacking, or border, use **XConfigureWindow**.

```
XConfigureWindow(display, w, value_mask, values)
      Display *display;
      Window w;
      unsigned int value_mask;
      XWindowChanges *values;
```

display	Specifies the connection to the X server.
w	Specifies the window to be reconfigured.
value_mask	Specifies which values are to be set using information in the values structure. This mask is the bitwise inclusive OR of the valid configure window values bits.
values	Specifies the **XWindowChanges** structure.

The **XConfigureWindow** function uses the values specified in the **XWindowChanges** structure to reconfigure a window's size, position, border, and stacking order. Values not specified are taken from the existing geometry of the window.

If a sibling is specified without a stack_mode or if the window is not actually a sibling, a **BadMatch** error results. Note that the computations for **BottomIf**, **TopIf**, and **Opposite** are performed with respect to the window's final geometry (as controlled by the other arguments passed to **XConfigureWindow**), not its initial geometry. Any backing store contents of the window, its inferiors, and other newly visible windows are either discarded or changed to reflect the current screen contents (depending on the implementation).

XConfigureWindow can generate **BadMatch**, **BadValue**, and **BadWindow** errors.

To move a window without changing its size, use **XMoveWindow**.

```
XMoveWindow(display, w, x, y)
      Display *display;
      Window w;
      int x, y;
```

display	Specifies the connection to the X server.
w	Specifies the window to be moved.
x	
y	Specify the x and y coordinates, which define the new location of the top-left pixel of the window's border or the window itself if it has no border.

The **XMoveWindow** function moves the specified window to the specified x and y coordinates, but it does not change the window's size, raise the window, or change the mapping state of the window. Moving a mapped window may or may not lose the window's contents depending on if the window is obscured by nonchildren and if no backing store exists. If the contents of the window are lost, the X server generates **Expose** events. Moving a mapped window generates **Expose** events on any formerly obscured windows.

If the override-redirect flag of the window is **False** and some other client has selected **SubstructureRedirectMask** on the parent, the X server generates a **ConfigureRequest** event, and no further processing is performed. Otherwise, the window is moved.

XMoveWindow can generate a **BadWindow** error.

To change a window’s size without changing the upper-left coordinate, use **XResizeWindow**.

```
XResizeWindow(display, w, width, height)
      Display *display;
      Window w;
      unsigned int width, height;
```

display	Specifies the connection to the X server.
w	Specifies the window.
width	
height	Specify the width and height, which are the interior dimensions of the window after the call completes.

The **XResizeWindow** function changes the inside dimensions of the specified window, not including its borders. This function does not change the window’s upper-left coordinate or the origin and does not restack the window. Changing the size of a mapped window may lose its contents and generate **Expose** events. If a mapped window is made smaller, changing its size generates **Expose** events on windows that the mapped window formerly obscured.

If the override-redirect flag of the window is **False** and some other client has selected **SubstructureRedirectMask** on the parent, the X server generates a **ConfigureRequest** event, and no further processing is performed. If either width or height is zero, a **BadValue** error results.

XResizeWindow can generate **BadValue** and **BadWindow** errors.

To change the size and location of a window, use **XMoveResizeWindow**.

```
XMoveResizeWindow(display, w, x, y, width, height)
      Display *display;
      Window w;
      int x, y;
      unsigned int width, height;
```

display	Specifies the connection to the X server.
w	Specifies the window to be reconfigured.
x	
y	Specify the x and y coordinates, which define the new position of the window relative to its parent.
width	
height	Specify the width and height, which define the interior size of the window.

The **XMoveResizeWindow** function changes the size and location of the specified window without raising it. Moving and resizing a mapped window may generate an **Expose** event on the window. Depending on the new size and location parameters, moving and resizing a window may generate **Expose** events on windows that the window formerly obscured.

If the override-redirect flag of the window is **False** and some other client has selected **SubstructureRedirectMask** on the parent, the X server generates a **ConfigureRequest** event, and no further processing is performed. Otherwise, the window size and location are changed.

XMoveResizeWindow can generate **BadValue** and **BadWindow** errors.

To change the border width of a given window, use **XSetWindowBorderWidth**.

```
XSetWindowBorderWidth(display, w, width)
      Display *display;
      Window w;
      unsigned int width;
```

display	Specifies the connection to the X server.
w	Specifies the window.
width	Specifies the width of the window border.

The **XSetWindowBorderWidth** function sets the specified window's border width to the specified width.

XSetWindowBorderWidth can generate a **BadWindow** error.

3.8. Changing Window Stacking Order

Xlib provides functions that you can use to raise, lower, circulate, or restack windows.

To raise a window so that no sibling window obscures it, use **XRaiseWindow**.

```
XRaiseWindow(display, w)
      Display *display;
      Window w;
```

display	Specifies the connection to the X server.
w	Specifies the window.

The **XRaiseWindow** function raises the specified window to the top of the stack so that no sibling window obscures it. If the windows are regarded as overlapping sheets of paper stacked on a desk, then raising a window is analogous to moving the sheet to the top of the stack but leaving its x and y location on the desk constant. Raising a mapped window may generate **Expose** events for the window and any mapped subwindows that were formerly obscured.

If the override-redirect attribute of the window is **False** and some other client has selected **SubstructureRedirectMask** on the parent, the X server generates a **ConfigureRequest** event, and no processing is performed. Otherwise, the window is raised.

XRaiseWindow can generate a **BadWindow** error.

To lower a window so that it does not obscure any sibling windows, use **XLowerWindow**.

XLowerWindow(*display*, *w*)
  Display **display*;
  Window *w*;

display	Specifies the connection to the X server.
w	Specifies the window.

The **XLowerWindow** function lowers the specified window to the bottom of the stack so that it does not obscure any sibling windows. If the windows are regarded as overlapping sheets of paper stacked on a desk, then lowering a window is analogous to moving the sheet to the bottom of the stack but leaving its x and y location on the desk constant. Lowering a mapped window will generate **Expose** events on any windows it formerly obscured.

If the override-redirect attribute of the window is **False** and some other client has selected **SubstructureRedirectMask** on the parent, the X server generates a **ConfigureRequest** event, and no processing is performed. Otherwise, the window is lowered to the bottom of the stack.

XLowerWindow can generate a **BadWindow** error.

To circulate a subwindow up or down, use **XCirculateSubwindows**.

XCirculateSubwindows(*display*, *w*, *direction*)
  Display **display*;
  Window *w*;
  int *direction*;

display	Specifies the connection to the X server.
w	Specifies the window.
direction	Specifies the direction (up or down) that you want to circulate the window. You can pass **RaiseLowest** or **LowerHighest**.

The **XCirculateSubwindows** function circulates children of the specified window in the specified direction. If you specify **RaiseLowest**, **XCirculateSubwindows** raises the lowest mapped child (if any) that is occluded by another child to the top of the stack. If you specify **LowerHighest**, **XCirculateSubwindows** lowers the highest mapped child (if any) that occludes another child to the bottom of the stack. Exposure processing is then performed on formerly obscured windows. If some other client has selected **SubstructureRedirectMask** on the window, the X server generates a **CirculateRequest** event, and no further processing is performed. If a child is actually restacked, the X server generates a **CirculateNotify** event.

XCirculateSubwindows can generate **BadValue** and **BadWindow** errors.

To raise the lowest mapped child of a window that is partially or completely occluded by another child, use **XCirculateSubwindowsUp**.

XCirculateSubwindowsUp(*display*, *w*)
    Display **display*;
    Window *w*;

display	Specifies the connection to the X server.
w	Specifies the window.

The **XCirculateSubwindowsUp** function raises the lowest mapped child of the specified window that is partially or completely occluded by another child. Completely unobscured children are not affected. This is a convenience function equivalent to **XCirculateSubwindows** with **RaiseLowest** specified.

XCirculateSubwindowsUp can generate a **BadWindow** error.

To lower the highest mapped child of a window that partially or completely occludes another child, use **XCirculateSubwindowsDown**.

XCirculateSubwindowsDown(*display*, *w*)
    Display **display*;
    Window *w*;

display	Specifies the connection to the X server.
w	Specifies the window.

The **XCirculateSubwindowsDown** function lowers the highest mapped child of the specified window that partially or completely occludes another child. Completely unobscured children are not affected. This is a convenience function equivalent to **XCirculateSubwindows** with **LowerHighest** specified.

XCirculateSubwindowsDown can generate a **BadWindow** error.

To restack a set of windows from top to bottom, use **XRestackWindows**.

XRestackWindows(*display*, *windows*, *nwindows*);
    Display **display*;
    Window *windows*[];
    int *nwindows*;

display	Specifies the connection to the X server.
windows	Specifies an array containing the windows to be restacked.
nwindows	Specifies the number of windows to be restacked.

The **XRestackWindows** function restacks the windows in the order specified, from top to bottom. The stacking order of the first window in the windows array is unaffected, but the other windows in the array are stacked underneath the first window, in the order of the array. The stacking order of the other windows is not affected. For each window in the window array that is not a child of the specified window, a **BadMatch** error results.

If the override-redirect attribute of a window is **False** and some other client has selected **SubstructureRedirectMask** on the parent, the X server generates **ConfigureRequest** events for each window whose override-redirect flag is not set, and no further processing is performed. Otherwise, the windows will be restacked in top to bottom order.

XRestackWindows can generate a **BadWindow** error.

3.9. Changing Window Attributes

Xlib provides functions that you can use to set window attributes. **XChangeWindowAttributes** is the more general function that allows you to set one or more window attributes provided by the **XSetWindowAttributes** structure. The other functions described in this section allow you to set one specific window attribute, such as a window's background.

To change one or more attributes for a given window, use **XChangeWindowAttributes**.

```
XChangeWindowAttributes(display, w, valuemask, attributes)
    Display *display;
    Window w;
    unsigned long valuemask;
    XSetWindowAttributes *attributes;
```

display	Specifies the connection to the X server.
w	Specifies the window.
valuemask	Specifies which window attributes are defined in the attributes argument. This mask is the bitwise inclusive OR of the valid attribute mask bits. If valuemask is zero, the attributes are ignored and are not referenced. The values and restrictions are the same as for **XCreateWindow**.
attributes	Specifies the structure from which the values (as specified by the value mask) are to be taken. The value mask should have the appropriate bits set to indicate which attributes have been set in the structure (see section 3.2).

Depending on the valuemask, the **XChangeWindowAttributes** function uses the window attributes in the **XSetWindowAttributes** structure to change the specified window attributes. Changing the background does not cause the window contents to be changed. To repaint the window and its background, use **XClearWindow**. Setting the border or changing the background such that the border tile origin changes causes the border to be repainted. Changing the background of a root window to **None** or **ParentRelative** restores the default background pixmap. Changing the border of a root window to **CopyFromParent** restores the default border pixmap. Changing the win-gravity does not affect the current position of the window. Changing the backing-store of an obscured window to **WhenMapped** or **Always**, or changing the backing-planes, backing-pixel, or save-under of a mapped window may have no immediate effect. Changing the colormap of a window (that is, defining a new map, not changing the contents of the existing map) generates a **ColormapNotify** event. Changing the colormap of a visible window may have no immediate effect on the screen because the map may not be installed (see **XInstallColormap**). Changing the cursor of a root window to **None** restores the default cursor. Whenever possible, you are encouraged to share colormaps.

Multiple clients can select input on the same window. Their event masks are maintained separately. When an event is generated, it is reported to all interested clients. However, only one client at a time can select for **SubstructureRedirectMask**, **ResizeRedirectMask**, and **ButtonPressMask**. If a client attempts to select any of these event masks and some other client has already selected one, a **BadAccess** error results. There is only one do-not-propagate-mask for a window, not one per client.

XChangeWindowAttributes can generate **BadAccess**, **BadColor**, **BadCursor**, **BadMatch**, **BadPixmap**, **BadValue**, and **BadWindow** errors.

To set the background of a window to a given pixel, use **XSetWindowBackground**.

```
XSetWindowBackground(display, w, background_pixel)
    Display *display;
    Window w;
    unsigned long background_pixel;
```

display	Specifies the connection to the X server.
w	Specifies the window.
background_pixel	Specifies the pixel that is to be used for the background.

The **XSetWindowBackground** function sets the background of the window to the specified pixel value. Changing the background does not cause the window contents to be changed. **XSetWindowBackground** uses a pixmap of undefined size filled with the pixel value you passed. If you try to change the background of an **InputOnly** window, a **BadMatch** error results.

XSetWindowBackground can generate **BadMatch** and **BadWindow** errors.

To set the background of a window to a given pixmap, use **XSetWindowBackgroundPixmap**.

```
XSetWindowBackgroundPixmap(display, w, background_pixmap)
    Display *display;
    Window w;
    Pixmap background_pixmap;
```

display	Specifies the connection to the X server.
w	Specifies the window.
background_pixmap	Specifies the background pixmap, **ParentRelative**, or **None**.

The **XSetWindowBackgroundPixmap** function sets the background pixmap of the window to the specified pixmap. The background pixmap can immediately be freed if no further explicit references to it are to be made. If **ParentRelative** is specified, the background pixmap of the window's parent is used, or on the root window, the default background is restored. If you try to change the background of an **InputOnly** window, a **BadMatch** error results. If the background is set to **None**, the window has no defined background.

XSetWindowBackgroundPixmap can generate **BadMatch**, **BadPixmap**, and **BadWindow** errors.

Note

XSetWindowBackground and **XSetWindowBackgroundPixmap** do not change the current contents of the window.

To change and repaint a window's border to a given pixel, use **XSetWindowBorder**.

```
XSetWindowBorder(display, w, border_pixel)
    Display *display;
    Window w;
    unsigned long border_pixel;
```

display	Specifies the connection to the X server.
w	Specifies the window.
border_pixel	Specifies the entry in the colormap.

The **XSetWindowBorder** function sets the border of the window to the pixel value you specify. If you attempt to perform this on an **InputOnly** window, a **BadMatch** error results.

XSetWindowBorder can generate **BadMatch** and **BadWindow** errors.

To change and repaint the border tile of a given window, use **XSetWindowBorderPixmap**.

```
XSetWindowBorderPixmap(display, w, border_pixmap)
    Display *display;
    Window w;
    Pixmap border_pixmap;
```

display	Specifies the connection to the X server.
w	Specifies the window.
border_pixmap	Specifies the border pixmap or **CopyFromParent**.

The **XSetWindowBorderPixmap** function sets the border pixmap of the window to the pixmap you specify. The border pixmap can be freed immediately if no further explicit references to it are to be made. If you specify **CopyFromParent**, a copy of the parent window's border pixmap is used. If you attempt to perform this on an **InputOnly** window, a **BadMatch** error results.

XSetWindowBorderPixmap can generate **BadMatch**, **BadPixmap**, and **BadWindow** errors.

To set the colormap of a given window, use **XSetWindowColormap**.

```
XSetWindowColormap(display, w, colormap)
    Display *display;
    Window w;
    Colormap colormap;
```

display	Specifies the connection to the X server.
w	Specifies the window.
colormap	Specifies the colormap.

The **XSetWindowColormap** function sets the specified colormap of the specified window. The colormap must have the same visual type as the window, or a **BadMatch** error results.

XSetWindowColormap can generate **BadColor**, **BadMatch**, and **BadWindow** errors.

To define which cursor will be used in a window, use **XDefineCursor**.

```
XDefineCursor(display, w, cursor)
    Display *display;
    Window w;
    Cursor cursor;
```

display	Specifies the connection to the X server.
w	Specifies the window.
cursor	Specifies the cursor that is to be displayed or **None**.

If a cursor is set, it will be used when the pointer is in the window. If the cursor is **None**, it is equivalent to **XUndefineCursor**.

XDefineCursor can generate **BadCursor** and **BadWindow** errors.

To undefine the cursor in a given window, use **XUndefineCursor**.

```
XUndefineCursor(display, w)
    Display *display;
    Window w;
```

display	Specifies the connection to the X server.
w	Specifies the window.

The **XUndefineCursor** function undoes the effect of a previous **XDefineCursor** for this window. When the pointer is in the window, the parent's cursor will now be used. On the root window, the default cursor is restored.

XUndefineCursor can generate a **BadWindow** error.

Chapter 4

Window Information Functions

After you connect the display to the X server and create a window, you can use the Xlib window information functions to:

- Obtain information about a window
- Translate screen coordinates
- Manipulate property lists
- Obtain and change window properties
- Manipulate selections

4.1. Obtaining Window Information

Xlib provides functions that you can use to obtain information about the window tree, the window's current attributes, the window's current geometry, or the current pointer coordinates. Because they are most frequently used by window managers, these functions all return a status to indicate whether the window still exists.

To obtain the parent, a list of children, and number of children for a given window, use **XQueryTree**.

Status XQueryTree(*display*, *w*, *root_return*, *parent_return*, *children_return*, *nchildren_return*)
    Display **display*;
    Window *w*;
    Window **root_return*;
    Window **parent_return*;
    Window ***children_return*;
    unsigned int **nchildren_return*;

display	Specifies the connection to the X server.
w	Specifies the window whose list of children, root, parent, and number of children you want to obtain.
root_return	Returns the root window.
parent_return	Returns the parent window.
children_return	Returns the list of children.
nchildren_return	Returns the number of children.

The **XQueryTree** function returns the root ID, the parent window ID, a pointer to the list of children windows (NULL when there are no children), and the number of children in the list for the specified window. The children are listed in current stacking order, from bottommost (first) to topmost (last). **XQueryTree** returns zero if it fails and nonzero if it succeeds. To free a non-

NULL children list when it is no longer needed, use **XFree**.

XQueryTree can generate a **BadWindow** error.

To obtain the current attributes of a given window, use **XGetWindowAttributes**.

```
Status XGetWindowAttributes(display, w, window_attributes_return)
    Display *display;
    Window w;
    XWindowAttributes *window_attributes_return;
```

display	Specifies the connection to the X server.
w	Specifies the window whose current attributes you want to obtain.
window_attributes_return	Returns the specified window's attributes in the **XWindowAttributes** structure.

The **XGetWindowAttributes** function returns the current attributes for the specified window to an **XWindowAttributes** structure.

```
typedef struct {
        int x, y;                             /* location of window */
        int width, height;                    /* width and height of window */
        int border_width;                     /* border width of window */
        int depth;                            /* depth of window */
        Visual *visual;                       /* the associated visual structure */
        Window root;                          /* root of screen containing window */
        int class;                            /* InputOutput, InputOnly*/
        int bit_gravity;                      /* one of the bit gravity values */
        int win_gravity;                      /* one of the window gravity values */
        int backing_store;                    /* NotUseful, WhenMapped, Always */
        unsigned long backing_planes;         /* planes to be preserved if possible */
        unsigned long backing_pixel;          /* value to be used when restoring planes */
        Bool save_under;                      /* boolean, should bits under be saved? */
        Colormap colormap;                    /* color map to be associated with window */
        Bool map_installed;                   /* boolean, is color map currently installed*/
        int map_state;                        /* IsUnmapped, IsUnviewable, IsViewable */
        long all_event_masks;                 /* set of events all people have interest in*/
        long your_event_mask;                 /* my event mask */
        long do_not_propagate_mask;           /* set of events that should not propagate */
        Bool override_redirect;               /* boolean value for override-redirect */
        Screen *screen;                       /* back pointer to correct screen */
} XWindowAttributes;
```

The x and y members are set to the upper-left outer corner relative to the parent window's origin. The width and height members are set to the inside size of the window, not including the border. The border_width member is set to the window's border width in pixels. The depth member is set to the depth of the window (that is, bits per pixel for the object). The visual member is a pointer to the screen's associated **Visual** structure. The root member is set to the root window of the screen containing the window. The class member is set to the window's class and can be either **InputOutput** or **InputOnly**.

The bit_gravity member is set to the window's bit gravity and can be one of the following:

ForgetGravity
NorthWestGravity
NorthGravity
NorthEastGravity
WestGravity
CenterGravity
EastGravity
SouthWestGravity
SouthGravity
SouthEastGravity
StaticGravity

The win_gravity member is set to the window's window gravity and can be one of the following:

UnmapGravity
NorthWestGravity
NorthGravity
NorthEastGravity
WestGravity
CenterGravity
EastGravity
SouthWestGravity
SouthGravity
SouthEastGravity
StaticGravity

For additional information on gravity, see section 3.3.

The backing_store member is set to indicate how the X server should maintain the contents of a window and can be **WhenMapped**, **Always**, or **NotUseful**. The backing_planes member is set to indicate (with bits set to 1) which bit planes of the window hold dynamic data that must be preserved in backing_stores and during save_unders. The backing_pixel member is set to indicate what values to use for planes not set in backing_planes.

The save_under member is set to **True** or **False**. The colormap member is set to the colormap for the specified window and can be a colormap ID or **None**. The map_installed member is set to indicate whether the colormap is currently installed and can be **True** or **False**. The map_state member is set to indicate the state of the window and can be **IsUnmapped**, **IsUnviewable**, or **IsViewable**. **IsUnviewable** is used if the window is mapped but some ancestor is unmapped.

The all_event_masks member is set to the bitwise inclusive OR of all event masks selected on the window by all clients. The your_event_mask member is set to the bitwise inclusive OR of all event masks selected by the querying client. The do_not_propagate_mask member is set to the bitwise inclusive OR of the set of events that should not propagate.

The override_redirect member is set to indicate whether this window overrides structure control facilities and can be **True** or **False**. Window manager clients should ignore the window if this member is **True**.

The screen member is set to a screen pointer that gives you a back pointer to the correct screen. This makes it easier to obtain the screen information without having to loop over the root window fields to see which field matches.

XGetWindowAttributes can generate **BadDrawable** and **BadWindow** errors.

To obtain the current geometry of a given drawable, use **XGetGeometry**.

```
Status XGetGeometry(display, d, root_return, x_return, y_return, width_return,
              height_return, border_width_return, depth_return)
      Display *display;
      Drawable d;
      Window *root_return;
      int *x_return, *y_return;
      unsigned int *width_return, *height_return;
      unsigned int *border_width_return;
      unsigned int *depth_return;
```

display	Specifies the connection to the X server.
d	Specifies the drawable, which can be a window or a pixmap.
root_return	Returns the root window.
x_return *y_return*	Return the x and y coordinates that define the location of the drawable. For a window, these coordinates specify the upper-left outer corner relative to its parent's origin. For pixmaps, these coordinates are always zero.
width_return *height_return*	Return the drawable's dimensions (width and height). For a window, these dimensions specify the inside size, not including the border.
border_width_return	Returns the border width in pixels. If the drawable is a pixmap, it returns zero.
depth_return	Returns the depth of the drawable (bits per pixel for the object).

The **XGetGeometry** function returns the root window and the current geometry of the drawable. The geometry of the drawable includes the x and y coordinates, width and height, border width, and depth. These are described in the argument list. It is legal to pass to this function a window whose class is **InputOnly**.

XGetGeometry can generate a **BadDrawable** error.

4.2. Translating Screen Coordinates

Applications sometimes need to perform a coordinate transformation from the coordinate space of one window to another window or need to determine which window the pointing device is in. **XTranslateCoordinates** and **XQueryPointer** fulfill these needs (and avoid any race conditions) by asking the X server to perform these operations.

To translate a coordinate in one window to the coordinate space of another window, use **XTranslateCoordinates**.

```
Bool XTranslateCoordinates(display, src_w, dest_w, src_x, src_y, dest_x_return,
                          dest_y_return, child_return)
    Display *display;
    Window src_w, dest_w;
    int src_x, src_y;
    int *dest_x_return, *dest_y_return;
    Window *child_return;
```

display	Specifies the connection to the X server.
src_w	Specifies the source window.
dest_w	Specifies the destination window.
src_x	
src_y	Specify the x and y coordinates within the source window.
dest_x_return	
dest_y_return	Return the x and y coordinates within the destination window.
child_return	Returns the child if the coordinates are contained in a mapped child of the destination window.

If **XTranslateCoordinates** returns **True**, it takes the src_x and src_y coordinates relative to the source window's origin and returns these coordinates to dest_x_return and dest_y_return relative to the destination window's origin. If **XTranslateCoordinates** returns **False**, src_w and dest_w are on different screens, and dest_x_return and dest_y_return are zero. If the coordinates are contained in a mapped child of dest_w, that child is returned to child_return. Otherwise, child_return is set to **None**.

XTranslateCoordinates can generate a **BadWindow** error.

To obtain the screen coordinates of the pointer or to determine the pointer coordinates relative to a specified window, use **XQueryPointer**.

```
Bool XQueryPointer(display, w, root_return, child_return, root_x_return, root_y_return,
            win_x_return, win_y_return, mask_return)
    Display *display;
    Window w;
    Window *root_return, *child_return;
    int *root_x_return, *root_y_return;
    int *win_x_return, *win_y_return;
    unsigned int *mask_return;
```

display	Specifies the connection to the X server.
w	Specifies the window.
root_return	Returns the root window that the pointer is in.
child_return	Returns the child window that the pointer is located in, if any.
root_x_return *root_y_return*	Return the pointer coordinates relative to the root window's origin.
win_x_return *win_y_return*	Return the pointer coordinates relative to the specified window.
mask_return	Returns the current state of the modifier keys and pointer buttons.

The **XQueryPointer** function returns the root window the pointer is logically on and the pointer coordinates relative to the root window's origin. If **XQueryPointer** returns **False**, the pointer is not on the same screen as the specified window, and **XQueryPointer** returns **None** to child_return and zero to win_x_return and win_y_return. If **XQueryPointer** returns **True**, the pointer coordinates returned to win_x_return and win_y_return are relative to the origin of the specified window. In this case, **XQueryPointer** returns the child that contains the pointer, if any, or else **None** to child_return.

XQueryPointer returns the current logical state of the keyboard buttons and the modifier keys in mask_return. It sets mask_return to the bitwise inclusive OR of one or more of the button or modifier key bitmasks to match the current state of the mouse buttons and the modifier keys.

Note that the logical state of a device (as seen through Xlib) may lag the physical state if device event processing is frozen (see section 12.1).

XQueryPointer can generate a **BadWindow** error.

4.3. Properties and Atoms

A property is a collection of named, typed data. The window system has a set of predefined properties (for example, the name of a window, size hints, and so on), and users can define any other arbitrary information and associate it with windows. Each property has a name, which is an ISO Latin-1 string. For each named property, a unique identifier (atom) is associated with it. A property also has a type, for example, string or integer. These types are also indicated using atoms, so arbitrary new types can be defined. Data of only one type may be associated with a single property name. Clients can store and retrieve properties associated with windows. For efficiency reasons, an atom is used rather than a character string. **XInternAtom** can be used to obtain the atom for property names.

A property is also stored in one of several possible formats. The X server can store the information as 8-bit quantities, 16-bit quantities, or 32-bit quantities. This permits the X server to present the data in the byte order that the client expects.

Note

> If you define further properties of complex type, you must encode and decode them yourself. These functions must be carefully written if they are to be portable. For further information about how to write a library extension, see appendix C.

The type of a property is defined by an atom, which allows for arbitrary extension in this type scheme.

Certain property names are predefined in the server for commonly used functions. The atoms for these properties are defined in **<X11/Xatom.h>**. To avoid name clashes with user symbols, the **#define** name for each atom has the XA_ prefix. For definitions of these properties, see section 4.3. For an explanation of the functions that let you get and set much of the information stored in these predefined properties, see chapter 14.

The core protocol imposes no semantics on these property names, but semantics are specified in other X Consortium standards, such as the *Inter-Client Communication Conventions Manual* and the *X Logical Font Description Conventions*.

You can use properties to communicate other information between applications. The functions described in this section let you define new properties and get the unique atom IDs in your applications.

Although any particular atom can have some client interpretation within each of the name spaces, atoms occur in five distinct name spaces within the protocol:

- Selections
- Property names
- Property types
- Font properties
- Type of a **ClientMessage** event (none are built into the X server)

The built-in selection property names are:

PRIMARY
SECONDARY

The built-in property names are:

CUT_BUFFER0
CUT_BUFFER1
CUT_BUFFER2
CUT_BUFFER3
CUT_BUFFER4
CUT_BUFFER5
CUT_BUFFER6
CUT_BUFFER7
RGB_BEST_MAP
RGB_BLUE_MAP
RGB_DEFAULT_MAP
RGB_GRAY_MAP
RGB_GREEN_MAP
RGB_RED_MAP
RESOURCE_MANAGER
WM_CLASS
WM_CLIENT_MACHINE
WM_COLORMAP_WINDOWS
WM_COMMAND
WM_HINTS
WM_ICON_NAME
WM_ICON_SIZE
WM_NAME
WM_NORMAL_HINTS
WM_PROTOCOLS
WM_STATE
WM_TRANSIENT_FOR
WM_ZOOM_HINTS

The built-in property types are:

ARC
ATOM
BITMAP
CARDINAL
COLORMAP
CURSOR
DRAWABLE
FONT
INTEGER
PIXMAP
POINT
RGB_COLOR_MAP
RECTANGLE
STRING
VISUALID
WINDOW
WM_HINTS
WM_SIZE_HINTS

The built-in font property names are:

MIN_SPACE
NORM_SPACE
MAX_SPACE
END_SPACE
SUPERSCRIPT_X
SUPERSCRIPT_Y
SUBSCRIPT_X
SUBSCRIPT_Y
UNDERLINE_POSITION
UNDERLINE_THICKNESS
FONT_NAME
FULL_NAME
STRIKEOUT_DESCENT
STRIKEOUT_ASCENT
ITALIC_ANGLE
X_HEIGHT
QUAD_WIDTH
WEIGHT
POINT_SIZE
RESOLUTION
COPYRIGHT
NOTICE
FAMILY_NAME
CAP_HEIGHT

For further information about font properties, see section 8.5.

To return an atom for a given name, use **XInternAtom**.

```
Atom XInternAtom(display, atom_name, only_if_exists)
    Display *display;
    char *atom_name;
    Bool only_if_exists;
```

display	Specifies the connection to the X server.
atom_name	Specifies the name associated with the atom you want returned.
only_if_exists	Specifies a Boolean value that indicates whether the atom must be created.

The **XInternAtom** function returns the atom identifier associated with the specified atom_name string. If only_if_exists is **False**, the atom is created if it does not exist. Therefore, **XInternAtom** can return **None**. If the atom name is not in the Host Portable Character Encoding, the result is implementation dependent. Uppercase and lowercase matter; the strings ‘‘thing’’, ‘‘Thing’’, and ‘‘thinG’’ all designate different atoms. The atom will remain defined even after the client’s connection closes. It will become undefined only when the last connection to the X server closes.

XInternAtom can generate **BadAlloc** and **BadValue** errors.

To return atoms for an array of names, use **XInternAtoms**.

```
Status XInternAtoms(display, names, count, only_if_exists, atoms_return)
      Display *display;
      char **names;
      int count;
      Bool only_if_exists;
      Atom *atoms_return;
```

display	Specifies the connection to the X server.
names	Specifies the array of atom names.
count	Specifies the number of atom names in the array.
only_if_exists	Specifies a Boolean value that indicates whether the atom must be created.
atoms_return	Returns the atoms.

The **XInternAtoms** function returns the atom identifiers associated with the specified names. The atoms are stored in the atoms_return array supplied by the caller. Calling this function is equivalent to calling **XInternAtom** for each of the names in turn with the specified value of only_if_exists, but this function minimizes the number of round trip protocol exchanges between the client and the X server.

This function returns a nonzero status if atoms are returned for all of the names; otherwise, it returns zero.

XInternAtoms can generate **BadAlloc** and **BadValue** errors.

To return a name for a given atom identifier, use **XGetAtomName**.

```
char *XGetAtomName(display, atom)
      Display *display;
      Atom atom;
```

display	Specifies the connection to the X server.
atom	Specifies the atom for the property name you want returned.

The **XGetAtomName** function returns the name associated with the specified atom. If the data returned by the server is in the Latin Portable Character Encoding, then the returned string is in the Host Portable Character Encoding. Otherwise, the result is implementation dependent. To free the resulting string, call **XFree**.

XGetAtomName can generate a **BadAtom** error.

To return the names for an array of atom identifiers, use **XGetAtomNames**.

```
Status XGetAtomNames(display, atoms, count, names_return)
      Display *display;
      Atom *atoms;
      int count;
      char **names_return;
```

display	Specifies the connection to the X server.
atoms	Specifies the array of atoms.
count	Specifies the number of atoms in the array.
names_return	Returns the atom names.

The **XGetAtomNames** function returns the names associated with the specified atoms. The names are stored in the names_return array supplied by the caller. Calling this function is equivalent to calling **XGetAtomName** for each of the atoms in turn, but this function minimizes the number of round trip protocol exchanges between the client and the X server.

This function returns a nonzero status if names are returned for all of the atoms; otherwise, it returns zero.

XGetAtomNames can generate a **BadAtom** error.

4.4. Obtaining and Changing Window Properties

You can attach a property list to every window. Each property has a name, a type, and a value (see section 4.3). The value is an array of 8-bit, 16-bit, or 32-bit quantities, whose interpretation is left to the clients. The type **char** is used to represent 8-bit quantities, the type **short** is used to represent 16-bit quantities, and the type **long** is used to represent 32-bit quantities.

Xlib provides functions that you can use to obtain, change, update, or interchange window properties. In addition, Xlib provides other utility functions for inter-client communication (see chapter 14).

To obtain the type, format, and value of a property of a given window, use **XGetWindowProperty**.

```
int XGetWindowProperty(display, w, property, long_offset, long_length, delete, req_type,
                       actual_type_return, actual_format_return, nitems_return, bytes_after_return,
                       prop_return)
      Display *display;
      Window w;
      Atom property;
      long long_offset, long_length;
      Bool delete;
      Atom req_type;
      Atom *actual_type_return;
      int *actual_format_return;
      unsigned long *nitems_return;
      unsigned long *bytes_after_return;
      unsigned char **prop_return;
```

display	Specifies the connection to the X server.
w	Specifies the window whose property you want to obtain.
property	Specifies the property name.
long_offset	Specifies the offset in the specified property (in 32-bit quantities) where the data is to be retrieved.
long_length	Specifies the length in 32-bit multiples of the data to be retrieved.
delete	Specifies a Boolean value that determines whether the property is deleted.
req_type	Specifies the atom identifier associated with the property type or **AnyPropertyType**.
actual_type_return	Returns the atom identifier that defines the actual type of the property.
actual_format_return	Returns the actual format of the property.
nitems_return	Returns the actual number of 8-bit, 16-bit, or 32-bit items stored in the prop_return data.
bytes_after_return	Returns the number of bytes remaining to be read in the property if a partial read was performed.
prop_return	Returns the data in the specified format.

The **XGetWindowProperty** function returns the actual type of the property; the actual format of the property; the number of 8-bit, 16-bit, or 32-bit items transferred; the number of bytes remaining to be read in the property; and a pointer to the data actually returned. **XGetWindowProperty** sets the return arguments as follows:

- If the specified property does not exist for the specified window, **XGetWindowProperty** returns **None** to actual_type_return and the value zero to actual_format_return and bytes_after_return. The nitems_return argument is empty. In this case, the delete argument is ignored.
- If the specified property exists but its type does not match the specified type, **XGetWindowProperty** returns the actual property type to actual_type_return, the actual property format (never zero) to actual_format_return, and the property length in bytes (even if the

actual_format_return is 16 or 32) to bytes_after_return. It also ignores the delete argument. The nitems_return argument is empty.

- If the specified property exists and either you assign **AnyPropertyType** to the req_type argument or the specified type matches the actual property type, **XGetWindowProperty** returns the actual property type to actual_type_return and the actual property format (never zero) to actual_format_return. It also returns a value to bytes_after_return and nitems_return, by defining the following values:

  N = actual length of the stored property in bytes
  (even if the format is 16 or 32)
  I = 4 * long_offset
  T = N - I
  L = MINIMUM(T, 4 * long_length)
  A = N - (I + L)

  The returned value starts at byte index I in the property (indexing from zero), and its length in bytes is L. If the value for long_offset causes L to be negative, a **BadValue** error results. The value of bytes_after_return is A, giving the number of trailing unread bytes in the stored property.

If the returned format is 8, the returned data is represented as a **char** array. If the returned format is 16, the returned data is represented as a **short** array and should be cast to that type to obtain the elements. If the returned format is 32, the returned data is represented as a **long** array and should be cast to that type to obtain the elements.

XGetWindowProperty always allocates one extra byte in prop_return (even if the property is zero length) and sets it to zero so that simple properties consisting of characters do not have to be copied into yet another string before use.

If delete is **True** and bytes_after_return is zero, **XGetWindowProperty** deletes the property from the window and generates a **PropertyNotify** event on the window.

The function returns **Success** if it executes successfully. To free the resulting data, use **XFree**.

XGetWindowProperty can generate **BadAtom**, **BadValue**, and **BadWindow** errors.

To obtain a given window's property list, use **XListProperties**.

Atom *XListProperties(*display*, *w*, *num_prop_return*)
    Display **display*;
    Window *w*;
    int **num_prop_return*;

display	Specifies the connection to the X server.
w	Specifies the window whose property list you want to obtain.
num_prop_return	Returns the length of the properties array.

The **XListProperties** function returns a pointer to an array of atom properties that are defined for the specified window or returns NULL if no properties were found. To free the memory allocated by this function, use **XFree**.

XListProperties can generate a **BadWindow** error.

To change a property of a given window, use **XChangeProperty**.

XChangeProperty(*display*, *w*, *property*, *type*, *format*, *mode*, *data*, *nelements*)
  Display **display*;
  Window *w*;
  Atom *property*, *type*;
  int *format*;
  int *mode*;
  unsigned char **data*;
  int *nelements*;

display	Specifies the connection to the X server.
w	Specifies the window whose property you want to change.
property	Specifies the property name.
type	Specifies the type of the property. The X server does not interpret the type but simply passes it back to an application that later calls **XGetWindowProperty**.
format	Specifies whether the data should be viewed as a list of 8-bit, 16-bit, or 32-bit quantities. Possible values are 8, 16, and 32. This information allows the X server to correctly perform byte-swap operations as necessary. If the format is 16-bit or 32-bit, you must explicitly cast your data pointer to an (unsigned char *) in the call to **XChangeProperty**.
mode	Specifies the mode of the operation. You can pass **PropModeReplace**, **PropModePrepend**, or **PropModeAppend**.
data	Specifies the property data.
nelements	Specifies the number of elements of the specified data format.

The **XChangeProperty** function alters the property for the specified window and causes the X server to generate a **PropertyNotify** event on that window. **XChangeProperty** performs the following:

- If mode is **PropModeReplace**, **XChangeProperty** discards the previous property value and stores the new data.
- If mode is **PropModePrepend** or **PropModeAppend**, **XChangeProperty** inserts the specified data before the beginning of the existing data or onto the end of the existing data, respectively. The type and format must match the existing property value, or a **BadMatch** error results. If the property is undefined, it is treated as defined with the correct type and format with zero-length data.

If the specified format is 8, the property data must be a **char** array. If the specified format is 16, the property data must be a **short** array. If the specified format is 32, the property data must be a **long** array.

The lifetime of a property is not tied to the storing client. Properties remain until explicitly deleted, until the window is destroyed, or until the server resets. For a discussion of what happens when the connection to the X server is closed, see section 2.6. The maximum size of a property is server dependent and can vary dynamically depending on the amount of memory the server has available. (If there is insufficient space, a **BadAlloc** error results.)

XChangeProperty can generate **BadAlloc**, **BadAtom**, **BadMatch**, **BadValue**, and **BadWindow** errors.

To rotate a window's property list, use **XRotateWindowProperties**.

```
XRotateWindowProperties(display, w, properties, num_prop, npositions)
      Display *display;
      Window w;
      Atom properties[];
      int num_prop;
      int npositions;
```

display	Specifies the connection to the X server.
w	Specifies the window.
properties	Specifies the array of properties that are to be rotated.
num_prop	Specifies the length of the properties array.
npositions	Specifies the rotation amount.

The **XRotateWindowProperties** function allows you to rotate properties on a window and causes the X server to generate **PropertyNotify** events. If the property names in the properties array are viewed as being numbered starting from zero and if there are num_prop property names in the list, then the value associated with property name I becomes the value associated with property name (I + npositions) mod N for all I from zero to N − 1. The effect is to rotate the states by npositions places around the virtual ring of property names (right for positive npositions, left for negative npositions). If npositions mod N is nonzero, the X server generates a **PropertyNotify** event for each property in the order that they are listed in the array. If an atom occurs more than once in the list or no property with that name is defined for the window, a **BadMatch** error results. If a **BadAtom** or **BadMatch** error results, no properties are changed.

XRotateWindowProperties can generate **BadAtom**, **BadMatch**, and **BadWindow** errors.

To delete a property on a given window, use **XDeleteProperty**.

```
XDeleteProperty(display, w, property)
      Display *display;
      Window w;
      Atom property;
```

display	Specifies the connection to the X server.
w	Specifies the window whose property you want to delete.
property	Specifies the property name.

The **XDeleteProperty** function deletes the specified property only if the property was defined on the specified window and causes the X server to generate a **PropertyNotify** event on the window unless the property does not exist.

XDeleteProperty can generate **BadAtom** and **BadWindow** errors.

4.5. Selections

Selections are one method used by applications to exchange data. By using the property mechanism, applications can exchange data of arbitrary types and can negotiate the type of the data. A selection can be thought of as an indirect property with a dynamic type. That is, rather than having the property stored in the X server, the property is maintained by some client (the owner). A selection is global in nature (considered to belong to the user but be maintained by clients) rather than being private to a particular window subhierarchy or a particular set of clients.

Xlib provides functions that you can use to set, get, or request conversion of selections. This allows applications to implement the notion of current selection, which requires that notification be sent to applications when they no longer own the selection. Applications that support selection often highlight the current selection and so must be informed when another application has acquired the selection so that they can unhighlight the selection.

When a client asks for the contents of a selection, it specifies a selection target type. This target type can be used to control the transmitted representation of the contents. For example, if the selection is ‘‘the last thing the user clicked on’’ and that is currently an image, then the target type might specify whether the contents of the image should be sent in XY format or Z format.

The target type can also be used to control the class of contents transmitted, for example, asking for the ‘‘looks’’ (fonts, line spacing, indentation, and so forth) of a paragraph selection, not the text of the paragraph. The target type can also be used for other purposes. The protocol does not constrain the semantics.

To set the selection owner, use **XSetSelectionOwner**.

```
XSetSelectionOwner(display, selection, owner, time)
    Display *display;
    Atom selection;
    Window owner;
    Time time;
```

display	Specifies the connection to the X server.
selection	Specifies the selection atom.
owner	Specifies the owner of the specified selection atom. You can pass a window or **None**.
time	Specifies the time. You can pass either a timestamp or **CurrentTime**.

The **XSetSelectionOwner** function changes the owner and last-change time for the specified selection and has no effect if the specified time is earlier than the current last-change time of the specified selection or is later than the current X server time. Otherwise, the last-change time is set to the specified time, with **CurrentTime** replaced by the current server time. If the owner window is specified as **None**, then the owner of the selection becomes **None** (that is, no owner). Otherwise, the owner of the selection becomes the client executing the request.

If the new owner (whether a client or **None**) is not the same as the current owner of the selection and the current owner is not **None**, the current owner is sent a **SelectionClear** event. If the client that is the owner of a selection is later terminated (that is, its connection is closed) or if the owner window it has specified in the request is later destroyed, the owner of the selection automatically reverts to **None**, but the last-change time is not affected. The selection atom is uninterpreted by the X server. **XGetSelectionOwner** returns the owner window, which is reported in **SelectionRequest** and **SelectionClear** events. Selections are global to the X server.

XSetSelectionOwner can generate **BadAtom** and **BadWindow** errors.

To return the selection owner, use **XGetSelectionOwner**.

```
Window XGetSelectionOwner(display, selection)
      Display *display;
      Atom selection;
```

display	Specifies the connection to the X server.
selection	Specifies the selection atom whose owner you want returned.

The **XGetSelectionOwner** function returns the window ID associated with the window that currently owns the specified selection. If no selection was specified, the function returns the constant **None**. If **None** is returned, there is no owner for the selection.

XGetSelectionOwner can generate a **BadAtom** error.

To request conversion of a selection, use **XConvertSelection**.

```
XConvertSelection(display, selection, target, property, requestor, time)
      Display *display;
      Atom selection, target;
      Atom property;
      Window requestor;
      Time time;
```

display	Specifies the connection to the X server.
selection	Specifies the selection atom.
target	Specifies the target atom.
property	Specifies the property name. You also can pass **None**.
requestor	Specifies the requestor.
time	Specifies the time. You can pass either a timestamp or **CurrentTime**.

XConvertSelection requests that the specified selection be converted to the specified target type:

- If the specified selection has an owner, the X server sends a **SelectionRequest** event to that owner.
- If no owner for the specified selection exists, the X server generates a **SelectionNotify** event to the requestor with property **None**.

The arguments are passed on unchanged in either of the events. There are two predefined selection atoms: PRIMARY and SECONDARY.

XConvertSelection can generate **BadAtom** and **BadWindow** errors.

Chapter 5

Pixmap and Cursor Functions

Once you have connected to an X server, you can use the Xlib functions to:

- Create and free pixmaps
- Create, recolor, and free cursors

5.1. Creating and Freeing Pixmaps

Pixmaps can only be used on the screen on which they were created. Pixmaps are off-screen resources that are used for various operations, for example, defining cursors as tiling patterns or as the source for certain raster operations. Most graphics requests can operate either on a window or on a pixmap. A bitmap is a single bit-plane pixmap.

To create a pixmap of a given size, use **XCreatePixmap**.

```
Pixmap XCreatePixmap(display, d, width, height, depth)
      Display *display;
      Drawable d;
      unsigned int width, height;
      unsigned int depth;
```

display	Specifies the connection to the X server.
d	Specifies which screen the pixmap is created on.
width *height*	Specify the width and height, which define the dimensions of the pixmap.
depth	Specifies the depth of the pixmap.

The **XCreatePixmap** function creates a pixmap of the width, height, and depth you specified and returns a pixmap ID that identifies it. It is valid to pass an **InputOnly** window to the drawable argument. The width and height arguments must be nonzero, or a **BadValue** error results. The depth argument must be one of the depths supported by the screen of the specified drawable, or a **BadValue** error results.

The server uses the specified drawable to determine on which screen to create the pixmap. The pixmap can be used only on this screen and only with other drawables of the same depth (see **XCopyPlane** for an exception to this rule). The initial contents of the pixmap are undefined.

XCreatePixmap can generate **BadAlloc**, **BadDrawable**, and **BadValue** errors.

To free all storage associated with a specified pixmap, use **XFreePixmap**.

XFreePixmap(*display*, *pixmap*)
    Display **display*;
    Pixmap *pixmap*;

display	Specifies the connection to the X server.
pixmap	Specifies the pixmap.

The **XFreePixmap** function first deletes the association between the pixmap ID and the pixmap. Then, the X server frees the pixmap storage when there are no references to it. The pixmap should never be referenced again.

XFreePixmap can generate a **BadPixmap** error.

5.2. Creating, Recoloring, and Freeing Cursors

Each window can have a different cursor defined for it. Whenever the pointer is in a visible window, it is set to the cursor defined for that window. If no cursor was defined for that window, the cursor is the one defined for the parent window.

From X's perspective, a cursor consists of a cursor source, mask, colors, and a hotspot. The mask pixmap determines the shape of the cursor and must be a depth of one. The source pixmap must have a depth of one, and the colors determine the colors of the source. The hotspot defines the point on the cursor that is reported when a pointer event occurs. There may be limitations imposed by the hardware on cursors as to size and whether a mask is implemented. **XQueryBestCursor** can be used to find out what sizes are possible. There is a standard font for creating cursors, but Xlib provides functions that you can use to create cursors from an arbitrary font or from bitmaps.

To create a cursor from the standard cursor font, use **XCreateFontCursor**.

#include <X11/cursorfont.h>

Cursor XCreateFontCursor(*display*, *shape*)
    Display **display*;
    unsigned int *shape*;

display	Specifies the connection to the X server.
shape	Specifies the shape of the cursor.

X provides a set of standard cursor shapes in a special font named cursor. Applications are encouraged to use this interface for their cursors because the font can be customized for the individual display type. The shape argument specifies which glyph of the standard fonts to use.

The hotspot comes from the information stored in the cursor font. The initial colors of a cursor are a black foreground and a white background (see **XRecolorCursor**). For further information about cursor shapes, see appendix B.

XCreateFontCursor can generate **BadAlloc** and **BadValue** errors.

To create a cursor from font glyphs, use **XCreateGlyphCursor**.

```
Cursor XCreateGlyphCursor(display, source_font, mask_font, source_char, mask_char,
                          foreground_color, background_color)
      Display *display;
      Font source_font, mask_font;
      unsigned int source_char, mask_char;
      XColor *foreground_color;
      XColor *background_color;
```

display	Specifies the connection to the X server.
source_font	Specifies the font for the source glyph.
mask_font	Specifies the font for the mask glyph or **None**.
source_char	Specifies the character glyph for the source.
mask_char	Specifies the glyph character for the mask.
foreground_color	Specifies the RGB values for the foreground of the source.
background_color	Specifies the RGB values for the background of the source.

The **XCreateGlyphCursor** function is similar to **XCreatePixmapCursor** except that the source and mask bitmaps are obtained from the specified font glyphs. The source_char must be a defined glyph in source_font, or a **BadValue** error results. If mask_font is given, mask_char must be a defined glyph in mask_font, or a **BadValue** error results. The mask_font and character are optional. The origins of the source_char and mask_char (if defined) glyphs are positioned coincidently and define the hotspot. The source_char and mask_char need not have the same bounding box metrics, and there is no restriction on the placement of the hotspot relative to the bounding boxes. If no mask_char is given, all pixels of the source are displayed. You can free the fonts immediately by calling **XFreeFont** if no further explicit references to them are to be made.

For 2-byte matrix fonts, the 16-bit value should be formed with the byte1 member in the most-significant byte and the byte2 member in the least-significant byte.

XCreateGlyphCursor can generate **BadAlloc**, **BadFont**, and **BadValue** errors.

To create a cursor from two bitmaps, use **XCreatePixmapCursor**.

Cursor XCreatePixmapCursor(*display*, *source*, *mask*, *foreground_color*, *background_color*, *x*, *y*)
Display **display*;
Pixmap *source*;
Pixmap *mask*;
XColor **foreground_color*;
XColor **background_color*;
unsigned int *x*, *y*;

display	Specifies the connection to the X server.
source	Specifies the shape of the source cursor.
mask	Specifies the cursor's source bits to be displayed or **None**.
foreground_color	Specifies the RGB values for the foreground of the source.
background_color	Specifies the RGB values for the background of the source.
x	
y	Specify the x and y coordinates, which indicate the hotspot relative to the source's origin.

The **XCreatePixmapCursor** function creates a cursor and returns the cursor ID associated with it. The foreground and background RGB values must be specified using foreground_color and background_color, even if the X server only has a **StaticGray** or **GrayScale** screen. The foreground color is used for the pixels set to 1 in the source, and the background color is used for the pixels set to 0. Both source and mask, if specified, must have depth one (or a **BadMatch** error results) but can have any root. The mask argument defines the shape of the cursor. The pixels set to 1 in the mask define which source pixels are displayed, and the pixels set to 0 define which pixels are ignored. If no mask is given, all pixels of the source are displayed. The mask, if present, must be the same size as the pixmap defined by the source argument, or a **BadMatch** error results. The hotspot must be a point within the source, or a **BadMatch** error results.

The components of the cursor can be transformed arbitrarily to meet display limitations. The pixmaps can be freed immediately if no further explicit references to them are to be made. Subsequent drawing in the source or mask pixmap has an undefined effect on the cursor. The X server might or might not make a copy of the pixmap.

XCreatePixmapCursor can generate **BadAlloc** and **BadPixmap** errors.

To determine useful cursor sizes, use **XQueryBestCursor**.

```
Status XQueryBestCursor(display, d, width, height, width_return, height_return)
      Display *display;
      Drawable d;
      unsigned int width, height;
      unsigned int *width_return, *height_return;
```

display	Specifies the connection to the X server.
d	Specifies the drawable, which indicates the screen.
width *height*	Specify the width and height of the cursor that you want the size information for.
width_return *height_return*	Return the best width and height that is closest to the specified width and height.

Some displays allow larger cursors than other displays. The **XQueryBestCursor** function provides a way to find out what size cursors are actually possible on the display. It returns the largest size that can be displayed. Applications should be prepared to use smaller cursors on displays that cannot support large ones.

XQueryBestCursor can generate a **BadDrawable** error.

To change the color of a given cursor, use **XRecolorCursor**.

```
XRecolorCursor(display, cursor, foreground_color, background_color)
      Display *display;
      Cursor cursor;
      XColor *foreground_color, *background_color;
```

display	Specifies the connection to the X server.
cursor	Specifies the cursor.
foreground_color	Specifies the RGB values for the foreground of the source.
background_color	Specifies the RGB values for the background of the source.

The **XRecolorCursor** function changes the color of the specified cursor, and if the cursor is being displayed on a screen, the change is visible immediately. The pixel members of the **XColor** structures are ignored; only the RGB values are used.

XRecolorCursor can generate a **BadCursor** error.

To free (destroy) a given cursor, use **XFreeCursor**.

XFreeCursor(*display*, *cursor*)
  Display **display*;
  Cursor *cursor*;

display	Specifies the connection to the X server.
cursor	Specifies the cursor.

The **XFreeCursor** function deletes the association between the cursor resource ID and the specified cursor. The cursor storage is freed when no other resource references it. The specified cursor ID should not be referred to again.

XFreeCursor can generate a **BadCursor** error.

Chapter 6

Color Management Functions

Each X window always has an associated colormap that provides a level of indirection between pixel values and colors displayed on the screen. Xlib provides functions that you can use to manipulate a colormap. The X protocol defines colors using values in the RGB color space. The RGB color space is device-dependent; rendering an RGB value on differing output devices typically results in different colors. Xlib also provides a means for clients to specify color using device-independent color spaces for consistent results across devices. Xlib supports device-independent color spaces derivable from the CIE XYZ color space. This includes the CIE XYZ, xyY, L*u*v*, and L*a*b* color spaces as well as the TekHVC color space.

This chapter discusses how to:

- Create, copy, and destroy a colormap
- Specify colors by name or value
- Allocate, modify, and free color cells
- Read entries in a colormap
- Convert between color spaces
- Control aspects of color conversion
- Query the color gamut of a screen
- Add new color spaces

All functions, types, and symbols in this chapter with the prefix ‘‘Xcms’’ are defined in **<X11/Xcms.h>**. The remaining functions and types are defined in **<X11/Xlib.h>**.

Functions in this chapter manipulate the representation of color on the screen. For each possible value that a pixel can take in a window, there is a color cell in the colormap. For example, if a window is four bits deep, pixel values 0 through 15 are defined. A colormap is a collection of color cells. A color cell consists of a triple of red, green, and blue values. The hardware imposes limits on the number of significant bits in these values. As each pixel is read out of display memory, the pixel is looked up in a colormap. The RGB value of the cell determines what color is displayed on the screen. On a grayscale display with a black-and-white monitor, the values are combined to determine the brightness on the screen.

Typically, an application allocates color cells or sets of color cells to obtain the desired colors. The client can allocate read-only cells. In which case, the pixel values for these colors can be shared among multiple applications, and the RGB value of the cell cannot be changed. If the client allocates read/write cells, they are exclusively owned by the client, and the color associated with the pixel value can be changed at will. Cells must be allocated (and, if read/write, initialized with an RGB value) by a client to obtain desired colors. The use of pixel value for an unallocated cell results in an undefined color.

Because colormaps are associated with windows, X supports displays with multiple colormaps and, indeed, different types of colormaps. If there are insufficient colormap resources in the display, some windows will display in their true colors, and others will display with incorrect colors. A window manager usually controls which windows are displayed in their true colors if more than one colormap is required for the color resources the applications are using. At any time, there is a set of installed colormaps for a screen. Windows using one of the installed colormaps display with true colors, and windows using other colormaps generally display with incorrect colors. You can control the set of installed colormaps by using **XInstallColormap** and **XUninstallColormap**.

Colormaps are local to a particular screen. Screens always have a default colormap, and programs typically allocate cells out of this colormap. Generally, you should not write applications that monopolize color resources. Although some hardware supports multiple colormaps installed at one time, many of the hardware displays built today support only a single installed colormap, so the primitives are written to encourage sharing of colormap entries between applications.

The **DefaultColormap** macro returns the default colormap. The **DefaultVisual** macro returns the default visual type for the specified screen. Possible visual types are **StaticGray**, **GrayScale**, **StaticColor**, **PseudoColor**, **TrueColor**, or **DirectColor** (see section 3.1).

6.1. Color Structures

Functions that operate only on RGB color space values use an **XColor** structure, which contains:

```
typedef struct {
        unsigned long pixel;                /* pixel value */
        unsigned short red, green, blue;    /* rgb values */
        char flags;                         /* DoRed, DoGreen, DoBlue */
        char pad;
} XColor;
```

The red, green, and blue values are always in the range 0 to 65535 inclusive, independent of the number of bits actually used in the display hardware. The server scales these values down to the range used by the hardware. Black is represented by (0,0,0), and white is represented by (65535,65535,65535). In some functions, the flags member controls which of the red, green, and blue members is used and can be the inclusive OR of zero or more of **DoRed**, **DoGreen**, and **DoBlue**.

Functions that operate on all color space values use an **XcmsColor** structure. This structure contains a union of substructures, each supporting color specification encoding for a particular color space. Like the **XColor** structure, the **XcmsColor** structure contains pixel and color specification information (the spec member in the **XcmsColor** structure).

```
typedef unsigned long XcmsColorFormat;/* Color Specification Format */

typedef struct {
        union {
                XcmsRGB RGB;
                XcmsRGBi RGBi;
                XcmsCIEXYZ CIEXYZ;
                XcmsCIEuvY CIEuvY;
                XcmsCIExyY CIExyY;
                XcmsCIELab CIELab;
                XcmsCIELuv CIELuv;
                XcmsTekHVC TekHVC;
                XcmsPad Pad;
        } spec;
        unsigned long pixel;
        XcmsColorFormat format;
} XcmsColor;                         /* Xcms Color Structure */
```

Because the color specification can be encoded for the various color spaces, encoding for the spec member is identified by the format member, which is of type **XcmsColorFormat**. The following macros define standard formats.

```
#define    XcmsUndefinedFormat    0x00000000
#define    XcmsCIEXYZFormat       0x00000001        /* CIE XYZ */
#define    XcmsCIEuvYFormat       0x00000002        /* CIE u'v'Y */
#define    XcmsCIExyYFormat       0x00000003        /* CIE xyY */
#define    XcmsCIELabFormat       0x00000004        /* CIE L*a*b* */
#define    XcmsCIELuvFormat       0x00000005        /* CIE L*u*v* */
#define    XcmsTekHVCFormat       0x00000006        /* TekHVC */
#define    XcmsRGBFormat          0x80000000        /* RGB Device */
#define    XcmsRGBiFormat         0x80000001        /* RGB Intensity */
```

Formats for device-independent color spaces are distinguishable from those for device-dependent spaces by the 32nd bit. If this bit is set, it indicates that the color specification is in a device-dependent form; otherwise, it is in a device-independent form. If the 31st bit is set, this indicates that the color space has been added to Xlib at run time (see section 6.12.4). The format value for a color space added at run time may be different each time the program is executed. If references to such a color space must be made outside the client (for example, storing a color specification in a file), then reference should be made by color space string prefix (see **XcmsFormatOfPrefix** and **XcmsPrefixOfFormat**).

Data types that describe the color specification encoding for the various color spaces are defined as follows:

```
typedef double XcmsFloat;

typedef struct {
        unsigned short red;           /* 0x0000 to 0xffff */
        unsigned short green;         /* 0x0000 to 0xffff */
        unsigned short blue;          /* 0x0000 to 0xffff */
} XcmsRGB;                            /* RGB Device */

typedef struct {
        XcmsFloat red;                /* 0.0 to 1.0 */
        XcmsFloat green;              /* 0.0 to 1.0 */
        XcmsFloat blue;               /* 0.0 to 1.0 */
} XcmsRGBi;                           /* RGB Intensity */

typedef struct {
        XcmsFloat X;
        XcmsFloat Y;                  /* 0.0 to 1.0 */
        XcmsFloat Z;
} XcmsCIEXYZ;                         /* CIE XYZ */

typedef struct {
        XcmsFloat u_prime;            /* 0.0 to ~0.6 */
        XcmsFloat v_prime;            /* 0.0 to ~0.6 */
        XcmsFloat Y;                  /* 0.0 to 1.0 */
} XcmsCIEuvY;                         /* CIE u'v'Y */

typedef struct {
        XcmsFloat x;                  /* 0.0 to ~.75 */
        XcmsFloat y;                  /* 0.0 to ~.85 */
        XcmsFloat Y;                  /* 0.0 to 1.0 */
} XcmsCIExyY;                         /* CIE xyY */

typedef struct {
        XcmsFloat L_star;             /* 0.0 to 100.0 */
        XcmsFloat a_star;
        XcmsFloat b_star;
} XcmsCIELab;                         /* CIE L*a*b* */

typedef struct {
        XcmsFloat L_star;             /* 0.0 to 100.0 */
        XcmsFloat u_star;
        XcmsFloat v_star;
} XcmsCIELuv;                         /* CIE L*u*v* */

typedef struct {
        XcmsFloat H;                  /* 0.0 to 360.0 */
        XcmsFloat V;                  /* 0.0 to 100.0 */
```

```
        XcmsFloat C;                    /* 0.0 to 100.0 */
} XcmsTekHVC;                           /* TekHVC */


typedef struct {
        XcmsFloat pad0;
        XcmsFloat pad1;
        XcmsFloat pad2;
        XcmsFloat pad3;
} XcmsPad;                              /* four doubles */
```

The device-dependent formats provided allow color specification in:

- RGB Intensity (**XcmsRGBi**)

  Red, green, and blue linear intensity values, floating-point values from 0.0 to 1.0, where 1.0 indicates full intensity, 0.5 half intensity, and so on.

- RGB Device (**XcmsRGB**)

  Red, green, and blue values appropriate for the specified output device. **XcmsRGB** values are of type unsigned short, scaled from 0 to 65535 inclusive, and are interchangeable with the red, green, and blue values in an **XColor** structure.

It is important to note that RGB Intensity values are not gamma corrected values. In contrast, RGB Device values generated as a result of converting color specifications are always gamma corrected, and RGB Device values acquired as a result of querying a colormap or passed in by the client are assumed by Xlib to be gamma corrected. The term *RGB value* in this manual always refers to an RGB Device value.

6.2. Color Strings

Xlib provides a mechanism for using string names for colors. A color string may either contain an abstract color name or a numerical color specification. Color strings are case-insensitive.

Color strings are used in the following functions:

- **XAllocNamedColor**
- **XcmsAllocNamedColor**
- **XLookupColor**
- **XcmsLookupColor**
- **XParseColor**
- **XStoreNamedColor**

Xlib supports the use of abstract color names, for example, red or blue. A value for this abstract name is obtained by searching one or more color name databases. Xlib first searches zero or more client-side databases; the number, location, and content of these databases is implementation dependent and might depend on the current locale. If the name is not found, Xlib then looks for the color in the X server's database. If the color name is not in the Host Portable Character Encoding the result is implementation dependent.

A numerical color specification consists of a color space name and a set of values in the following syntax:

<color_space_name>:*<value>*/.../*<value>*

The following are examples of valid color strings.

"CIEXYZ:0.3227/0.28133/0.2493"
"RGBi:1.0/0.0/0.0"
"rgb:00/ff/00"
"CIELuv:50.0/0.0/0.0"

The syntax and semantics of numerical specifications are given for each standard color space in the following sections.

6.2.1. RGB Device String Specification

An RGB Device specification is identified by the prefix “rgb:” and conforms to the following syntax:

rgb:*<red>*/*<green>*/*<blue>*

<red>, *<green>*, *<blue>* := *h* | *hh* | *hhh* | *hhhh*
h := single hexadecimal digits (case insignificant)

Note that *h* indicates the value scaled in 4 bits, *hh* the value scaled in 8 bits, *hhh* the value scaled in 12 bits, and *hhhh* the value scaled in 16 bits, respectively.

Typical examples are the strings “rgb:ea/75/52” and “rgb:ccc/320/320”, but mixed numbers of hexadecimal digit strings (“rgb:ff/a5/0” and “rgb:ccc/32/0”) are also allowed.

For backward compatibility, an older syntax for RGB Device is supported, but its continued use is not encouraged. The syntax is an initial sharp sign character followed by a numeric specification, in one of the following formats:

#RGB	(4 bits each)
#RRGGBB	(8 bits each)
#RRRGGGBBB	(12 bits each)
#RRRRGGGGBBBB	(16 bits each)

The R, G, and B represent single hexadecimal digits. When fewer than 16 bits each are specified, they represent the most-significant bits of the value (unlike the “rgb:” syntax, in which values are scaled). For example, the string “#3a7” is the same as “#3000a0007000”.

6.2.2. RGB Intensity String Specification

An RGB intensity specification is identified by the prefix “rgbi:” and conforms to the following syntax:

rgbi:*<red>*/*<green>*/*<blue>*

Note that red, green, and blue are floating-point values between 0.0 and 1.0, inclusive. The input format for these values is an optional sign, a string of numbers possibly containing a decimal point, and an optional exponent field containing an E or e followed by a possibly signed integer string.

6.2.3. Device-Independent String Specifications

The standard device-independent string specifications have the following syntax:

CIEXYZ:*<X>/<Y>/<Z>*
CIEuvY:*<u>/<v>/<Y>*
CIExyY:*<x>/<y>/<Y>*
CIELab:*<L>/<a>/<b>*
CIELuv:*<L>/<u>/<v>*
TekHVC:*<H>/<V>/<C>*

All of the values (C, H, V, X, Y, Z, a, b, u, v, y, x) are floating-point values. The syntax for these values is an optional plus or minus sign, a string of digits possibly containing a decimal point, and an optional exponent field consisting of an ‘‘E’’ or ‘‘e’’ followed by an optional plus or minus followed by a string of digits.

6.3. Color Conversion Contexts and Gamut Mapping

When Xlib converts device-independent color specifications into device-dependent specifications and vice-versa, it uses knowledge about the color limitations of the screen hardware. This information, typically called the device profile, is available in a Color Conversion Context (CCC).

Because a specified color may be outside the color gamut of the target screen and the white point associated with the color specification may differ from the white point inherent to the screen, Xlib applies gamut mapping when it encounters certain conditions:

- Gamut compression occurs when conversion of device-independent color specifications to device-dependent color specifications results in a color out of the target screen’s gamut.
- White adjustment occurs when the inherent white point of the screen differs from the white point assumed by the client.

Gamut handling methods are stored as callbacks in the CCC, which in turn are used by the color space conversion routines. Client data is also stored in the CCC for each callback. The CCC also contains the white point the client assumes to be associated with color specifications (that is, the Client White Point). The client can specify the gamut handling callbacks and client data as well as the Client White Point. Xlib does not preclude the X client from performing other forms of gamut handling (for example, gamut expansion); however, Xlib does not provide direct support for gamut handling other than white adjustment and gamut compression.

Associated with each colormap is an initial CCC transparently generated by Xlib. Therefore, when you specify a colormap as an argument to an Xlib function, you are indirectly specifying a CCC. There is a default CCC associated with each screen. Newly created CCCs inherit attributes from the default CCC, so the default CCC attributes can be modified to affect new CCCs.

Xcms functions in which gamut mapping can occur return **Status** and have specific status values defined for them, as follows:

- **XcmsFailure** indicates that the function failed.
- **XcmsSuccess** indicates that the function succeeded. In addition, if the function performed any color conversion, the colors did not need to be compressed.
- **XcmsSuccessWithCompression** indicates the function performed color conversion and at least one of the colors needed to be compressed. The gamut compression method is determined by the gamut compression procedure in the CCC that is specified directly as a function argument or in the CCC indirectly specified by means of the colormap argument.

6.4. Creating, Copying, and Destroying Colormaps

To create a colormap for a screen, use **XCreateColormap**.

```
Colormap XCreateColormap(display, w, visual, alloc)
    Display *display;
    Window w;
    Visual *visual;
    int alloc;
```

display	Specifies the connection to the X server.
w	Specifies the window on whose screen you want to create a colormap.
visual	Specifies a visual type supported on the screen. If the visual type is not one supported by the screen, a **BadMatch** error results.
alloc	Specifies the colormap entries to be allocated. You can pass **AllocNone** or **AllocAll**.

The **XCreateColormap** function creates a colormap of the specified visual type for the screen on which the specified window resides and returns the colormap ID associated with it. Note that the specified window is only used to determine the screen.

The initial values of the colormap entries are undefined for the visual classes **GrayScale**, **PseudoColor**, and **DirectColor**. For **StaticGray**, **StaticColor**, and **TrueColor**, the entries have defined values, but those values are specific to the visual and are not defined by X. For **StaticGray**, **StaticColor**, and **TrueColor**, alloc must be **AllocNone**, or a **BadMatch** error results. For the other visual classes, if alloc is **AllocNone**, the colormap initially has no allocated entries, and clients can allocate them. For information about the visual types, see section 3.1.

If alloc is **AllocAll**, the entire colormap is allocated writable. The initial values of all allocated entries are undefined. For **GrayScale** and **PseudoColor**, the effect is as if an **XAllocColorCells** call returned all pixel values from zero to N − 1, where N is the colormap entries value in the specified visual. For **DirectColor**, the effect is as if an **XAllocColorPlanes** call returned a pixel value of zero and red_mask, green_mask, and blue_mask values containing the same bits as the corresponding masks in the specified visual. However, in all cases, none of these entries can be freed by using **XFreeColors**.

XCreateColormap can generate **BadAlloc**, **BadMatch**, **BadValue**, and **BadWindow** errors.

To create a new colormap when the allocation out of a previously shared colormap has failed because of resource exhaustion, use **XCopyColormapAndFree**.

```
Colormap XCopyColormapAndFree(display, colormap)
    Display *display;
    Colormap colormap;
```

display	Specifies the connection to the X server.
colormap	Specifies the colormap.

The **XCopyColormapAndFree** function creates a colormap of the same visual type and for the same screen as the specified colormap and returns the new colormap ID. It also moves all of the client’s existing allocation from the specified colormap to the new colormap with their color values intact and their read-only or writable characteristics intact and frees those entries in the specified colormap. Color values in other entries in the new colormap are undefined. If the specified colormap was created by the client with alloc set to **AllocAll**, the new colormap is also created with **AllocAll**, all color values for all entries are copied from the specified colormap, and then all entries in the specified colormap are freed. If the specified colormap was not created by the client with **AllocAll**, the allocations to be moved are all those pixels and planes that have been allocated by the client using **XAllocColor**, **XAllocNamedColor**, **XAllocColorCells**, or **XAllocColorPlanes** and that have not been freed since they were allocated.

XCopyColormapAndFree can generate **BadAlloc** and **BadColor** errors.

To destroy a colormap, use **XFreeColormap**.

XFreeColormap(*display*, *colormap*)
  Display **display*;
  Colormap *colormap*;

display	Specifies the connection to the X server.
colormap	Specifies the colormap that you want to destroy.

The **XFreeColormap** function deletes the association between the colormap resource ID and the colormap and frees the colormap storage. However, this function has no effect on the default colormap for a screen. If the specified colormap is an installed map for a screen, it is uninstalled (see **XUninstallColormap**). If the specified colormap is defined as the colormap for a window (by **XCreateWindow**, **XSetWindowColormap**, or **XChangeWindowAttributes**), **XFreeColormap** changes the colormap associated with the window to **None** and generates a **ColormapNotify** event. X does not define the colors displayed for a window with a colormap of **None**.

XFreeColormap can generate a **BadColor** error.

6.5. Mapping Color Names to Values

To map a color name to an RGB value, use **XLookupColor**.

```
Status XLookupColor(display, colormap, color_name, exact_def_return, screen_def_return)
      Display *display;
      Colormap colormap;
      char *color_name;
      XColor *exact_def_return, *screen_def_return;
```

display	Specifies the connection to the X server.
colormap	Specifies the colormap.
color_name	Specifies the color name string (for example, red) whose color definition structure you want returned.
exact_def_return	Returns the exact RGB values.
screen_def_return	Returns the closest RGB values provided by the hardware.

The **XLookupColor** function looks up the string name of a color with respect to the screen associated with the specified colormap. It returns both the exact color values and the closest values provided by the screen with respect to the visual type of the specified colormap. If the color name is not in the Host Portable Character Encoding, the result is implementation dependent. Use of uppercase or lowercase does not matter. **XLookupColor** returns nonzero if the name is resolved; otherwise, it returns zero.

XLookupColor can generate a **BadColor** error.

To map a color name to the exact RGB value, use **XParseColor**.

```
Status XParseColor(display, colormap, spec, exact_def_return)
        Display *display;
        Colormap colormap;
        char *spec;
        XColor *exact_def_return;
```

display	Specifies the connection to the X server.
colormap	Specifies the colormap.
spec	Specifies the color name string; case is ignored.
exact_def_return	Returns the exact color value for later use and sets the **DoRed**, **DoGreen**, and **DoBlue** flags.

The **XParseColor** function looks up the string name of a color with respect to the screen associated with the specified colormap. It returns the exact color value. If the color name is not in the Host Portable Character Encoding, the result is implementation dependent. Use of uppercase or lowercase does not matter. **XParseColor** returns nonzero if the name is resolved; otherwise, it returns zero.

XParseColor can generate a **BadColor** error.

To map a color name to a value in an arbitrary color space, use **XcmsLookupColor**.

Status XcmsLookupColor(*display*, *colormap*, *color_string*, *color_exact_return*, *color_screen_return*, *result_format*)
Display **display*;
Colormap *colormap*;
char **color_string*;
XcmsColor **color_exact_return*, **color_screen_return*;
XcmsColorFormat *result_format*;

display	Specifies the connection to the X server.
colormap	Specifies the colormap.
color_string	Specifies the color string.
color_exact_return	Returns the color specification parsed from the color string or parsed from the corresponding string found in a color name database.
color_screen_return	Returns the color that can be reproduced on the screen.
result_format	Specifies the color format for the returned color specifications (color_screen_return and color_exact_return arguments). If the format is **XcmsUndefinedFormat** and the color string contains a numerical color specification, the specification is returned in the format used in that numerical color specification. If the format is **XcmsUndefinedFormat** and the color string contains a color name, the specification is returned in the format used to store the color in the database.

The **XcmsLookupColor** function looks up the string name of a color with respect to the screen associated with the specified colormap. It returns both the exact color values and the closest values provided by the screen with respect to the visual type of the specified colormap. The values are returned in the format specified by result_format. If the color name is not in the Host Portable Character Encoding, the result is implementation dependent. Use of uppercase or lowercase does not matter. **XcmsLookupColor** returns **XcmsSuccess** or **XcmsSuccessWithCompression** if the name is resolved; otherwise, it returns **XcmsFailure**. If **XcmsSuccessWithCompression** is returned, the color specification returned in color_screen_return is the result of gamut compression.

6.6. Allocating and Freeing Color Cells

There are two ways of allocating color cells: explicitly as read-only entries, one pixel value at a time, or read/write, where you can allocate a number of color cells and planes simultaneously. A read-only cell has its RGB value set by the server. Read/write cells do not have defined colors initially; functions described in the next section must be used to store values into them. Although it is possible for any client to store values into a read/write cell allocated by another client, read/write cells normally should be considered private to the client that allocated them.

Read-only colormap cells are shared among clients. The server counts each allocation and free of the cell by clients. When the last client frees a shared cell, the cell is finally deallocated. If a single client allocates the same read-only cell multiple times, the server counts each such allocation, not just the first one.

To allocate a read-only color cell with an RGB value, use **XAllocColor**.

```
Status XAllocColor(display, colormap, screen_in_out)
      Display *display;
      Colormap colormap;
      XColor *screen_in_out;
```

display	Specifies the connection to the X server.
colormap	Specifies the colormap.
screen_in_out	Specifies and returns the values actually used in the colormap.

The **XAllocColor** function allocates a read-only colormap entry corresponding to the closest RGB value supported by the hardware. **XAllocColor** returns the pixel value of the color closest to the specified RGB elements supported by the hardware and returns the RGB value actually used. The corresponding colormap cell is read-only. In addition, **XAllocColor** returns nonzero if it succeeded or zero if it failed. Multiple clients that request the same effective RGB value can be assigned the same read-only entry, thus allowing entries to be shared. When the last client deallocates a shared cell, it is deallocated. **XAllocColor** does not use or affect the flags in the **XColor** structure.

XAllocColor can generate a **BadColor** error.

To allocate a read-only color cell with a color in arbitrary format, use **XcmsAllocColor**.

```
Status XcmsAllocColor(display, colormap, color_in_out, result_format)
      Display *display;
      Colormap colormap;
      XcmsColor *color_in_out;
      XcmsColorFormat result_format;
```

display	Specifies the connection to the X server.
colormap	Specifies the colormap.
color_in_out	Specifies the color to allocate and returns the pixel and color that is actually used in the colormap.
result_format	Specifies the color format for the returned color specification.

The **XcmsAllocColor** function is similar to **XAllocColor** except the color can be specified in any format. The **XcmsAllocColor** function ultimately calls **XAllocColor** to allocate a read-only color cell (colormap entry) with the specified color. **XcmsAllocColor** first converts the color specified to an RGB value and then passes this to **XAllocColor**. **XcmsAllocColor** returns the pixel value of the color cell and the color specification actually allocated. This returned color specification is the result of converting the RGB value returned by **XAllocColor** into the format specified with the result_format argument. If there is no interest in a returned color specification, unnecessary computation can be bypassed if result_format is set to **XcmsRGBFormat**. The corresponding colormap cell is read-only. If this routine returns **XcmsFailure**, the color_in_out color specification is left unchanged.

XcmsAllocColor can generate a **BadColor** error.

To allocate a read-only color cell using a color name and return the closest color supported by the hardware in RGB format, use **XAllocNamedColor**.

Status XAllocNamedColor(*display*, *colormap*, *color_name*, *screen_def_return*, *exact_def_return*)
  Display **display*;
  Colormap *colormap*;
  char **color_name*;
  XColor **screen_def_return*, **exact_def_return*;

display	Specifies the connection to the X server.
colormap	Specifies the colormap.
color_name	Specifies the color name string (for example, red) whose color definition structure you want returned.
screen_def_return	Returns the closest RGB values provided by the hardware.
exact_def_return	Returns the exact RGB values.

The **XAllocNamedColor** function looks up the named color with respect to the screen that is associated with the specified colormap. It returns both the exact database definition and the closest color supported by the screen. The allocated color cell is read-only. The pixel value is returned in screen_def_return. If the color name is not in the Host Portable Character Encoding, the result is implementation dependent. Use of uppercase or lowercase does not matter. If screen_def_return and exact_def_return point to the same structure, the pixel field will be set correctly but the color values are undefined. **XAllocNamedColor** returns nonzero if a cell is allocated; otherwise, it returns zero.

XAllocNamedColor can generate a **BadColor** error.

To allocate a read-only color cell using a color name and return the closest color supported by the hardware in an arbitrary format, use **XcmsAllocNamedColor**.

```
Status XcmsAllocNamedColor(display, colormap, color_string, color_screen_return, color_exact_return,
                    result_format)
     Display *display;
     Colormap colormap;
     char *color_string;
     XcmsColor *color_screen_return;
     XcmsColor *color_exact_return;
     XcmsColorFormat result_format;
```

display	Specifies the connection to the X server.
colormap	Specifies the colormap.
color_string	Specifies the color string whose color definition structure is to be returned.
color_screen_return	Returns the pixel value of the color cell and color specification that actually is stored for that cell.
color_exact_return	Returns the color specification parsed from the color string or parsed from the corresponding string found in a color name database.
result_format	Specifies the color format for the returned color specifications (color_screen_return and color_exact_return arguments). If the format is **XcmsUndefinedFormat** and the color string contains a numerical color specification, the specification is returned in the format used in that numerical color specification. If the format is **XcmsUndefinedFormat** and the color string contains a color name, the specification is returned in the format used to store the color in the database.

The **XcmsAllocNamedColor** function is similar to **XAllocNamedColor** except the color returned can be in any format specified. This function ultimately calls **XAllocColor** to allocate a read-only color cell with the color specified by a color string. The color string is parsed into an **XcmsColor** structure (see **XcmsLookupColor**), converted to an RGB value, and finally passed to **XAllocColor**. If the color name is not in the Host Portable Character Encoding, the result is implementation dependent. Use of uppercase or lowercase does not matter.

This function returns both the color specification as a result of parsing (exact specification) and the actual color specification stored (screen specification). This screen specification is the result of converting the RGB value returned by **XAllocColor** into the format specified in result_format. If there is no interest in a returned color specification, unnecessary computation can be bypassed if result_format is set to **XcmsRGBFormat**. If color_screen_return and color_exact_return point to the same structure, the pixel field will be set correctly but the color values are undefined.

XcmsAllocNamedColor can generate a **BadColor** error.

To allocate read/write color cell and color plane combinations for a **PseudoColor** model, use **XAllocColorCells**.

```
Status XAllocColorCells(display, colormap, contig, plane_masks_return, nplanes,
                    pixels_return, npixels)
    Display *display;
    Colormap colormap;
    Bool contig;
    unsigned long plane_masks_return[ ];
    unsigned int nplanes;
    unsigned long pixels_return[ ];
    unsigned int npixels;
```

display	Specifies the connection to the X server.
colormap	Specifies the colormap.
contig	Specifies a Boolean value that indicates whether the planes must be contiguous.
plane_mask_return	Returns an array of plane masks.
nplanes	Specifies the number of plane masks that are to be returned in the plane masks array.
pixels_return	Returns an array of pixel values.
npixels	Specifies the number of pixel values that are to be returned in the pixels_return array.

The **XAllocColorCells** function allocates read/write color cells. The number of colors must be positive and the number of planes nonnegative, or a **BadValue** error results. If ncolors and nplanes are requested, then ncolors pixels and nplane plane masks are returned. No mask will have any bits set to 1 in common with any other mask or with any of the pixels. By ORing together each pixel with zero or more masks, ncolors * $2^{nplanes}$ distinct pixels can be produced. All of these are allocated writable by the request. For **GrayScale** or **PseudoColor**, each mask has exactly one bit set to 1. For **DirectColor**, each has exactly three bits set to 1. If contig is **True** and if all masks are ORed together, a single contiguous set of bits set to 1 will be formed for **GrayScale** or **PseudoColor** and three contiguous sets of bits set to 1 (one within each pixel subfield) for **DirectColor**. The RGB values of the allocated entries are undefined. **XAllocColorCells** returns nonzero if it succeeded or zero if it failed.

XAllocColorCells can generate **BadColor** and **BadValue** errors.

To allocate read/write color resources for a **DirectColor** model, use **XAllocColorPlanes**.

```
Status XAllocColorPlanes(display, colormap, contig, pixels_return, ncolors, nreds, ngreens,
              nblues, rmask_return, gmask_return, bmask_return)
    Display *display;
    Colormap colormap;
    Bool contig;
    unsigned long pixels_return[ ];
    int ncolors;
    int nreds, ngreens, nblues;
    unsigned long *rmask_return, *gmask_return, *bmask_return;
```

display	Specifies the connection to the X server.
colormap	Specifies the colormap.
contig	Specifies a Boolean value that indicates whether the planes must be contiguous.
pixels_return	Returns an array of pixel values. **XAllocColorPlanes** returns the pixel values in this array.
ncolors	Specifies the number of pixel values that are to be returned in the pixels_return array.
nreds *ngreens* *nblues*	Specify the number of red, green, and blue planes. The value you pass must be nonnegative.
rmask_return *gmask_return* *bmask_return*	Return bit masks for the red, green, and blue planes.

The specified ncolors must be positive; and nreds, ngreens, and nblues must be nonnegative, or a **BadValue** error results. If ncolors colors, nreds reds, ngreens greens, and nblues blues are requested, ncolors pixels are returned; and the masks have nreds, ngreens, and nblues bits set to 1, respectively. If contig is **True**, each mask will have a contiguous set of bits set to 1. No mask will have any bits set to 1 in common with any other mask or with any of the pixels. For **DirectColor**, each mask will lie within the corresponding pixel subfield. By ORing together subsets of masks with each pixel value, ncolors * $2^{(nreds+ngreens+nblues)}$ distinct pixel values can be produced. All of these are allocated by the request. However, in the colormap, there are only ncolors * 2^{nreds} independent red entries, ncolors * $2^{ngreens}$ independent green entries, and ncolors * 2^{nblues} independent blue entries. This is true even for **PseudoColor**. When the colormap entry of a pixel value is changed (using **XStoreColors**, **XStoreColor**, or **XStoreNamedColor**), the pixel is decomposed according to the masks, and the corresponding independent entries are updated. **XAllocColorPlanes** returns nonzero if it succeeded or zero if it failed.

XAllocColorPlanes can generate **BadColor** and **BadValue** errors.

To free colormap cells, use **XFreeColors**.

```
XFreeColors(display, colormap, pixels, npixels, planes)
    Display *display;
    Colormap colormap;
    unsigned long pixels[ ];
    int npixels;
    unsigned long planes;
```

display	Specifies the connection to the X server.
colormap	Specifies the colormap.
pixels	Specifies an array of pixel values that map to the cells in the specified colormap.
npixels	Specifies the number of pixels.
planes	Specifies the planes you want to free.

The **XFreeColors** function frees the cells represented by pixels whose values are in the pixels array. The planes argument should not have any bits set to 1 in common with any of the pixels. The set of all pixels is produced by ORing together subsets of the planes argument with the pixels. The request frees all of these pixels that were allocated by the client (using **XAllocColor**, **XAllocNamedColor**, **XAllocColorCells**, and **XAllocColorPlanes**). Note that freeing an individual pixel obtained from **XAllocColorPlanes** may not actually allow it to be reused until all of its related pixels are also freed. Similarly, a read-only entry is not actually freed until it has been freed by all clients, and if a client allocates the same read-only entry multiple times, it must free the entry that many times before the entry is actually freed.

All specified pixels that are allocated by the client in the colormap are freed, even if one or more pixels produce an error. If a specified pixel is not a valid index into the colormap, a **BadValue** error results. If a specified pixel is not allocated by the client (that is, is unallocated or is only allocated by another client) or if the colormap was created with all entries writable (by passing **AllocAll** to **XCreateColormap**), a **BadAccess** error results. If more than one pixel is in error, the one that gets reported is arbitrary.

XFreeColors can generate **BadAccess**, **BadColor**, and **BadValue** errors.

6.7. Modifying and Querying Colormap Cells

To store an RGB value in a single colormap cell, use **XStoreColor**.

```
XStoreColor(display, colormap, color)
    Display *display;
    Colormap colormap;
    XColor *color;
```

display	Specifies the connection to the X server.
colormap	Specifies the colormap.
color	Specifies the pixel and RGB values.

The **XStoreColor** function changes the colormap entry of the pixel value specified in the pixel member of the **XColor** structure. You specified this value in the pixel member of the **XColor** structure. This pixel value must be a read/write cell and a valid index into the colormap. If a specified pixel is not a valid index into the colormap, a **BadValue** error results. **XStoreColor** also changes the red, green, and/or blue color components. You specify which color components are to be changed by setting **DoRed**, **DoGreen**, and/or **DoBlue** in the flags member of the **XColor** structure. If the colormap is an installed map for its screen, the changes are visible immediately.

XStoreColor can generate **BadAccess**, **BadColor**, and **BadValue** errors.

To store multiple RGB values in multiple colormap cells, use **XStoreColors**.

```
XStoreColors(display, colormap, color, ncolors)
    Display *display;
    Colormap colormap;
    XColor color[];
    int ncolors;
```

display	Specifies the connection to the X server.
colormap	Specifies the colormap.
color	Specifies an array of color definition structures to be stored.
ncolors	Specifies the number of **XColor** structures in the color definition array.

The **XStoreColors** function changes the colormap entries of the pixel values specified in the pixel members of the **XColor** structures. You specify which color components are to be changed by setting **DoRed**, **DoGreen**, and/or **DoBlue** in the flags member of the **XColor** structures. If the colormap is an installed map for its screen, the changes are visible immediately. **XStoreColors** changes the specified pixels if they are allocated writable in the colormap by any client, even if one or more pixels generates an error. If a specified pixel is not a valid index into the colormap, a **BadValue** error results. If a specified pixel either is unallocated or is allocated read-only, a **BadAccess** error results. If more than one pixel is in error, the one that gets reported is arbitrary.

XStoreColors can generate **BadAccess**, **BadColor**, and **BadValue** errors.

To store a color of arbitrary format in a single colormap cell, use **XcmsStoreColor**.

```
Status XcmsStoreColor(display, colormap, color)
    Display *display;
    Colormap colormap;
    XcmsColor *color;
```

display	Specifies the connection to the X server.
colormap	Specifies the colormap.
color	Specifies the color cell and the color to store. Values specified in this **XcmsColor** structure remain unchanged upon return.

The **XcmsStoreColor** function converts the color specified in the **XcmsColor** structure into RGB values. It then uses this RGB specification in an **XColor** structure, whose three flags (**DoRed**, **DoGreen**, and **DoBlue**) are set, in a call to **XStoreColor** to change the color cell specified by the pixel member of the **XcmsColor** structure. This pixel value must be a valid index for the specified colormap, and the color cell specified by the pixel value must be a read/write cell. If the pixel value is not a valid index, a **BadValue** error results. If the color cell is unallocated or is allocated read-only, a **BadAccess** error results. If the colormap is an installed map for its screen, the changes are visible immediately.

Note that **XStoreColor** has no return value; therefore, an **XcmsSuccess** return value from this function indicates that the conversion to RGB succeeded and the call to **XStoreColor** was made. To obtain the actual color stored, use **XcmsQueryColor**. Due to the screen's hardware limitations or gamut compression, the color stored in the colormap may not be identical to the color specified.

XcmsStoreColor can generate **BadAccess**, **BadColor**, and **BadValue** errors.

To store multiple colors of arbitrary format in multiple colormap cells, use **XcmsStoreColors**.

Status XcmsStoreColors(*display*, *colormap*, *colors*, *ncolors*, *compression_flags_return*)
    Display **display*;
    Colormap *colormap*;
    XcmsColor *colors*[ ];
    int *ncolors*;
    Bool *compression_flags_return*[ ];

display	Specifies the connection to the X server.
colormap	Specifies the colormap.
colors	Specifies the color specification array of **XcmsColor** structures, each specifying a color cell and the color to store in that cell. Values specified in the array remain unchanged upon return.
ncolors	Specifies the number of **XcmsColor** structures in the color specification array.
compression_flags_return	Returns an array of Boolean values indicating compression status. If a non-NULL pointer is supplied, each element of the array is set to **True** if the corresponding color was compressed and **False** otherwise. Pass NULL if the compression status is not useful.

The **XcmsStoreColors** function converts the colors specified in the array of **XcmsColor** structures into RGB values and then uses these RGB specifications in **XColor** structures, whose three flags (**DoRed**, **DoGreen**, and **DoBlue**) are set, in a call to **XStoreColors** to change the color cells specified by the pixel member of the corresponding **XcmsColor** structure. Each pixel value must be a valid index for the specified colormap, and the color cell specified by each pixel value must be a read/write cell. If a pixel value is not a valid index, a **BadValue** error results. If a color cell is unallocated or is allocated read-only, a **BadAccess** error results. If more than one pixel is in error, the one that gets reported is arbitrary. If the colormap is an installed map for its screen, the changes are visible immediately.

Note that **XStoreColors** has no return value; therefore, an **XcmsSuccess** return value from this function indicates that conversions to RGB succeeded and the call to **XStoreColors** was made. To obtain the actual colors stored, use **XcmsQueryColors**. Due to the screen's hardware limitations or gamut compression, the colors stored in the colormap may not be identical to the colors specified.

XcmsStoreColors can generate **BadAccess**, **BadColor**, and **BadValue** errors.

To store a color specified by name in a single colormap cell, use **XStoreNamedColor**.

XStoreNamedColor(*display*, *colormap*, *color*, *pixel*, *flags*)
  Display **display*;
  Colormap *colormap*;
  char **color*;
  unsigned long *pixel*;
  int *flags*;

display	Specifies the connection to the X server.
colormap	Specifies the colormap.
color	Specifies the color name string (for example, red).
pixel	Specifies the entry in the colormap.
flags	Specifies which red, green, and blue components are set.

The **XStoreNamedColor** function looks up the named color with respect to the screen associated with the colormap and stores the result in the specified colormap. The pixel argument determines the entry in the colormap. The flags argument determines which of the red, green, and blue components are set. You can set this member to the bitwise inclusive OR of the bits **DoRed**, **DoGreen**, and **DoBlue**. If the color name is not in the Host Portable Character Encoding, the result is implementation dependent. Use of uppercase or lowercase does not matter. If the specified pixel is not a valid index into the colormap, a **BadValue** error results. If the specified pixel either is unallocated or is allocated read-only, a **BadAccess** error results.

XStoreNamedColor can generate **BadAccess**, **BadColor**, **BadName**, and **BadValue** errors.

The **XQueryColor** and **XQueryColors** functions take pixel values in the pixel member of **XColor** structures and store in the structures the RGB values for those pixels from the specified colormap. The values returned for an unallocated entry are undefined. These functions also set the flags member in the **XColor** structure to all three colors. If a pixel is not a valid index into the specified colormap, a **BadValue** error results. If more than one pixel is in error, the one that gets reported is arbitrary.

To query the RGB value of a single colormap cell, use **XQueryColor**.

XQueryColor(*display*, *colormap*, *def_in_out*)
  Display **display*;
  Colormap *colormap*;
  XColor **def_in_out*;

display	Specifies the connection to the X server.
colormap	Specifies the colormap.
def_in_out	Specifies and returns the RGB values for the pixel specified in the structure.

The **XQueryColor** function returns the current RGB value for the pixel in the **XColor** structure and sets the **DoRed**, **DoGreen**, and **DoBlue** flags.

XQueryColor can generate **BadColor** and **BadValue** errors.

To query the RGB values of multiple colormap cells, use **XQueryColors**.

```
XQueryColors(display, colormap, defs_in_out, ncolors)
      Display *display;
      Colormap colormap;
      XColor defs_in_out[ ];
      int ncolors;
```

display	Specifies the connection to the X server.
colormap	Specifies the colormap.
defs_in_out	Specifies and returns an array of color definition structures for the pixel specified in the structure.
ncolors	Specifies the number of **XColor** structures in the color definition array.

The **XQueryColors** function returns the RGB value for each pixel in each **XColor** structure and sets the **DoRed**, **DoGreen**, and **DoBlue** flags in each structure.

XQueryColors can generate **BadColor** and **BadValue** errors.

To query the color of a single colormap cell in an arbitrary format, use **XcmsQueryColor**.

```
Status XcmsQueryColor(display, colormap, color_in_out, result_format)
      Display *display;
      Colormap colormap;
      XcmsColor *color_in_out;
      XcmsColorFormat result_format;
```

display	Specifies the connection to the X server.
colormap	Specifies the colormap.
color_in_out	Specifies the pixel member that indicates the color cell to query. The color specification stored for the color cell is returned in this **XcmsColor** structure.
result_format	Specifies the color format for the returned color specification.

The **XcmsQueryColor** function obtains the RGB value for the pixel value in the pixel member of the specified **XcmsColor** structure and then converts the value to the target format as specified by the result_format argument. If the pixel is not a valid index in the specified colormap, a **BadValue** error results.

XcmsQueryColor can generate **BadColor** and **BadValue** errors.

To query the color of multiple colormap cells in an arbitrary format, use **XcmsQueryColors**.

```
Status XcmsQueryColors(display, colormap, colors_in_out, ncolors, result_format)
      Display *display;
      Colormap colormap;
      XcmsColor colors_in_out[ ];
      unsigned int ncolors;
      XcmsColorFormat result_format;
```

display	Specifies the connection to the X server.
colormap	Specifies the colormap.
colors_in_out	Specifies an array of **XcmsColor** structures, each pixel member indicating the color cell to query. The color specifications for the color cells are returned in these structures.
ncolors	Specifies the number of **XcmsColor** structures in the color specification array.
result_format	Specifies the color format for the returned color specification.

The **XcmsQueryColors** function obtains the RGB values for pixel values in the pixel members of **XcmsColor** structures and then converts the values to the target format as specified by the result_format argument. If a pixel is not a valid index into the specified colormap, a **BadValue** error results. If more than one pixel is in error, the one that gets reported is arbitrary.

XcmsQueryColors can generate **BadColor** and **BadValue** errors.

6.8. Color Conversion Context Functions

This section describes functions to create, modify, and query CCCs.

Associated with each colormap is an initial CCC transparently generated by Xlib. Therefore, when you specify a colormap as an argument to a function, you are indirectly specifying a CCC. The CCC attributes that can be modified by the X client are:

- Client White Point
- Gamut compression procedure and client data
- White point adjustment procedure and client data

The initial values for these attributes are implementation specific. The CCC attributes for subsequently created CCCs can be defined by changing the CCC attributes of the default CCC. There is a default CCC associated with each screen.

6.8.1. Getting and Setting the Color Conversion Context of a Colormap

To obtain the CCC associated with a colormap, use **XcmsCCCOfColormap**.

```
XcmsCCC XcmsCCCOfColormap(display, colormap)
      Display *display;
      Colormap colormap;
```

display	Specifies the connection to the X server.
colormap	Specifies the colormap.

The **XcmsCCCOfColormap** function returns the CCC associated with the specified colormap. Once obtained, the CCC attributes can be queried or modified. Unless the CCC associated with the specified colormap is changed with **XcmsSetCCCOfColormap**, this CCC is used when the specified colormap is used as an argument to color functions.

To change the CCC associated with a colormap, use **XcmsSetCCCOfColormap**.

```
XcmsCCC XcmsSetCCCOfColormap(display, colormap, ccc)
      Display *display;
      Colormap colormap;
      XcmsCCC ccc;
```

display	Specifies the connection to the X server.
colormap	Specifies the colormap.
ccc	Specifies the CCC.

The **XcmsSetCCCOfColormap** function changes the CCC associated with the specified colormap. It returns the CCC previously associated with the colormap. If they are not used again in the application, CCCs should be freed by calling **XcmsFreeCCC**. Several colormaps may share the same CCC without restriction; this includes the CCCs generated by Xlib with each colormap. Xlib, however, creates a new CCC with each new colormap.

6.8.2. Obtaining the Default Color Conversion Context

You can change the default CCC attributes for subsequently created CCCs by changing the CCC attributes of the default CCC. A default CCC is associated with each screen.

To obtain the default CCC for a screen, use **XcmsDefaultCCC**.

```
XcmsCCC XcmsDefaultCCC(display, screen_number)
      Display *display;
      int screen_number;
```

display	Specifies the connection to the X server.
screen_number	Specifies the appropriate screen number on the host server.

The **XcmsDefaultCCC** function returns the default CCC for the specified screen. Its visual is the default visual of the screen. Its initial gamut compression and white point adjustment procedures as well as the associated client data are implementation specific.

6.8.3. Color Conversion Context Macros

Applications should not directly modify any part of the **XcmsCCC**. The following lists the C language macros, their corresponding function equivalents for other language bindings, and what data they both can return.

DisplayOfCCC(*ccc*)
XcmsCCC *ccc*;

Display *XcmsDisplayOfCCC(*ccc*)
XcmsCCC *ccc*;

ccc	Specifies the CCC.

Both return the display associated with the specified CCC.

VisualOfCCC(*ccc*)
XcmsCCC *ccc*;

Visual *XcmsVisualOfCCC(*ccc*)
XcmsCCC *ccc*;

ccc	Specifies the CCC.

Both return the visual associated with the specified CCC.

ScreenNumberOfCCC(*ccc*)
XcmsCCC *ccc*;

int XcmsScreenNumberOfCCC(*ccc*)
XcmsCCC *ccc*;

ccc	Specifies the CCC.

Both return the number of the screen associated with the specified CCC.

ScreenWhitePointOfCCC(*ccc*)
XcmsCCC *ccc*;

XcmsColor *XcmsScreenWhitePointOfCCC(*ccc*)
XcmsCCC *ccc*;

ccc	Specifies the CCC.

Both return the white point of the screen associated with the specified CCC.

```
ClientWhitePointOfCCC(ccc)
    XcmsCCC ccc;

XcmsColor *XcmsClientWhitePointOfCCC(ccc)
    XcmsCCC ccc;
```

ccc	Specifies the CCC.

Both return the Client White Point of the specified CCC.

6.8.4. Modifying Attributes of a Color Conversion Context

To set the Client White Point in the CCC, use **XcmsSetWhitePoint**.

```
Status XcmsSetWhitePoint(ccc, color)
     XcmsCCC ccc;
     XcmsColor *color;
```

ccc	Specifies the CCC.
color	Specifies the new Client White Point.

The **XcmsSetWhitePoint** function changes the Client White Point in the specified CCC. Note that the pixel member is ignored and that the color specification is left unchanged upon return. The format for the new white point must be **XcmsCIEXYZFormat**, **XcmsCIEuvYFormat**, **XcmsCIExyYFormat**, or **XcmsUndefinedFormat**. If the color argument is NULL, this function sets the format component of the Client White Point specification to **XcmsUndefinedFormat**, indicating that the Client White Point is assumed to be the same as the Screen White Point.

This function returns nonzero status if the format for the new white point is valid; otherwise, it returns zero.

To set the gamut compression procedure and corresponding client data in a specified CCC, use **XcmsSetCompressionProc**.

XcmsCompressionProc XcmsSetCompressionProc(*ccc*, *compression_proc*, *client_data*)
  XcmsCCC *ccc*;
  XcmsCompressionProc *compression_proc*;
  XPointer *client_data*;

ccc Specifies the CCC.

compression_proc
Specifies the gamut compression procedure that is to be applied when a color lies outside the screen's color gamut. If NULL is specified and a function using this CCC must convert a color specification to a device-dependent format and encounters a color that lies outside the screen's color gamut, that function will return **XcmsFailure**.

client_data Specifies client data for the gamut compression procedure or NULL.

The **XcmsSetCompressionProc** function first sets the gamut compression procedure and client data in the specified CCC with the newly specified procedure and client data and then returns the old procedure.

To set the white point adjustment procedure and corresponding client data in a specified CCC, use **XcmsSetWhiteAdjustProc**.

XcmsWhiteAdjustProc XcmsSetWhiteAdjustProc(*ccc*, *white_adjust_proc*, *client_data*)
  XcmsCCC *ccc*;
  XcmsWhiteAdjustProc *white_adjust_proc*;
  XPointer *client_data*;

ccc Specifies the CCC.

white_adjust_proc
Specifies the white point adjustment procedure.

client_data Specifies client data for the white point adjustment procedure or NULL.

The **XcmsSetWhiteAdjustProc** function first sets the white point adjustment procedure and client data in the specified CCC with the newly specified procedure and client data and then returns the old procedure.

6.8.5. Creating and Freeing a Color Conversion Context

You can explicitly create a CCC within your application by calling **XcmsCreateCCC**. These created CCCs can then be used by those functions that explicitly call for a CCC argument. Old CCCs that will not be used by the application should be freed using **XcmsFreeCCC**.

To create a CCC, use **XcmsCreateCCC**.

```
XcmsCCC XcmsCreateCCC(display, screen_number, visual, client_white_point, compression_proc,
            compression_client_data, white_adjust_proc, white_adjust_client_data)
    Display *display;
    int screen_number;
    Visual *visual;
    XcmsColor *client_white_point;
    XcmsCompressionProc compression_proc;
    XPointer compression_client_data;
    XcmsWhiteAdjustProc white_adjust_proc;
    XPointer white_adjust_client_data;
```

display	Specifies the connection to the X server.
screen_number	Specifies the appropriate screen number on the host server.
visual	Specifies the visual type.
client_white_point	Specifies the Client White Point. If NULL is specified, the Client White Point is to be assumed to be the same as the Screen White Point. Note that the pixel member is ignored.
compression_proc	Specifies the gamut compression procedure that is to be applied when a color lies outside the screen's color gamut. If NULL is specified and a function using this CCC must convert a color specification to a device-dependent format and encounters a color that lies outside the screen's color gamut, that function will return **XcmsFailure**.
compression_client_data	Specifies client data for use by the gamut compression procedure or NULL.
white_adjust_proc	Specifies the white adjustment procedure that is to be applied when the Client White Point differs from the Screen White Point. NULL indicates that no white point adjustment is desired.
white_adjust_client_data	Specifies client data for use with the white point adjustment procedure or NULL.

The **XcmsCreateCCC** function creates a CCC for the specified display, screen, and visual.

To free a CCC, use **XcmsFreeCCC**.

```
void XcmsFreeCCC(ccc)
    XcmsCCC ccc;
```

ccc	Specifies the CCC.

The **XcmsFreeCCC** function frees the memory used for the specified CCC. Note that default CCCs and those currently associated with colormaps are ignored.

6.9. Converting Between Color Spaces

To convert an array of color specifications in arbitrary color formats to a single destination format, use **XcmsConvertColors**.

```
Status XcmsConvertColors(ccc, colors_in_out, ncolors, target_format, compression_flags_return)
    XcmsCCC ccc;
    XcmsColor colors_in_out[ ];
    unsigned int ncolors;
    XcmsColorFormat target_format;
    Bool compression_flags_return[ ];
```

ccc	Specifies the CCC. If conversion is between device-independent color spaces only (for example, TekHVC to CIELuv), the CCC is necessary only to specify the Client White Point.
colors_in_out	Specifies an array of color specifications. Pixel members are ignored and remain unchanged upon return.
ncolors	Specifies the number of **XcmsColor** structures in the color specification array.
target_format	Specifies the target color specification format.
compression_flags_return	Returns an array of Boolean values indicating compression status. If a non-NULL pointer is supplied, each element of the array is set to **True** if the corresponding color was compressed and **False** otherwise. Pass NULL if the compression status is not useful.

The **XcmsConvertColors** function converts the color specifications in the specified array of **XcmsColor** structures from their current format to a single target format, using the specified CCC. When the return value is **XcmsFailure**, the contents of the color specification array are left unchanged.

The array may contain a mixture of color specification formats (for example, 3 CIE XYZ, 2 CIE Luv, and so on). When the array contains both device-independent and device-dependent color specifications and the target_format argument specifies a device-dependent format (for example, **XcmsRGBiFormat**, **XcmsRGBFormat**), all specifications are converted to CIE XYZ format and then to the target device-dependent format.

6.10. Callback Functions

This section describes the gamut compression and white point adjustment callbacks.

The gamut compression procedure specified in the CCC is called when an attempt to convert a color specification from **XcmsCIEXYZ** to a device-dependent format (typically **XcmsRGBi**) results in a color that lies outside the screen's color gamut. If the gamut compression procedure requires client data, this data is passed via the gamut compression client data in the CCC.

During color specification conversion between device-independent and device-dependent color spaces, if a white point adjustment procedure is specified in the CCC, it is triggered when the Client White Point and Screen White Point differ. If required, the client data is obtained from the CCC.

6.10.1. Prototype Gamut Compression Procedure

The gamut compression callback interface must adhere to the following:

```
typedef Status (*XcmsCompressionProc)(ccc, colors_in_out, ncolors, index, compression_flags_return)
      XcmsCCC ccc;
      XcmsColor colors_in_out[];
      unsigned int ncolors;
      unsigned int index;
      Bool compression_flags_return[];
```

ccc	Specifies the CCC.
colors_in_out	Specifies an array of color specifications. Pixel members should be ignored and must remain unchanged upon return.
ncolors	Specifies the number of **XcmsColor** structures in the color specification array.
index	Specifies the index into the array of **XcmsColor** structures for the encountered color specification that lies outside the screen's color gamut. Valid values are 0 (for the first element) to ncolors − 1.
compression_flags_return	Returns an array of Boolean values for indicating compression status. If a non-NULL pointer is supplied and a color at a given index is compressed, then **True** should be stored at the corresponding index in this array; otherwise, the array should not be modified.

When implementing a gamut compression procedure, consider the following rules and assumptions:

- The gamut compression procedure can attempt to compress one or multiple specifications at a time.
- When called, elements 0 to index − 1 in the color specification array can be assumed to fall within the screen's color gamut. In addition, these color specifications are already in some device-dependent format (typically **XcmsRGBi**). If any modifications are made to these color specifications, they must be in their initial device-dependent format upon return.
- When called, the element in the color specification array specified by the index argument contains the color specification outside the screen's color gamut encountered by the calling routine. In addition, this color specification can be assumed to be in **XcmsCIEXYZ**. Upon return, this color specification must be in **XcmsCIEXYZ**.
- When called, elements from index to ncolors − 1 in the color specification array may or may not fall within the screen's color gamut. In addition, these color specifications can be assumed to be in **XcmsCIEXYZ**. If any modifications are made to these color specifications, they must be in **XcmsCIEXYZ** upon return.
- The color specifications passed to the gamut compression procedure have already been adjusted to the Screen White Point. This means that at this point the color specification's white point is the Screen White Point.
- If the gamut compression procedure uses a device-independent color space not initially accessible for use in the color management system, use **XcmsAddColorSpace** to insure that it is added.

6.10.2. Supplied Gamut Compression Procedures

The following equations are useful in describing gamut compression functions:

$$CIELab\ Psychometric\ Chroma = sqrt(a\_star^2 + b\_star^2)$$

$$CIELab\ Psychometric\ Hue = \tan^{-1}\left[\frac{b\_star}{a\_star}\right]$$

$$CIELuv\ Psychometric\ Chroma = sqrt(u\_star^2 + v\_star^2)$$

$$CIELuv\ Psychometric\ Hue = \tan^{-1}\left[\frac{v\_star}{u\_star}\right]$$

The gamut compression callback procedures provided by Xlib are as follows:

- **XcmsCIELabClipL**

  This brings the encountered out-of-gamut color specification into the screen's color gamut by reducing or increasing CIE metric lightness (L*) in the CIE L*a*b* color space until the color is within the gamut. If the Psychometric Chroma of the color specification is beyond maximum for the Psychometric Hue Angle, then while maintaining the same Psychometric Hue Angle, the color will be clipped to the CIE L*a*b* coordinates of maximum Psychometric Chroma. See **XcmsCIELabQueryMaxC**. No client data is necessary.

- **XcmsCIELabClipab**

  This brings the encountered out-of-gamut color specification into the screen's color gamut by reducing Psychometric Chroma, while maintaining Psychometric Hue Angle, until the color is within the gamut. No client data is necessary.

- **XcmsCIELabClipLab**

  This brings the encountered out-of-gamut color specification into the screen's color gamut by replacing it with CIE L*a*b* coordinates that fall within the color gamut while maintaining the original Psychometric Hue Angle and whose vector to the original coordinates is the shortest attainable. No client data is necessary.

- **XcmsCIELuvClipL**

  This brings the encountered out-of-gamut color specification into the screen's color gamut by reducing or increasing CIE metric lightness (L*) in the CIE L*u*v* color space until the color is within the gamut. If the Psychometric Chroma of the color specification is beyond maximum for the Psychometric Hue Angle, then, while maintaining the same Psychometric Hue Angle, the color will be clipped to the CIE L*u*v* coordinates of maximum Psychometric Chroma. See **XcmsCIELuvQueryMaxC**. No client data is necessary.

- **XcmsCIELuvClipuv**

  This brings the encountered out-of-gamut color specification into the screen's color gamut by reducing Psychometric Chroma, while maintaining Psychometric Hue Angle, until the color is within the gamut. No client data is necessary.

- **XcmsCIELuvClipLuv**

  This brings the encountered out-of-gamut color specification into the screen's color gamut by replacing it with CIE L*u*v* coordinates that fall within the color gamut while maintaining the original Psychometric Hue Angle and whose vector to the original coordinates is the shortest attainable. No client data is necessary.

- **XcmsTekHVCClipV**

  This brings the encountered out-of-gamut color specification into the screen's color gamut by reducing or increasing the Value dimension in the TekHVC color space until the color is within the gamut. If Chroma of the color specification is beyond maximum for the particular Hue, then, while maintaining the same Hue, the color will be clipped to the Value and Chroma coordinates that represent maximum Chroma for that particular Hue. No client data is necessary.
- **XcmsTekHVCClipC**

  This brings the encountered out-of-gamut color specification into the screen's color gamut by reducing the Chroma dimension in the TekHVC color space until the color is within the gamut. No client data is necessary.
- **XcmsTekHVCClipVC**

  This brings the encountered out-of-gamut color specification into the screen's color gamut by replacing it with TekHVC coordinates that fall within the color gamut while maintaining the original Hue and whose vector to the original coordinates is the shortest attainable. No client data is necessary.

6.10.3. Prototype White Point Adjustment Procedure

The white point adjustment procedure interface must adhere to the following:

```
typedef Status (*XcmsWhiteAdjustProc)(ccc, initial_white_point, target_white_point, target_format,
        colors_in_out, ncolors, compression_flags_return)
    XcmsCCC ccc;
    XcmsColor *initial_white_point;
    XcmsColor *target_white_point;
    XcmsColorFormat target_format;
    XcmsColor colors_in_out[];
    unsigned int ncolors;
    Bool compression_flags_return[];
```

ccc	Specifies the CCC.
initial_white_point	Specifies the initial white point.
target_white_point	Specifies the target white point.
target_format	Specifies the target color specification format.
colors_in_out	Specifies an array of color specifications. Pixel members should be ignored and must remain unchanged upon return.
ncolors	Specifies the number of **XcmsColor** structures in the color specification array.
compression_flags_return	Returns an array of Boolean values for indicating compression status. If a non-NULL pointer is supplied and a color at a given index is compressed, then **True** should be stored at the corresponding index in this array; otherwise, the array should not be modified.

6.10.4. Supplied White Point Adjustment Procedures

White point adjustment procedures provided by Xlib are as follows:

- **XcmsCIELabWhiteShiftColors**

  This uses the CIE L*a*b* color space for adjusting the chromatic character of colors to compensate for the chromatic differences between the source and destination white points. This procedure simply converts the color specifications to **XcmsCIELab** using the source white point and then converts to the target specification format using the destinations white point. No client data is necessary.

- **XcmsCIELuvWhiteShiftColors**

  This uses the CIE L*u*v* color space for adjusting the chromatic character of colors to compensate for the chromatic differences between the source and destination white points. This procedure simply converts the color specifications to **XcmsCIELuv** using the source white point and then converts to the target specification format using the destinations white point. No client data is necessary.

- **XcmsTekHVCWhiteShiftColors**

  This uses the TekHVC color space for adjusting the chromatic character of colors to compensate for the chromatic differences between the source and destination white points. This procedure simply converts the color specifications to **XcmsTekHVC** using the source white point and then converts to the target specification format using the destinations white point. An advantage of this procedure over those previously described is an attempt to minimize hue shift. No client data is necessary.

From an implementation point of view, these white point adjustment procedures convert the color specifications to a device-independent but white-point-dependent color space (for example, CIE L*u*v*, CIE L*a*b*, TekHVC) using one white point and then converting those specifications to the target color space using another white point. In other words, the specification goes in the color space with one white point but comes out with another white point, resulting in a chromatic shift based on the chromatic displacement between the initial white point and target white point. The CIE color spaces that are assumed to be white-point-independent are CIE u’v’Y, CIE XYZ, and CIE xyY. When developing a custom white point adjustment procedure that uses a device-independent color space not initially accessible for use in the color management system, use **XcmsAddColorSpace** to insure that it is added.

As an example, if the CCC specifies a white point adjustment procedure and if the Client White Point and Screen White Point differ, the **XcmsAllocColor** function will use the white point adjustment procedure twice:

- Once to convert to **XcmsRGB**
- A second time to convert from **XcmsRGB**

For example, assume the specification is in **XcmsCIEuvY** and the adjustment procedure is **XcmsCIELuvWhiteShiftColors**. During conversion to **XcmsRGB**, the call to **XcmsAllocColor** results in the following series of color specification conversions:

- From **XcmsCIEuvY** to **XcmsCIELuv** using the Client White Point
- From **XcmsCIELuv** to **XcmsCIEuvY** using the Screen White Point
- From **XcmsCIEuvY** to **XcmsCIEXYZ** (CIE u’v’Y and XYZ are white-point-independent color spaces)
- From **XcmsCIEXYZ** to **XcmsRGBi**

- From **XcmsRGBi** to **XcmsRGB**

The resulting RGB specification is passed to **XAllocColor**, and the RGB specification returned by **XAllocColor** is converted back to **XcmsCIEuvY** by reversing the color conversion sequence.

6.11. Gamut Querying Functions

This section describes the gamut querying functions that Xlib provides. These functions allow the client to query the boundary of the screen's color gamut in terms of the CIE L*a*b*, CIE L*u*v*, and TekHVC color spaces. Functions are also provided that allow you to query the color specification of:

- White (full intensity red, green, and blue)
- Red (full intensity red while green and blue are zero)
- Green (full intensity green while red and blue are zero)
- Blue (full intensity blue while red and green are zero)
- Black (zero intensity red, green, and blue)

The white point associated with color specifications passed to and returned from these gamut querying functions is assumed to be the Screen White Point. This is a reasonable assumption, because the client is trying to query the screen's color gamut.

The following naming convention is used for the Max and Min functions:

Xcms<*color_space*>QueryMax<*dimensions*>

Xcms<*color_space*>QueryMin<*dimensions*>

The <dimensions> consists of a letter or letters that identify the dimensions of the color space that are not fixed. For example, **XcmsTekHVCQueryMaxC** is given a fixed Hue and Value for which maximum Chroma is found.

6.11.1. Red, Green, and Blue Queries

To obtain the color specification for black (zero intensity red, green, and blue), use **XcmsQueryBlack**.

Status XcmsQueryBlack(*ccc*, *target_format*, *color_return*)
    XcmsCCC *ccc*;
    XcmsColorFormat *target_format*;
    XcmsColor **color_return*;

ccc	Specifies the CCC. The CCC's Client White Point and white point adjustment procedures are ignored.
target_format	Specifies the target color specification format.
color_return	Returns the color specification in the specified target format for zero intensity red, green, and blue. The white point associated with the returned color specification is the Screen White Point. The value returned in the pixel member is undefined.

The **XcmsQueryBlack** function returns the color specification in the specified target format for zero intensity red, green, and blue.

To obtain the color specification for blue (full intensity blue while red and green are zero), use **XcmsQueryBlue**.

```
Status XcmsQueryBlue(ccc, target_format, color_return)
      XcmsCCC ccc;
      XcmsColorFormat target_format;
      XcmsColor *color_return;
```

ccc	Specifies the CCC. The CCC's Client White Point and white point adjustment procedures are ignored.
target_format	Specifies the target color specification format.
color_return	Returns the color specification in the specified target format for full intensity blue while red and green are zero. The white point associated with the returned color specification is the Screen White Point. The value returned in the pixel member is undefined.

The **XcmsQueryBlue** function returns the color specification in the specified target format for full intensity blue while red and green are zero.

To obtain the color specification for green (full intensity green while red and blue are zero), use **XcmsQueryGreen**.

```
Status XcmsQueryGreen(ccc, target_format, color_return)
      XcmsCCC ccc;
      XcmsColorFormat target_format;
      XcmsColor *color_return;
```

ccc	Specifies the CCC. The CCC's Client White Point and white point adjustment procedures are ignored.
target_format	Specifies the target color specification format.
color_return	Returns the color specification in the specified target format for full intensity green while red and blue are zero. The white point associated with the returned color specification is the Screen White Point. The value returned in the pixel member is undefined.

The **XcmsQueryGreen** function returns the color specification in the specified target format for full intensity green while red and blue are zero.

To obtain the color specification for red (full intensity red while green and blue are zero), use **XcmsQueryRed**.

Status XcmsQueryRed(*ccc*, *target_format*, *color_return*)
    XcmsCCC *ccc*;
    XcmsColorFormat *target_format*;
    XcmsColor **color_return*;

ccc	Specifies the CCC. The CCC's Client White Point and white point adjustment procedures are ignored.
target_format	Specifies the target color specification format.
color_return	Returns the color specification in the specified target format for full intensity red while green and blue are zero. The white point associated with the returned color specification is the Screen White Point. The value returned in the pixel member is undefined.

The **XcmsQueryRed** function returns the color specification in the specified target format for full intensity red while green and blue are zero.

To obtain the color specification for white (full intensity red, green, and blue), use **XcmsQueryWhite**.

Status XcmsQueryWhite(*ccc*, *target_format*, *color_return*)
    XcmsCCC *ccc*;
    XcmsColorFormat *target_format*;
    XcmsColor **color_return*;

ccc	Specifies the CCC. The CCC's Client White Point and white point adjustment procedures are ignored.
target_format	Specifies the target color specification format.
color_return	Returns the color specification in the specified target format for full intensity red, green, and blue. The white point associated with the returned color specification is the Screen White Point. The value returned in the pixel member is undefined.

The **XcmsQueryWhite** function returns the color specification in the specified target format for full intensity red, green, and blue.

6.11.2. CIELab Queries

The following equations are useful in describing the CIELab query functions:

$$\textit{CIELab Psychometric Chroma} = \textit{sqrt}(\textit{a\_star}^2 + \textit{b\_star}^2)$$

$$\textit{CIELab Psychometric Hue} = \tan^{-1}\left[\frac{\textit{b\_star}}{\textit{a\_star}}\right]$$

To obtain the CIE L*a*b* coordinates of maximum Psychometric Chroma for a given Psychometric Hue Angle and CIE metric lightness (L*), use **XcmsCIELabQueryMaxC**.

Status XcmsCIELabQueryMaxC(*ccc*, *hue_angle*, *L_star*, *color_return*)
    XcmsCCC *ccc*;
    XcmsFloat *hue_angle*;
    XcmsFloat *L_star*;
    XcmsColor **color_return*;

ccc	Specifies the CCC. The CCC's Client White Point and white point adjustment procedures are ignored.
hue_angle	Specifies the hue angle (in degrees) at which to find maximum chroma.
L_star	Specifies the lightness (L*) at which to find maximum chroma.
color_return	Returns the CIE L*a*b* coordinates of maximum chroma displayable by the screen for the given hue angle and lightness. The white point associated with the returned color specification is the Screen White Point. The value returned in the pixel member is undefined.

The **XcmsCIELabQueryMaxC** function, given a hue angle and lightness, finds the point of maximum chroma displayable by the screen. It returns this point in CIE L*a*b* coordinates.

To obtain the CIE L*a*b* coordinates of maximum CIE metric lightness (L*) for a given Psychometric Hue Angle and Psychometric Chroma, use **XcmsCIELabQueryMaxL**.

Status XcmsCIELabQueryMaxL(*ccc*, *hue_angle*, *chroma*, *color_return*)
    XcmsCCC *ccc*;
    XcmsFloat *hue_angle*;
    XcmsFloat *chroma*;
    XcmsColor **color_return*;

ccc	Specifies the CCC. The CCC's Client White Point and white point adjustment procedures are ignored.
hue_angle	Specifies the hue angle (in degrees) at which to find maximum lightness.
chroma	Specifies the chroma at which to find maximum lightness.
color_return	Returns the CIE L*a*b* coordinates of maximum lightness displayable by the screen for the given hue angle and chroma. The white point associated with the returned color specification is the Screen White Point. The value returned in the pixel member is undefined.

The **XcmsCIELabQueryMaxL** function, given a hue angle and chroma, finds the point in CIE L*a*b* color space of maximum lightness (L*) displayable by the screen. It returns this point in CIE L*a*b* coordinates. An **XcmsFailure** return value usually indicates that the given chroma is beyond maximum for the given hue angle.

To obtain the CIE L*a*b* coordinates of maximum Psychometric Chroma for a given Psychometric Hue Angle, use **XcmsCIELabQueryMaxLC**.

```
Status XcmsCIELabQueryMaxLC(ccc, hue_angle, color_return)
    XcmsCCC ccc;
    XcmsFloat hue_angle;
    XcmsColor *color_return;
```

ccc	Specifies the CCC. The CCC's Client White Point and white point adjustment procedures are ignored.
hue_angle	Specifies the hue angle (in degrees) at which to find maximum chroma.
color_return	Returns the CIE L*a*b* coordinates of maximum chroma displayable by the screen for the given hue angle. The white point associated with the returned color specification is the Screen White Point. The value returned in the pixel member is undefined.

The **XcmsCIELabQueryMaxLC** function, given a hue angle, finds the point of maximum chroma displayable by the screen. It returns this point in CIE L*a*b* coordinates.

To obtain the CIE L*a*b* coordinates of minimum CIE metric lightness (L*) for a given Psychometric Hue Angle and Psychometric Chroma, use **XcmsCIELabQueryMinL**.

```
Status XcmsCIELabQueryMinL(ccc, hue_angle, chroma, color_return)
    XcmsCCC ccc;
    XcmsFloat hue_angle;
    XcmsFloat chroma;
    XcmsColor *color_return;
```

ccc	Specifies the CCC. The CCC's Client White Point and white point adjustment procedures are ignored.
hue_angle	Specifies the hue angle (in degrees) at which to find minimum lightness.
chroma	Specifies the chroma at which to find minimum lightness.
color_return	Returns the CIE L*a*b* coordinates of minimum lightness displayable by the screen for the given hue angle and chroma. The white point associated with the returned color specification is the Screen White Point. The value returned in the pixel member is undefined.

The **XcmsCIELabQueryMinL** function, given a hue angle and chroma, finds the point of minimum lightness (L*) displayable by the screen. It returns this point in CIE L*a*b* coordinates. An **XcmsFailure** return value usually indicates that the given chroma is beyond maximum for the given hue angle.

6.11.3. CIELuv Queries

The following equations are useful in describing the CIELuv query functions:

$$CIELuv\ Psychometric\ Chroma = sqrt(u\_star^2 + v\_star^2)$$

$$CIELuv\ Psychometric\ Hue = \tan^{-1}\left[\frac{v\_star}{u\_star}\right]$$

To obtain the CIE L*u*v* coordinates of maximum Psychometric Chroma for a given Psychometric Hue Angle and CIE metric lightness (L*), use **XcmsCIELuvQueryMaxC**.

```
Status XcmsCIELuvQueryMaxC(ccc, hue_angle, L_star, color_return)
      XcmsCCC ccc;
      XcmsFloat hue_angle;
      XcmsFloat L_star;
      XcmsColor *color_return;
```

ccc	Specifies the CCC. The CCC's Client White Point and white point adjustment procedures are ignored.
hue_angle	Specifies the hue angle (in degrees) at which to find maximum chroma.
L_star	Specifies the lightness (L*) at which to find maximum chroma.
color_return	Returns the CIE L*u*v* coordinates of maximum chroma displayable by the screen for the given hue angle and lightness. The white point associated with the returned color specification is the Screen White Point. The value returned in the pixel member is undefined.

The **XcmsCIELuvQueryMaxC** function, given a hue angle and lightness, finds the point of maximum chroma displayable by the screen. It returns this point in CIE L*u*v* coordinates.

To obtain the CIE L*u*v* coordinates of maximum CIE metric lightness (L*) for a given Psychometric Hue Angle and Psychometric Chroma, use **XcmsCIELuvQueryMaxL**.

```
Status XcmsCIELuvQueryMaxL(ccc, hue_angle, chroma, color_return)
      XcmsCCC ccc;
      XcmsFloat hue_angle;
      XcmsFloat chroma;
      XcmsColor *color_return;
```

ccc	Specifies the CCC. The CCC's Client White Point and white point adjustment procedures are ignored.
hue_angle	Specifies the hue angle (in degrees) at which to find maximum lightness.
L_star	Specifies the lightness (L*) at which to find maximum lightness.
color_return	Returns the CIE L*u*v* coordinates of maximum lightness displayable by the screen for the given hue angle and chroma. The white point associated with the returned color specification is the Screen White Point. The value returned in the pixel member is undefined.

The **XcmsCIELuvQueryMaxL** function, given a hue angle and chroma, finds the point in CIE L*u*v* color space of maximum lightness (L*) displayable by the screen. It returns this point in CIE L*u*v* coordinates. An **XcmsFailure** return value usually indicates that the given chroma is beyond maximum for the given hue angle.

To obtain the CIE L*u*v* coordinates of maximum Psychometric Chroma for a given Psychometric Hue Angle, use **XcmsCIELuvQueryMaxLC**.

```
Status XcmsCIELuvQueryMaxLC(ccc, hue_angle, color_return)
      XcmsCCC ccc;
      XcmsFloat hue_angle;
      XcmsColor *color_return;
```

ccc	Specifies the CCC. The CCC's Client White Point and white point adjustment procedures are ignored.
hue_angle	Specifies the hue angle (in degrees) at which to find maximum chroma.
color_return	Returns the CIE L*u*v* coordinates of maximum chroma displayable by the screen for the given hue angle. The white point associated with the returned color specification is the Screen White Point. The value returned in the pixel member is undefined.

The **XcmsCIELuvQueryMaxLC** function, given a hue angle, finds the point of maximum chroma displayable by the screen. It returns this point in CIE L*u*v* coordinates.

To obtain the CIE L*u*v* coordinates of minimum CIE metric lightness (L*) for a given Psychometric Hue Angle and Psychometric Chroma, use **XcmsCIELuvQueryMinL**.

```
Status XcmsCIELuvQueryMinL(ccc, hue_angle, chroma, color_return)
      XcmsCCC ccc;
      XcmsFloat hue_angle;
      XcmsFloat chroma;
      XcmsColor *color_return;
```

ccc	Specifies the CCC. The CCC's Client White Point and white point adjustment procedures are ignored.
hue_angle	Specifies the hue angle (in degrees) at which to find minimum lightness.
chroma	Specifies the chroma at which to find minimum lightness.
color_return	Returns the CIE L*u*v* coordinates of minimum lightness displayable by the screen for the given hue angle and chroma. The white point associated with the returned color specification is the Screen White Point. The value returned in the pixel member is undefined.

The **XcmsCIELuvQueryMinL** function, given a hue angle and chroma, finds the point of minimum lightness (L*) displayable by the screen. It returns this point in CIE L*u*v* coordinates. An **XcmsFailure** return value usually indicates that the given chroma is beyond maximum for the given hue angle.

6.11.4. TekHVC Queries

To obtain the maximum Chroma for a given Hue and Value, use **XcmsTekHVCQueryMaxC**.

```
Status XcmsTekHVCQueryMaxC(ccc, hue, value, color_return)
    XcmsCCC ccc;
    XcmsFloat hue;
    XcmsFloat value;
    XcmsColor *color_return;
```

ccc	Specifies the CCC. The CCC's Client White Point and white point adjustment procedures are ignored.
hue	Specifies the Hue in which to find the maximum Chroma.
value	Specifies the Value in which to find the maximum Chroma.
color_return	Returns the maximum Chroma along with the actual Hue and Value at which the maximum Chroma was found. The white point associated with the returned color specification is the Screen White Point. The value returned in the pixel member is undefined.

The **XcmsTekHVCQueryMaxC** function, given a Hue and Value, determines the maximum Chroma in TekHVC color space displayable by the screen. It returns the maximum Chroma along with the actual Hue and Value at which the maximum Chroma was found.

To obtain the maximum Value for a given Hue and Chroma, use **XcmsTekHVCQueryMaxV**.

```
Status XcmsTekHVCQueryMaxV(ccc, hue, chroma, color_return)
    XcmsCCC ccc;
    XcmsFloat hue;
    XcmsFloat chroma;
    XcmsColor *color_return;
```

ccc	Specifies the CCC. The CCC's Client White Point and white point adjustment procedures are ignored.
hue	Specifies the Hue in which to find the maximum Value.
chroma	Specifies the chroma at which to find maximum Value.
color_return	Returns the maximum Value along with the Hue and Chroma at which the maximum Value was found. The white point associated with the returned color specification is the Screen White Point. The value returned in the pixel member is undefined.

The **XcmsTekHVCQueryMaxV** function, given a Hue and Chroma, determines the maximum Value in TekHVC color space displayable by the screen. It returns the maximum Value and the actual Hue and Chroma at which the maximum Value was found.

To obtain the maximum Chroma and Value at which it is reached for a specified Hue, use **XcmsTekHVCQueryMaxVC**.

Status XcmsTekHVCQueryMaxVC(*ccc*, *hue*, *color_return*)
    XcmsCCC *ccc*;
    XcmsFloat *hue*;
    XcmsColor **color_return*;

ccc	Specifies the CCC. The CCC's Client White Point and white point adjustment procedures are ignored.
hue	Specifies the Hue in which to find the maximum Chroma.
color_return	Returns the color specification in XcmsTekHVC for the maximum Chroma, the Value at which that maximum Chroma is reached, and the actual Hue at which the maximum Chroma was found. The white point associated with the returned color specification is the Screen White Point. The value returned in the pixel member is undefined.

The **XcmsTekHVCQueryMaxVC** function, given a Hue, determines the maximum Chroma in TekHVC color space displayable by the screen and the Value at which that maximum Chroma is reached. It returns the maximum Chroma, the Value at which that maximum Chroma is reached, and the actual Hue for which the maximum Chroma was found.

To obtain a specified number of TekHVC specifications such that they contain maximum Values for a specified Hue and the Chroma at which the maximum Values are reached, use **XcmsTekHVCQueryMaxVSamples**.

Status XcmsTekHVCQueryMaxVSamples(*ccc*, *hue*, *colors_return*, *nsamples*)
    XcmsCCC *ccc*;
    XcmsFloat *hue*;
    XcmsColor *colors_return[]*;
    unsigned int *nsamples*;

ccc	Specifies the CCC. The CCC's Client White Point and white point adjustment procedures are ignored.
hue	Specifies the Hue for maximum Chroma/Value samples.
nsamples	Specifies the number of samples.
colors_return	Returns nsamples of color specifications in XcmsTekHVC such that the Chroma is the maximum attainable for the Value and Hue. The white point associated with the returned color specification is the Screen White Point. The value returned in the pixel member is undefined.

The **XcmsTekHVCQueryMaxVSamples** returns nsamples of maximum Value, the Chroma at which that maximum Value is reached, and the actual Hue for which the maximum Chroma was found. These sample points may then be used to plot the maximum Value/Chroma boundary of the screen's color gamut for the specified Hue in TekHVC color space.

To obtain the minimum Value for a given Hue and Chroma, use **XcmsTekHVCQueryMinV**.

Status XcmsTekHVCQueryMinV(*ccc*, *hue*, *chroma*, *color_return*)
    XcmsCCC *ccc*;
    XcmsFloat *hue*;
    XcmsFloat *chroma*;
    XcmsColor **color_return*;

ccc	Specifies the CCC. The CCC's Client White Point and white point adjustment procedures are ignored.
hue	Specifies the Hue in which to find the minimum Value.
value	Specifies the Value in which to find the minimum Value.
color_return	Returns the minimum Value and the actual Hue and Chroma at which the minimum Value was found. The white point associated with the returned color specification is the Screen White Point. The value returned in the pixel member is undefined.

The **XcmsTekHVCQueryMinV** function, given a Hue and Chroma, determines the minimum Value in TekHVC color space displayable by the screen. It returns the minimum Value and the actual Hue and Chroma at which the minimum Value was found.

6.12. Color Management Extensions

The Xlib color management facilities can be extended in two ways:

- Device-Independent Color Spaces

  Device-independent color spaces that are derivable to CIE XYZ space can be added using the **XcmsAddColorSpace** function.

- Color Characterization Function Set

  A Color Characterization Function Set consists of device-dependent color spaces and their functions that convert between these color spaces and the CIE XYZ color space, bundled together for a specific class of output devices. A function set can be added using the **XcmsAddFunctionSet** function.

6.12.1. Color Spaces

The CIE XYZ color space serves as the hub for all conversions between device-independent and device-dependent color spaces. Therefore, the knowledge to convert an **XcmsColor** structure to and from CIE XYZ format is associated with each color space. For example, conversion from CIE L*u*v* to RGB requires the knowledge to convert from CIE L*u*v* to CIE XYZ and from CIE XYZ to RGB. This knowledge is stored as an array of functions that, when applied in series, will convert the **XcmsColor** structure to or from CIE XYZ format. This color specification conversion mechanism facilitates the addition of color spaces.

Of course, when converting between only device-independent color spaces or only device-dependent color spaces, shortcuts are taken whenever possible. For example, conversion from TekHVC to CIE L*u*v* is performed by intermediate conversion to CIE u*v*Y and then to CIE L*u*v*, thus bypassing conversion between CIE u*v*Y and CIE XYZ.

6.12.2. Adding Device-Independent Color Spaces

To add a device-independent color space, use **XcmsAddColorSpace**.

```
Status XcmsAddColorSpace(color_space)
    XcmsColorSpace *color_space;
```

color_space Specifies the device-independent color space to add.

The **XcmsAddColorSpace** function makes a device-independent color space (actually an **XcmsColorSpace** structure) accessible by the color management system. Because format values for unregistered color spaces are assigned at run time, they should be treated as private to the client. If references to an unregistered color space must be made outside the client (for example, storing color specifications in a file using the unregistered color space), then reference should be made by color space prefix (see **XcmsFormatOfPrefix** and **XcmsPrefixOfFormat**).

If the **XcmsColorSpace** structure is already accessible in the color management system, **XcmsAddColorSpace** returns **XcmsSuccess**.

Note that added **XcmsColorSpaces** must be retained for reference by Xlib.

6.12.3. Querying Color Space Format and Prefix

To obtain the format associated with the color space associated with a specified color string prefix, use **XcmsFormatOfPrefix**.

```
XcmsColorFormat XcmsFormatOfPrefix(prefix)
    char *prefix;
```

prefix Specifies the string that contains the color space prefix.

The **XcmsFormatOfPrefix** function returns the format for the specified color space prefix (for example, the string “CIEXYZ”). The prefix is case-insensitive. If the color space is not accessible in the color management system, **XcmsFormatOfPrefix** returns **XcmsUndefinedFormat**.

To obtain the color string prefix associated with the color space specified by a color format, use **XcmsPrefixOfFormat**.

```
char *XcmsPrefixOfFormat(format)
    XcmsColorFormat format;
```

format Specifies the color specification format.

The **XcmsPrefixOfFormat** function returns the string prefix associated with the color specification encoding specified by the format argument. Otherwise, if no encoding is found, it returns NULL. The returned string must be treated as read-only.

6.12.4. Creating Additional Color Spaces

Color space specific information necessary for color space conversion and color string parsing is stored in an **XcmsColorSpace** structure. Therefore, a new structure containing this information is required for each additional color space. In the case of device-independent color spaces, a handle to this new structure (that is, by means of a global variable) is usually made accessible to the client program for use with the **XcmsAddColorSpace** function.

If a new **XcmsColorSpace** structure specifies a color space not registered with the X Consortium, they should be treated as private to the client because format values for unregistered color spaces are assigned at run time. If references to an unregistered color space must be made outside the client (for example, storing color specifications in a file using the unregistered color space), then reference should be made by color space prefix (see **XcmsFormatOfPrefix** and **XcmsPrefixOfFormat**).

```
typedef (*XcmsConversionProc)();
typedef XcmsConversionProc *XcmsFuncListPtr;
                                        /* A NULL terminated list of function pointers*/

typedef struct _XcmsColorSpace {
        char *prefix;
        XcmsColorFormat format;
        XcmsParseStringProc parseString;
        XcmsFuncListPtr to_CIEXYZ;
        XcmsFuncListPtr from_CIEXYZ;
        int inverse_flag;
} XcmsColorSpace;
```

The prefix member specifies the prefix that indicates a color string is in this color space's string format. For example, the strings ‘‘ciexyz’’ or ‘‘CIEXYZ’’ for CIE XYZ, and ‘‘rgb’’ or ‘‘RGB’’ for RGB. The prefix is case-insensitive. The format member specifies the color specification format. Formats for unregistered color spaces are assigned at run time. The parseString member contains a pointer to the function that can parse a color string into an **XcmsColor** structure. This function returns an integer (int): nonzero if it succeeded and zero otherwise. The to_CIEXYZ and from_CIEXYZ members contain pointers, each to a NULL terminated list of function pointers. When the list of functions is executed in series, it will convert the color specified in an **XcmsColor** structure from/to the current color space format to/from the CIE XYZ format. Each function returns an integer (int): nonzero if it succeeded and zero otherwise. The white point to be associated with the colors is specified explicitly, even though white points can be found in the Color Conversion Context. The inverse_flag member, if nonzero, specifies that for each function listed in to_CIEXYZ, its inverse function can be found in from_CIEXYZ such that:

Given: n = number of functions in each list

```
for each i, such that 0 <= i < n
   from_CIEXYZ[n - i - 1] is the inverse of to_CIEXYZ[i].
```

This allows Xlib to use the shortest conversion path, thus bypassing CIE XYZ if possible (for example, TekHVC to CIE L*u*v*).

6.12.5. Parse String Callback

The callback in the **XcmsColorSpace** structure for parsing a color string for the particular color space must adhere to the following software interface specification:

```
typedef int (*XcmsParseStringProc)(color_string, color_return)
    char *color_string;
    XcmsColor *color_return;
```

color_string	Specifies the color string to parse.
color_return	Returns the color specification in the color space's format.

6.12.6. Color Specification Conversion Callback

Callback functions in the **XcmsColorSpace** structure for converting a color specification between device-independent spaces must adhere to the following software interface specification:

```
Status ConversionProc(ccc, white_point, colors_in_out, ncolors)
    XcmsCCC ccc;
    XcmsColor *white_point;
    XcmsColor *colors_in_out;
    unsigned int ncolors;
```

ccc	Specifies the CCC.
white_point	Specifies the white point associated with color specifications. The pixel member should be ignored, and the entire structure remain unchanged upon return.
colors_in_out	Specifies an array of color specifications. Pixel members should be ignored and must remain unchanged upon return.
ncolors	Specifies the number of **XcmsColor** structures in the color specification array.

Callback functions in the **XcmsColorSpace** structure for converting a color specification to or from a device-dependent space must adhere to the following software interface specification:

```
Status ConversionProc(ccc, colors_in_out, ncolors, compression_flags_return)
    XcmsCCC ccc;
    XcmsColor *colors_in_out;
    unsigned int ncolors;
    Bool compression_flags_return[];
```

ccc	Specifies the CCC.
colors_in_out	Specifies an array of color specifications. Pixel members should be ignored and must remain unchanged upon return.
ncolors	Specifies the number of **XcmsColor** structures in the color specification array.
compression_flags_return	Returns an array of Boolean values for indicating compression status. If a non-NULL pointer is supplied and a color at a given index is compressed, then **True** should be stored at the corresponding index in this array; otherwise, the array should not be modified.

Conversion functions are available globally for use by other color spaces. The conversion functions provided by Xlib are:

Function	Converts from	Converts to
XcmsCIELabToCIEXYZ	**XcmsCIELabFormat**	**XcmsCIEXYZFormat**
XcmsCIELuvToCIEuvY	**XcmsCIELuvFormat**	**XcmsCIEuvYFormat**
XcmsCIEXYZToCIELab	**XcmsCIEXYZFormat**	**XcmsCIELabFormat**
XcmsCIEXYZToCIEuvY	**XcmsCIEXYZFormat**	**XcmsCIEuvYFormat**
XcmsCIEXYZToCIExyY	**XcmsCIEXYZFormat**	**XcmsCIExyYFormat**
XcmsCIEXYZToRGBi	**XcmsCIEXYZFormat**	**XcmsRGBiFormat**
XcmsCIEuvYToCIELuv	**XcmsCIEuvYFormat**	**XcmsCIELabFormat**
XcmsCIEuvYToCIEXYZ	**XcmsCIEuvYFormat**	**XcmsCIEXYZFormat**
XcmsCIEuvYToTekHVC	**XcmsCIEuvYFormat**	**XcmsTekHVCFormat**
XcmsCIExyYToCIEXYZ	**XcmsCIExyYFormat**	**XcmsCIEXYZFormat**
XcmsRGBToRGBi	**XcmsRGBFormat**	**XcmsRGBiFormat**
XcmsRGBiToCIEXYZ	**XcmsRGBiFormat**	**XcmsCIEXYZFormat**
XcmsRGBiToRGB	**XcmsRGBiFormat**	**XcmsRGBFormat**
XcmsTekHVCToCIEuvY	**XcmsTekHVCFormat**	**XcmsCIEuvYFormat**

6.12.7. Function Sets

Functions to convert between device-dependent color spaces and CIE XYZ may differ for different classes of output devices (for example, color versus gray monitors). Therefore, the notion of a Color Characterization Function Set has been developed. A function set consists of device-dependent color spaces and the functions that convert color specifications between these device-dependent color spaces and the CIE XYZ color space appropriate for a particular class of output devices. The function set also contains a function that reads color characterization data off root window properties. It is this characterization data that will differ between devices within a class of output devices. For details about how color characterization data is stored in root window properties, see the section on Device Color Characterization in the *Inter-Client Communication Conventions Manual*. The LINEAR_RGB function set is provided by Xlib and will support most color monitors. Function sets may require data that differs from those needed for the LINEAR_RGB function set. In that case, its corresponding data may be stored on different root window properties.

6.12.8. Adding Function Sets

To add a function set, use **XcmsAddFunctionSet**.

Status XcmsAddFunctionSet(*function_set*)
   XcmsFunctionSet **function_set*;

function_set Specifies the function set to add.

The **XcmsAddFunctionSet** function adds a function set to the color management system. If the function set uses device-dependent **XcmsColorSpace** structures not accessible in the color management system, **XcmsAddFunctionSet** adds them. If an added **XcmsColorSpace** structure is for a device-dependent color space not registered with the X Consortium, they should be treated as private to the client because format values for unregistered color spaces are assigned at run time. If references to an unregistered color space must be made outside the client (for example, storing color specifications in a file using the unregistered color space), then reference should be made by color space prefix (see **XcmsFormatOfPrefix** and **XcmsPrefixOfFormat**).

Additional function sets should be added before any calls to other Xlib routines are made. If not, the **XcmsPerScrnInfo** member of a previously created **XcmsCCC** does not have the opportunity to initialize with the added function set.

6.12.9. Creating Additional Function Sets

The creation of additional function sets should be required only when an output device does not conform to existing function sets or when additional device-dependent color spaces are necessary. A function set consists primarily of a collection of device-dependent **XcmsColorSpace** structures and a means to read and store a screen's color characterization data. This data is stored in an **XcmsFunctionSet** structure. A handle to this structure (that is, by means of global variable) is usually made accessible to the client program for use with **XcmsAddFunctionSet**.

If a function set uses new device-dependent **XcmsColorSpace** structures, they will be transparently processed into the color management system. Function sets can share an **XcmsColorSpace** structure for a device-dependent color space. In addition, multiple **XcmsColorSpace** structures are allowed for a device-dependent color space; however, a function set can reference only one of them. These **XcmsColorSpace** structures will differ in the functions to convert to and from CIE XYZ, thus tailored for the specific function set.

```
typedef struct _XcmsFunctionSet {
        XcmsColorSpace **DDColorSpaces;
        XcmsScreenInitProc screenInitProc;
        XcmsScreenFreeProc screenFreeProc;
} XcmsFunctionSet;
```

The DDColorSpaces member is a pointer to a NULL terminated list of pointers to **XcmsColorSpace** structures for the device-dependent color spaces that are supported by the function set. The screenInitProc member is set to the callback procedure (see the following interface specification) that initializes the **XcmsPerScrnInfo** structure for a particular screen.

The screen initialization callback must adhere to the following software interface specification:

```
typedef Status (*XcmsScreenInitProc)(display, screen_number, screen_info)
    Display *display;
    int screen_number;
    XcmsPerScrnInfo *screen_info;
```

display Specifies the connection to the X server.

screen_number
Specifies the appropriate screen number on the host server.

screen_info Specifies the **XcmsPerScrnInfo** structure, which contains the per screen information.

The screen initialization callback in the **XcmsFunctionSet** structure fetches the color characterization data (device profile) for the specified screen, typically off properties on the screen's root window. It then initializes the specified **XcmsPerScrnInfo** structure. If successful, the procedure fills in the **XcmsPerScrnInfo** structure as follows:

- It sets the screenData member to the address of the created device profile data structure (contents known only by the function set).

- It next sets the screenWhitePoint member.
- It next sets the functionSet member to the address of the **XcmsFunctionSet** structure.
- It then sets the state member to **XcmsInitSuccess** and finally returns **XcmsSuccess**.

If unsuccessful, the procedure sets the state member to **XcmsInitFailure** and returns **XcmsFailure**.

The **XcmsPerScrnInfo** structure contains:

```
typedef struct _XcmsPerScrnInfo {
        XcmsColor screenWhitePoint;
        XPointer functionSet;
        XPointer screenData;
        unsigned char state;
        char pad[3];
} XcmsPerScrnInfo;
```

The screenWhitePoint member specifies the white point inherent to the screen. The functionSet member specifies the appropriate function set. The screenData member specifies the device profile. The state member is set to one of the following:

- **XcmsInitNone** indicates initialization has not been previously attempted.
- **XcmsInitFailure** indicates initialization has been previously attempted but failed.
- **XcmsInitSuccess** indicates initialization has been previously attempted and succeeded.

The screen free callback must adhere to the following software interface specification:

```
typedef void (*XcmsScreenFreeProc)(screenData)
    XPointer screenData;
```

screenData Specifies the data to be freed.

This function is called to free the screenData stored in an **XcmsPerScrnInfo** structure.

Chapter 7

Graphics Context Functions

A number of resources are used when performing graphics operations in X. Most information about performing graphics (for example, foreground color, background color, line style, and so on) is stored in resources called graphics contexts (GC). Most graphics operations (see chapter 8) take a GC as an argument. Although in theory the X protocol permits sharing of GCs between applications, it is expected that applications will use their own GCs when performing operations. Sharing of GCs is highly discouraged because the library may cache GC state.

Graphics operations can be performed to either windows or pixmaps, which collectively are called drawables. Each drawable exists on a single screen. A GC is created for a specific screen and drawable depth and can only be used with drawables of matching screen and depth.

This chapter discusses how to:

- Manipulate graphics context/state
- Use GC convenience functions

7.1. Manipulating Graphics Context/State

Most attributes of graphics operations are stored in Graphic Contexts (GCs). These include line width, line style, plane mask, foreground, background, tile, stipple, clipping region, end style, join style, and so on. Graphics operations (for example, drawing lines) use these values to determine the actual drawing operation. Extensions to X may add additional components to GCs. The contents of a GC are private to Xlib.

Xlib implements a write-back cache for all elements of a GC that are not resource IDs to allow Xlib to implement the transparent coalescing of changes to GCs. For example, a call to **XSetForeground** of a GC followed by a call to **XSetLineAttributes** results in only a single-change GC protocol request to the server. GCs are neither expected nor encouraged to be shared between client applications, so this write-back caching should present no problems. Applications cannot share GCs without external synchronization. Therefore, sharing GCs between applications is highly discouraged.

To set an attribute of a GC, set the appropriate member of the **XGCValues** structure and OR in the corresponding value bitmask in your subsequent calls to **XCreateGC**. The symbols for the value mask bits and the **XGCValues** structure are:

```
/* GC attribute value mask bits */

#define     GCFunction                  (1L<<0)
#define     GCPlaneMask                 (1L<<1)
#define     GCForeground                (1L<<2)
#define     GCBackground                (1L<<3)
#define     GCLineWidth                 (1L<<4)
#define     GCLineStyle                 (1L<<5)
#define     GCCapStyle                  (1L<<6)
#define     GCJoinStyle                 (1L<<7)
#define     GCFillStyle                 (1L<<8)
#define     GCFillRule                  (1L<<9)
#define     GCTile                      (1L<<10)
#define     GCStipple                   (1L<<11)
#define     GCTileStipXOrigin           (1L<<12)
#define     GCTileStipYOrigin           (1L<<13)
#define     GCFont                      (1L<<14)
#define     GCSubwindowMode             (1L<<15)
#define     GCGraphicsExposures         (1L<<16)
#define     GCClipXOrigin               (1L<<17)
#define     GCClipYOrigin               (1L<<18)
#define     GCClipMask                  (1L<<19)
#define     GCDashOffset                (1L<<20)
#define     GCDashList                  (1L<<21)
#define     GCArcMode                   (1L<<22)

/* Values */

typedef struct {
        int function;                   /* logical operation */
        unsigned long plane_mask;       /* plane mask */
        unsigned long foreground;       /* foreground pixel */
        unsigned long background;       /* background pixel */
        int line_width;                 /* line width (in pixels) */
        int line_style;                 /* LineSolid, LineOnOffDash, LineDoubleDash */
        int cap_style;                  /* CapNotLast, CapButt, CapRound, CapProjecting */
        int join_style;                 /* JoinMiter, JoinRound, JoinBevel */
        int fill_style;                 /* FillSolid, FillTiled, FillStippled FillOpaqueStippled*/
        int fill_rule;                  /* EvenOddRule, WindingRule */
        int arc_mode;                   /* ArcChord, ArcPieSlice */
        Pixmap tile;                    /* tile pixmap for tiling operations */
        Pixmap stipple;                 /* stipple 1 plane pixmap for stippling */
        int ts_x_origin;                /* offset for tile or stipple operations */
        int ts_y_origin;
        Font font;                      /* default text font for text operations */
        int subwindow_mode;             /* ClipByChildren, IncludeInferiors */
        Bool graphics_exposures;        /* boolean, should exposures be generated */
        int clip_x_origin;              /* origin for clipping */
        int clip_y_origin;
        Pixmap clip_mask;               /* bitmap clipping; other calls for rects */
        int dash_offset;                /* patterned/dashed line information */
```

```
        char dashes;
} XGCValues;
```

The default GC values are:

Component	Default
function	**GXcopy**
plane_mask	All ones
foreground	0
background	1
line_width	0
line_style	**LineSolid**
cap_style	**CapButt**
join_style	**JoinMiter**
fill_style	**FillSolid**
fill_rule	**EvenOddRule**
arc_mode	**ArcPieSlice**
tile	Pixmap of unspecified size filled with foreground pixel (that is, client specified pixel if any, else 0) (subsequent changes to foreground do not affect this pixmap)
stipple	Pixmap of unspecified size filled with ones
ts_x_origin	0
ts_y_origin	0
font	<implementation dependent>
subwindow_mode	**ClipByChildren**
graphics_exposures	**True**
clip_x_origin	0
clip_y_origin	0
clip_mask	**None**
dash_offset	0
dashes	4 (that is, the list [4, 4])

Note that foreground and background are not set to any values likely to be useful in a window.

The function attributes of a GC are used when you update a section of a drawable (the destination) with bits from somewhere else (the source). The function in a GC defines how the new destination bits are to be computed from the source bits and the old destination bits. **GXcopy** is typically the most useful because it will work on a color display, but special applications may use other functions, particularly in concert with particular planes of a color display. The 16 GC functions, defined in **<X11/X.h>**, are:

Function Name	Value	Operation
GXclear	0x0	0
GXand	0x1	src AND dst
GXandReverse	0x2	src AND NOT dst
GXcopy	0x3	src

Function Name	Value	Operation
GXandInverted	0x4	(NOT src) AND dst
GXnoop	0x5	dst
GXxor	0x6	src XOR dst
GXor	0x7	src OR dst
GXnor	0x8	(NOT src) AND (NOT dst)
GXequiv	0x9	(NOT src) XOR dst
GXinvert	0xa	NOT dst
GXorReverse	0xb	src OR (NOT dst)
GXcopyInverted	0xc	NOT src
GXorInverted	0xd	(NOT src) OR dst
GXnand	0xe	(NOT src) OR (NOT dst)
GXset	0xf	1

Many graphics operations depend on either pixel values or planes in a GC. The planes attribute is of type long, and it specifies which planes of the destination are to be modified, one bit per plane. A monochrome display has only one plane and will be the least-significant bit of the word. As planes are added to the display hardware, they will occupy more significant bits in the plane mask.

In graphics operations, given a source and destination pixel, the result is computed bitwise on corresponding bits of the pixels. That is, a Boolean operation is performed in each bit plane. The plane_mask restricts the operation to a subset of planes. A macro constant **AllPlanes** can be used to refer to all planes of the screen simultaneously. The result is computed by the following:

> ((src FUNC dst) AND plane-mask) OR (dst AND (NOT plane-mask))

Range checking is not performed on the values for foreground, background, or plane_mask. They are simply truncated to the appropriate number of bits. The line-width is measured in pixels and either can be greater than or equal to one (wide line) or can be the special value zero (thin line).

Wide lines are drawn centered on the path described by the graphics request. Unless otherwise specified by the join-style or cap-style, the bounding box of a wide line with endpoints [x1, y1], [x2, y2] and width w is a rectangle with vertices at the following real coordinates:

> [x1-(w*sn/2), y1+(w*cs/2)], [x1+(w*sn/2), y1-(w*cs/2)],
> [x2-(w*sn/2), y2+(w*cs/2)], [x2+(w*sn/2), y2-(w*cs/2)]

Here sn is the sine of the angle of the line, and cs is the cosine of the angle of the line. A pixel is part of the line and so is drawn if the center of the pixel is fully inside the bounding box (which is viewed as having infinitely thin edges). If the center of the pixel is exactly on the bounding box, it is part of the line if and only if the interior is immediately to its right (x increasing direction). Pixels with centers on a horizontal edge are a special case and are part of the line if and only if the interior or the boundary is immediately below (y increasing direction) and the interior or the boundary is immediately to the right (x increasing direction).

Thin lines (zero line-width) are one-pixel-wide lines drawn using an unspecified, device-dependent algorithm. There are only two constraints on this algorithm.

1. If a line is drawn unclipped from [x1,y1] to [x2,y2] and if another line is drawn unclipped from [x1+dx,y1+dy] to [x2+dx,y2+dy], a point [x,y] is touched by drawing the first line if and only if the point [x+dx,y+dy] is touched by drawing the second line.

2. The effective set of points comprising a line cannot be affected by clipping. That is, a point is touched in a clipped line if and only if the point lies inside the clipping region and the point would be touched by the line when drawn unclipped.

A wide line drawn from [x1,y1] to [x2,y2] always draws the same pixels as a wide line drawn from [x2,y2] to [x1,y1], not counting cap-style and join-style. It is recommended that this property be true for thin lines, but this is not required. A line-width of zero may differ from a line-width of one in which pixels are drawn. This permits the use of many manufacturers' line drawing hardware, which may run many times faster than the more precisely specified wide lines.

In general, drawing a thin line will be faster than drawing a wide line of width one. However, because of their different drawing algorithms, thin lines may not mix well aesthetically with wide lines. If it is desirable to obtain precise and uniform results across all displays, a client should always use a line-width of one rather than a line-width of zero.

The line-style defines which sections of a line are drawn:

LineSolid	The full path of the line is drawn.
LineDoubleDash	The full path of the line is drawn, but the even dashes are filled differently than the odd dashes (see fill-style) with **CapButt** style used where even and odd dashes meet.
LineOnOffDash	Only the even dashes are drawn, and cap-style applies to all internal ends of the individual dashes, except **CapNotLast** is treated as **CapButt**.

The cap-style defines how the endpoints of a path are drawn:

CapNotLast	This is equivalent to **CapButt** except that for a line-width of zero the final endpoint is not drawn.
CapButt	The line is square at the endpoint (perpendicular to the slope of the line) with no projection beyond.
CapRound	The line has a circular arc with the diameter equal to the line-width, centered on the endpoint. (This is equivalent to **CapButt** for line-width of zero).
CapProjecting	The line is square at the end, but the path continues beyond the endpoint for a distance equal to half the line-width. (This is equivalent to **CapButt** for line-width of zero).

The join-style defines how corners are drawn for wide lines:

JoinMiter	The outer edges of two lines extend to meet at an angle. However, if the angle is less than 11 degrees, then a **JoinBevel** join-style is used instead.
JoinRound	The corner is a circular arc with the diameter equal to the line-width, centered on the joinpoint.
JoinBevel	The corner has **CapButt** endpoint styles with the triangular notch filled.

For a line with coincident endpoints (x1=x2, y1=y2), when the cap-style is applied to both endpoints, the semantics depends on the line-width and the cap-style:

CapNotLast	thin	The results are device-dependent, but the desired effect is that nothing is drawn.

CapButt	thin	The results are device-dependent, but the desired effect is that a single pixel is drawn.
CapRound	thin	The results are the same as for **CapButt**/thin.
CapProjecting	thin	The results are the same as for **CapButt**/thin.
CapButt	wide	Nothing is drawn.
CapRound	wide	The closed path is a circle, centered at the endpoint, and with the diameter equal to the line-width.
CapProjecting	wide	The closed path is a square, aligned with the coordinate axes, centered at the endpoint, and with the sides equal to the line-width.

For a line with coincident endpoints (x1=x2, y1=y2), when the join-style is applied at one or both endpoints, the effect is as if the line was removed from the overall path. However, if the total path consists of or is reduced to a single point joined with itself, the effect is the same as when the cap-style is applied at both endpoints.

The tile/stipple represents an infinite two-dimensional plane, with the tile/stipple replicated in all dimensions. When that plane is superimposed on the drawable for use in a graphics operation, the upper-left corner of some instance of the tile/stipple is at the coordinates within the drawable specified by the tile/stipple origin. The tile/stipple and clip origins are interpreted relative to the origin of whatever destination drawable is specified in a graphics request. The tile pixmap must have the same root and depth as the GC, or a **BadMatch** error results. The stipple pixmap must have depth one and must have the same root as the GC, or a **BadMatch** error results. For stipple operations where the fill-style is **FillStippled** but not **FillOpaqueStippled**, the stipple pattern is tiled in a single plane and acts as an additional clip mask to be ANDed with the clip-mask. Although some sizes may be faster to use than others, any size pixmap can be used for tiling or stippling.

The fill-style defines the contents of the source for line, text, and fill requests. For all text and fill requests (for example, **XDrawText**, **XDrawText16**, **XFillRectangle**, **XFillPolygon**, and **XFillArc**); for line requests with line-style **LineSolid** (for example, **XDrawLine**, **XDrawSegments**, **XDrawRectangle**, **XDrawArc**); and for the even dashes for line requests with line-style **LineOnOffDash** or **LineDoubleDash**, the following apply:

FillSolid	Foreground
FillTiled	Tile
FillOpaqueStippled	A tile with the same width and height as stipple, but with background everywhere stipple has a zero and with foreground everywhere stipple has a one
FillStippled	Foreground masked by stipple

When drawing lines with line-style **LineDoubleDash**, the odd dashes are controlled by the fill-style in the following manner:

FillSolid	Background
FillTiled	Same as for even dashes
FillOpaqueStippled	Same as for even dashes

FillStippled	Background masked by stipple

Storing a pixmap in a GC might or might not result in a copy being made. If the pixmap is later used as the destination for a graphics request, the change might or might not be reflected in the GC. If the pixmap is used simultaneously in a graphics request both as a destination and as a tile or stipple, the results are undefined.

For optimum performance, you should draw as much as possible with the same GC (without changing its components). The costs of changing GC components relative to using different GCs depend upon the display hardware and the server implementation. It is quite likely that some amount of GC information will be cached in display hardware and that such hardware can only cache a small number of GCs.

The dashes value is actually a simplified form of the more general patterns that can be set with **XSetDashes**. Specifying a value of N is equivalent to specifying the two-element list [N, N] in **XSetDashes**. The value must be nonzero, or a **BadValue** error results.

The clip-mask restricts writes to the destination drawable. If the clip-mask is set to a pixmap, it must have depth one and have the same root as the GC, or a **BadMatch** error results. If clip-mask is set to **None**, the pixels are always drawn regardless of the clip origin. The clip-mask also can be set by calling the **XSetClipRectangles** or **XSetRegion** functions. Only pixels where the clip-mask has a bit set to 1 are drawn. Pixels are not drawn outside the area covered by the clip-mask or where the clip-mask has a bit set to 0. The clip-mask affects all graphics requests. The clip-mask does not clip sources. The clip-mask origin is interpreted relative to the origin of whatever destination drawable is specified in a graphics request.

You can set the subwindow-mode to **ClipByChildren** or **IncludeInferiors**. For **ClipByChildren**, both source and destination windows are additionally clipped by all viewable **InputOutput** children. For **IncludeInferiors**, neither source nor destination window is clipped by inferiors. This will result in including subwindow contents in the source and drawing through subwindow boundaries of the destination. The use of **IncludeInferiors** on a window of one depth with mapped inferiors of differing depth is not illegal, but the semantics are undefined by the core protocol.

The fill-rule defines what pixels are inside (drawn) for paths given in **XFillPolygon** requests and can be set to **EvenOddRule** or **WindingRule**. For **EvenOddRule**, a point is inside if an infinite ray with the point as origin crosses the path an odd number of times. For **WindingRule**, a point is inside if an infinite ray with the point as origin crosses an unequal number of clockwise and counterclockwise directed path segments. A clockwise directed path segment is one that crosses the ray from left to right as observed from the point. A counterclockwise segment is one that crosses the ray from right to left as observed from the point. The case where a directed line segment is coincident with the ray is uninteresting because you can simply choose a different ray that is not coincident with a segment.

For both **EvenOddRule** and **WindingRule**, a point is infinitely small, and the path is an infinitely thin line. A pixel is inside if the center point of the pixel is inside and the center point is not on the boundary. If the center point is on the boundary, the pixel is inside if and only if the polygon interior is immediately to its right (x increasing direction). Pixels with centers on a horizontal edge are a special case and are inside if and only if the polygon interior is immediately below (y increasing direction).

The arc-mode controls filling in the **XFillArcs** function and can be set to **ArcPieSlice** or **ArcChord**. For **ArcPieSlice**, the arcs are pie-slice filled. For **ArcChord**, the arcs are chord filled.

The graphics-exposure flag controls **GraphicsExpose** event generation for **XCopyArea** and **XCopyPlane** requests (and any similar requests defined by extensions).

To create a new GC that is usable on a given screen with a depth of drawable, use **XCreateGC**.

```
GC XCreateGC(display, d, valuemask, values)
      Display *display;
      Drawable d;
      unsigned long valuemask;
      XGCValues *values;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
valuemask	Specifies which components in the GC are to be set using the information in the specified values structure. This argument is the bitwise inclusive OR of zero or more of the valid GC component mask bits.
values	Specifies any values as specified by the valuemask.

The **XCreateGC** function creates a graphics context and returns a GC. The GC can be used with any destination drawable having the same root and depth as the specified drawable. Use with other drawables results in a **BadMatch** error.

XCreateGC can generate **BadAlloc**, **BadDrawable**, **BadFont**, **BadMatch**, **BadPixmap**, and **BadValue** errors.

To copy components from a source GC to a destination GC, use **XCopyGC**.

```
XCopyGC(display, src, valuemask, dest)
      Display *display;
      GC src, dest;
      unsigned long valuemask;
```

display	Specifies the connection to the X server.
src	Specifies the components of the source GC.
valuemask	Specifies which components in the GC are to be copied to the destination GC. This argument is the bitwise inclusive OR of zero or more of the valid GC component mask bits.
dest	Specifies the destination GC.

The **XCopyGC** function copies the specified components from the source GC to the destination GC. The source and destination GCs must have the same root and depth, or a **BadMatch** error results. The valuemask specifies which component to copy, as for **XCreateGC**.

XCopyGC can generate **BadAlloc**, **BadGC**, and **BadMatch** errors.

To change the components in a given GC, use **XChangeGC**.

XChangeGC(*display*, *gc*, *valuemask*, *values*)
  Display **display*;
  GC *gc*;
  unsigned long *valuemask*;
  XGCValues **values*;

display	Specifies the connection to the X server.
gc	Specifies the GC.
valuemask	Specifies which components in the GC are to be changed using information in the specified values structure. This argument is the bitwise inclusive OR of zero or more of the valid GC component mask bits.
values	Specifies any values as specified by the valuemask.

The **XChangeGC** function changes the components specified by valuemask for the specified GC. The values argument contains the values to be set. The values and restrictions are the same as for **XCreateGC**. Changing the clip-mask overrides any previous **XSetClipRectangles** request on the context. Changing the dash-offset or dash-list overrides any previous **XSetDashes** request on the context. The order in which components are verified and altered is server-dependent. If an error is generated, a subset of the components may have been altered.

XChangeGC can generate **BadAlloc**, **BadFont**, **BadGC**, **BadMatch**, **BadPixmap**, and **BadValue** errors.

To obtain components of a given GC, use **XGetGCValues**.

Status XGetGCValues(*display*, *gc*, *valuemask*, *values_return*)
  Display **display*;
  GC *gc*;
  unsigned long *valuemask*;
  XGCValues **values_return*;

display	Specifies the connection to the X server.
gc	Specifies the GC.
valuemask	Specifies which components in the GC are to be returned in the values_return argument. This argument is the bitwise inclusive OR of zero or more of the valid GC component mask bits.
values_return	Returns the GC values in the specified **XGCValues** structure.

The **XGetGCValues** function returns the components specified by valuemask for the specified GC. If the valuemask contains a valid set of GC mask bits (**GCFunction**, **GCPlaneMask**, **GCForeground**, **GCBackground**, **GCLineWidth**, **GCLineStyle**, **GCCapStyle**, **GCJoinStyle**, **GCFillStyle**, **GCFillRule**, **GCTile**, **GCStipple**, **GCTileStipXOrigin**, **GCTileStipYOrigin**, **GCFont**, **GCSubwindowMode**, **GCGraphicsExposures**, **GCClipXOrigin**, **GCCLipYOrigin**, **GCDashOffset**, or **GCArcMode**) and no error occurs, **XGetGCValues** sets the requested components in values_return and returns a nonzero status. Otherwise, it returns a zero status. Note that the clip-mask and dash-list (represented by the **GCClipMask** and **GCDashList** bits, respectively, in the valuemask) cannot be requested. Also note that an invalid resource ID (with one or more of the three most-significant bits set to 1) will be returned for **GCFont**, **GCTile**, and **GCStipple** if the component has never been explicitly set by the client.

To free a given GC, use **XFreeGC**.

```
XFreeGC(display, gc)
      Display *display;
      GC gc;
```

display Specifies the connection to the X server.

gc Specifies the GC.

The **XFreeGC** function destroys the specified GC as well as all the associated storage.

XFreeGC can generate a **BadGC** error.

To obtain the **GContext** resource ID for a given GC, use **XGContextFromGC**.

```
GContext XGContextFromGC(gc)
      GC gc;
```

gc Specifies the GC for which you want the resource ID.

Xlib usually defers sending changes to the components of a GC to the server until a graphics function is actually called with that GC. This permits batching of component changes into a single server request. In some circumstances, however, it may be necessary for the client to explicitly force sending the changes to the server. An example might be when a protocol extension uses the GC indirectly, in such a way that the extension interface cannot know what GC will be used. To force sending GC component changes, use **XFlushGC**.

```
void XFlushGC(display, gc)
      Display *display;
      GC gc;
```

display Specifies the connection to the X server.

gc Specifies the GC.

7.2. Using GC Convenience Routines

This section discusses how to set the:

- Foreground, background, plane mask, or function components
- Line attributes and dashes components
- Fill style and fill rule components
- Fill tile and stipple components
- Font component
- Clip region component

- Arc mode, subwindow mode, and graphics exposure components

7.2.1. Setting the Foreground, Background, Function, or Plane Mask

To set the foreground, background, plane mask, and function components for a given GC, use **XSetState**.

```
XSetState(display, gc, foreground, background, function, plane_mask)
      Display *display;
      GC gc;
      unsigned long foreground, background;
      int function;
      unsigned long plane_mask;
```

display	Specifies the connection to the X server.
gc	Specifies the GC.
foreground	Specifies the foreground you want to set for the specified GC.
background	Specifies the background you want to set for the specified GC.
function	Specifies the function you want to set for the specified GC.
plane_mask	Specifies the plane mask.

XSetState can generate **BadAlloc**, **BadGC**, and **BadValue** errors.

To set the foreground of a given GC, use **XSetForeground**.

```
XSetForeground(display, gc, foreground)
      Display *display;
      GC gc;
      unsigned long foreground;
```

display	Specifies the connection to the X server.
gc	Specifies the GC.
foreground	Specifies the foreground you want to set for the specified GC.

XSetForeground can generate **BadAlloc** and **BadGC** errors.

To set the background of a given GC, use **XSetBackground**.

```
XSetBackground(display, gc, background)
      Display *display;
      GC gc;
      unsigned long background;
```

display	Specifies the connection to the X server.
gc	Specifies the GC.
background	Specifies the background you want to set for the specified GC.

XSetBackground can generate **BadAlloc** and **BadGC** errors.

To set the display function in a given GC, use **XSetFunction**.

```
XSetFunction(display, gc, function)
      Display *display;
      GC gc;
      int function;
```

display	Specifies the connection to the X server.
gc	Specifies the GC.
function	Specifies the function you want to set for the specified GC.

XSetFunction can generate **BadAlloc**, **BadGC**, and **BadValue** errors.

To set the plane mask of a given GC, use **XSetPlaneMask**.

```
XSetPlaneMask(display, gc, plane_mask)
      Display *display;
      GC gc;
      unsigned long plane_mask;
```

display	Specifies the connection to the X server.
gc	Specifies the GC.
plane_mask	Specifies the plane mask.

XSetPlaneMask can generate **BadAlloc** and **BadGC** errors.

7.2.2. Setting the Line Attributes and Dashes

To set the line drawing components of a given GC, use **XSetLineAttributes**.

XSetLineAttributes(*display*, *gc*, *line_width*, *line_style*, *cap_style*, *join_style*)
  Display **display*;
  GC *gc*;
  unsigned int *line_width*;
  int *line_style*;
  int *cap_style*;
  int *join_style*;

display	Specifies the connection to the X server.
gc	Specifies the GC.
line_width	Specifies the line-width you want to set for the specified GC.
line_style	Specifies the line-style you want to set for the specified GC. You can pass **LineSolid**, **LineOnOffDash**, or **LineDoubleDash**.
cap_style	Specifies the line-style and cap-style you want to set for the specified GC. You can pass **CapNotLast**, **CapButt**, **CapRound**, or **CapProjecting**.
join_style	Specifies the line join-style you want to set for the specified GC. You can pass **JoinMiter**, **JoinRound**, or **JoinBevel**.

XSetLineAttributes can generate **BadAlloc**, **BadGC**, and **BadValue** errors.

To set the dash-offset and dash-list for dashed line styles of a given GC, use **XSetDashes**.

XSetDashes(*display*, *gc*, *dash_offset*, *dash_list*, *n*)
  Display **display*;
  GC *gc*;
  int *dash_offset*;
  char *dash_list*[];
  int *n*;

display	Specifies the connection to the X server.
gc	Specifies the GC.
dash_offset	Specifies the phase of the pattern for the dashed line-style you want to set for the specified GC.
dash_list	Specifies the dash-list for the dashed line-style you want to set for the specified GC.
n	Specifies the number of elements in dash_list.

The **XSetDashes** function sets the dash-offset and dash-list attributes for dashed line styles in the specified GC. There must be at least one element in the specified dash_list, or a **BadValue** error results. The initial and alternating elements (second, fourth, and so on) of the dash_list are the even dashes, and the others are the odd dashes. Each element specifies a dash length in pixels. All of the elements must be nonzero, or a **BadValue** error results. Specifying an odd-length list is equivalent to specifying the same list concatenated with itself to produce an even-length list.

The dash-offset defines the phase of the pattern, specifying how many pixels into the dash-list the pattern should actually begin in any single graphics request. Dashing is continuous through path elements combined with a join-style but is reset to the dash-offset between each sequence of joined lines.

The unit of measure for dashes is the same for the ordinary coordinate system. Ideally, a dash length is measured along the slope of the line, but implementations are only required to match this ideal for horizontal and vertical lines. Failing the ideal semantics, it is suggested that the length be measured along the major axis of the line. The major axis is defined as the x axis for lines drawn at an angle of between −45 and +45 degrees or between 135 and 225 degrees from the x axis. For all other lines, the major axis is the y axis.

XSetDashes can generate **BadAlloc**, **BadGC**, and **BadValue** errors.

7.2.3. Setting the Fill Style and Fill Rule

To set the fill-style of a given GC, use **XSetFillStyle**.

```
XSetFillStyle(display, gc, fill_style)
    Display *display;
    GC gc;
    int fill_style;
```

display	Specifies the connection to the X server.
gc	Specifies the GC.
fill_style	Specifies the fill-style you want to set for the specified GC. You can pass **FillSolid**, **FillTiled**, **FillStippled**, or **FillOpaqueStippled**.

XSetFillStyle can generate **BadAlloc**, **BadGC**, and **BadValue** errors.

To set the fill-rule of a given GC, use **XSetFillRule**.

```
XSetFillRule(display, gc, fill_rule)
    Display *display;
    GC gc;
    int fill_rule;
```

display	Specifies the connection to the X server.
gc	Specifies the GC.
fill_rule	Specifies the fill-rule you want to set for the specified GC. You can pass **EvenOddRule** or **WindingRule**.

XSetFillRule can generate **BadAlloc**, **BadGC**, and **BadValue** errors.

7.2.4. Setting the Fill Tile and Stipple

Some displays have hardware support for tiling or stippling with patterns of specific sizes. Tiling and stippling operations that restrict themselves to those specific sizes run much faster than such operations with arbitrary size patterns. Xlib provides functions that you can use to determine the best size, tile, or stipple for the display as well as to set the tile or stipple shape and the tile or stipple origin.

To obtain the best size of a tile, stipple, or cursor, use **XQueryBestSize**.

Status XQueryBestSize(*display*, *class*, *which_screen*, *width*, *height*, *width_return*, *height_return*)
    Display **display*;
    int *class*;
    Drawable *which_screen*;
    unsigned int *width*, *height*;
    unsigned int **width_return*, **height_return*;

display	Specifies the connection to the X server.
class	Specifies the class that you are interested in. You can pass **TileShape**, **CursorShape**, or **StippleShape**.
which_screen	Specifies any drawable on the screen.
width	
height	Specify the width and height.
width_return	
height_return	Return the width and height of the object best supported by the display hardware.

The **XQueryBestSize** function returns the best or closest size to the specified size. For **CursorShape**, this is the largest size that can be fully displayed on the screen specified by which_screen. For **TileShape**, this is the size that can be tiled fastest. For **StippleShape**, this is the size that can be stippled fastest. For **CursorShape**, the drawable indicates the desired screen. For **TileShape** and **StippleShape**, the drawable indicates the screen and possibly the window class and depth. An **InputOnly** window cannot be used as the drawable for **TileShape** or **StippleShape**, or a **BadMatch** error results.

XQueryBestSize can generate **BadDrawable**, **BadMatch**, and **BadValue** errors.

To obtain the best fill tile shape, use **XQueryBestTile**.

Status XQueryBestTile(*display*, *which_screen*, *width*, *height*, *width_return*, *height_return*)
    Display **display*;
    Drawable *which_screen*;
    unsigned int *width*, *height*;
    unsigned int **width_return*, **height_return*;

display	Specifies the connection to the X server.
which_screen	Specifies any drawable on the screen.
width	
height	Specify the width and height.
width_return	
height_return	Return the width and height of the object best supported by the display hardware.

The **XQueryBestTile** function returns the best or closest size, that is, the size that can be tiled fastest on the screen specified by which_screen. The drawable indicates the screen and possibly the window class and depth. If an **InputOnly** window is used as the drawable, a **BadMatch** error results.

XQueryBestTile can generate **BadDrawable** and **BadMatch** errors.

To obtain the best stipple shape, use **XQueryBestStipple**.

```
Status XQueryBestStipple(display, which_screen, width, height, width_return, height_return)
      Display *display;
      Drawable which_screen;
      unsigned int width, height;
      unsigned int *width_return, *height_return;
```

display	Specifies the connection to the X server.
which_screen	Specifies any drawable on the screen.
width *height*	Specify the width and height.
width_return *height_return*	Return the width and height of the object best supported by the display hardware.

The **XQueryBestStipple** function returns the best or closest size, that is, the size that can be stippled fastest on the screen specified by which_screen. The drawable indicates the screen and possibly the window class and depth. If an **InputOnly** window is used as the drawable, a **BadMatch** error results.

XQueryBestStipple can generate **BadDrawable** and **BadMatch** errors.

To set the fill tile of a given GC, use **XSetTile**.

```
XSetTile(display, gc, tile)
      Display *display;
      GC gc;
      Pixmap tile;
```

display	Specifies the connection to the X server.
gc	Specifies the GC.
tile	Specifies the fill tile you want to set for the specified GC.

The tile and GC must have the same depth, or a **BadMatch** error results.

XSetTile can generate **BadAlloc**, **BadGC**, **BadMatch**, and **BadPixmap** errors.

To set the stipple of a given GC, use **XSetStipple**.

```
XSetStipple(display, gc, stipple)
      Display *display;
      GC gc;
      Pixmap stipple;
```

display	Specifies the connection to the X server.
gc	Specifies the GC.
stipple	Specifies the stipple you want to set for the specified GC.

The stipple must have a depth of one, or a **BadMatch** error results.

XSetStipple can generate **BadAlloc**, **BadGC**, **BadMatch**, and **BadPixmap** errors.

To set the tile or stipple origin of a given GC, use **XSetTSOrigin**.

```
XSetTSOrigin(display, gc, ts_x_origin, ts_y_origin)
      Display *display;
      GC gc;
      int ts_x_origin, ts_y_origin;
```

display	Specifies the connection to the X server.
gc	Specifies the GC.
ts_x_origin	
ts_y_origin	Specify the x and y coordinates of the tile and stipple origin.

When graphics requests call for tiling or stippling, the parent's origin will be interpreted relative to whatever destination drawable is specified in the graphics request.

XSetTSOrigin can generate **BadAlloc** and **BadGC** error.

7.2.5. Setting the Current Font

To set the current font of a given GC, use **XSetFont**.

```
XSetFont(display, gc, font)
      Display *display;
      GC gc;
      Font font;
```

display	Specifies the connection to the X server.
gc	Specifies the GC.
font	Specifies the font.

XSetFont can generate **BadAlloc**, **BadFont**, and **BadGC** errors.

7.2.6. Setting the Clip Region

Xlib provides functions that you can use to set the clip-origin and the clip-mask or set the clip-mask to a list of rectangles.

To set the clip-origin of a given GC, use **XSetClipOrigin**.

```
XSetClipOrigin(display, gc, clip_x_origin, clip_y_origin)
    Display *display;
    GC gc;
    int clip_x_origin, clip_y_origin;
```

display	Specifies the connection to the X server.
gc	Specifies the GC.
clip_x_origin	
clip_y_origin	Specify the x and y coordinates of the clip-mask origin.

The clip-mask origin is interpreted relative to the origin of whatever destination drawable is specified in the graphics request.

XSetClipOrigin can generate **BadAlloc** and **BadGC** errors.

To set the clip-mask of a given GC to the specified pixmap, use **XSetClipMask**.

```
XSetClipMask(display, gc, pixmap)
    Display *display;
    GC gc;
    Pixmap pixmap;
```

display	Specifies the connection to the X server.
gc	Specifies the GC.
pixmap	Specifies the pixmap or **None**.

If the clip-mask is set to **None**, the pixels are are always drawn (regardless of the clip-origin).

XSetClipMask can generate **BadAlloc**, **BadGC**, **BadMatch**, and **BadPixmap** errors.

To set the clip-mask of a given GC to the specified list of rectangles, use **XSetClipRectangles**.

XSetClipRectangles(*display*, *gc*, *clip_x_origin*, *clip_y_origin*, *rectangles*, *n*, *ordering*)
  Display **display*;
  GC *gc*;
  int *clip_x_origin*, *clip_y_origin*;
  XRectangle *rectangles*[];
  int *n*;
  int *ordering*;

display	Specifies the connection to the X server.
gc	Specifies the GC.
clip_x_origin *clip_y_origin*	Specify the x and y coordinates of the clip-mask origin.
rectangles	Specifies an array of rectangles that define the clip-mask.
n	Specifies the number of rectangles.
ordering	Specifies the ordering relations on the rectangles. You can pass **Unsorted**, **YSorted**, **YXSorted**, or **YXBanded**.

The **XSetClipRectangles** function changes the clip-mask in the specified GC to the specified list of rectangles and sets the clip origin. The output is clipped to remain contained within the rectangles. The clip-origin is interpreted relative to the origin of whatever destination drawable is specified in a graphics request. The rectangle coordinates are interpreted relative to the clip-origin. The rectangles should be nonintersecting, or the graphics results will be undefined. Note that the list of rectangles can be empty, which effectively disables output. This is the opposite of passing **None** as the clip-mask in **XCreateGC**, **XChangeGC**, and **XSetClipMask**.

If known by the client, ordering relations on the rectangles can be specified with the ordering argument. This may provide faster operation by the server. If an incorrect ordering is specified, the X server may generate a **BadMatch** error, but it is not required to do so. If no error is generated, the graphics results are undefined. **Unsorted** means the rectangles are in arbitrary order. **YSorted** means that the rectangles are nondecreasing in their Y origin. **YXSorted** additionally constrains **YSorted** order in that all rectangles with an equal Y origin are nondecreasing in their X origin. **YXBanded** additionally constrains **YXSorted** by requiring that, for every possible Y scanline, all rectangles that include that scanline have an identical Y origins and Y extents.

XSetClipRectangles can generate **BadAlloc**, **BadGC**, **BadMatch**, and **BadValue** errors.

Xlib provides a set of basic functions for performing region arithmetic. For information about these functions, see section 16.5.

7.2.7. Setting the Arc Mode, Subwindow Mode, and Graphics Exposure

To set the arc mode of a given GC, use **XSetArcMode**.

XSetArcMode(*display*, *gc*, *arc_mode*)
  Display **display*;
  GC *gc*;
  int *arc_mode*;

display	Specifies the connection to the X server.
gc	Specifies the GC.
arc_mode	Specifies the arc mode. You can pass **ArcChord** or **ArcPieSlice**.

XSetArcMode can generate **BadAlloc**, **BadGC**, and **BadValue** errors.

To set the subwindow mode of a given GC, use **XSetSubwindowMode**.

XSetSubwindowMode(*display*, *gc*, *subwindow_mode*)
  Display **display*;
  GC *gc*;
  int *subwindow_mode*;

display	Specifies the connection to the X server.
gc	Specifies the GC.
subwindow_mode	Specifies the subwindow mode. You can pass **ClipByChildren** or **IncludeInferiors**.

XSetSubwindowMode can generate **BadAlloc**, **BadGC**, and **BadValue** errors.

To set the graphics-exposures flag of a given GC, use **XSetGraphicsExposures**.

XSetGraphicsExposures(*display*, *gc*, *graphics_exposures*)
  Display **display*;
  GC *gc*;
  Bool *graphics_exposures*;

display	Specifies the connection to the X server.
gc	Specifies the GC.
graphics_exposures	Specifies a Boolean value that indicates whether you want **GraphicsExpose** and **NoExpose** events to be reported when calling **XCopyArea** and **XCopyPlane** with this GC.

XSetGraphicsExposures can generate **BadAlloc**, **BadGC**, and **BadValue** errors.

Chapter 8

Graphics Functions

Once you have established a connection to a display, you can use the Xlib graphics functions to:

- Clear and copy areas
- Draw points, lines, rectangles, and arcs
- Fill areas
- Manipulate fonts
- Draw text
- Transfer images between clients and the server

If the same drawable and GC is used for each call, Xlib batches back-to-back calls to **XDrawPoint**, **XDrawLine**, **XDrawRectangle**, **XFillArc**, and **XFillRectangle**. Note that this reduces the total number of requests sent to the server.

8.1. Clearing Areas

Xlib provides functions that you can use to clear an area or the entire window. Because pixmaps do not have defined backgrounds, they cannot be filled by using the functions described in this section. Instead, to accomplish an analogous operation on a pixmap, you should use **XFillRectangle**, which sets the pixmap to a known value.

To clear a rectangular area of a given window, use **XClearArea**.

```
XClearArea(display, w, x, y, width, height, exposures)
    Display *display;
    Window w;
    int x, y;
    unsigned int width, height;
    Bool exposures;
```

display	Specifies the connection to the X server.
w	Specifies the window.
x	
y	Specify the x and y coordinates, which are relative to the origin of the window and specify the upper-left corner of the rectangle.
width	
height	Specify the width and height, which are the dimensions of the rectangle.
exposures	Specifies a Boolean value that indicates if **Expose** events are to be generated.

The **XClearArea** function paints a rectangular area in the specified window according to the specified dimensions with the window's background pixel or pixmap. The subwindow-mode effectively is **ClipByChildren**. If width is zero, it is replaced with the current width of the window minus x. If height is zero, it is replaced with the current height of the window minus y. If the window has a defined background tile, the rectangle clipped by any children is filled with this tile. If the window has background **None**, the contents of the window are not changed. In either case, if exposures is **True**, one or more **Expose** events are generated for regions of the rectangle that are either visible or are being retained in a backing store. If you specify a window whose class is **InputOnly**, a **BadMatch** error results.

XClearArea can generate **BadMatch**, **BadValue**, and **BadWindow** errors.

To clear the entire area in a given window, use **XClearWindow**.

```
XClearWindow(display, w)
    Display *display;
    Window w;
```

display	Specifies the connection to the X server.
w	Specifies the window.

The **XClearWindow** function clears the entire area in the specified window and is equivalent to **XClearArea** (display, w, 0, 0, 0, 0, **False**). If the window has a defined background tile, the rectangle is tiled with a plane-mask of all ones and **GXcopy** function. If the window has background **None**, the contents of the window are not changed. If you specify a window whose class is **InputOnly**, a **BadMatch** error results.

XClearWindow can generate **BadMatch** and **BadWindow** errors.

8.2. Copying Areas

Xlib provides functions that you can use to copy an area or a bit plane.

To copy an area between drawables of the same root and depth, use **XCopyArea**.

```
XCopyArea(display, src, dest, gc, src_x, src_y, width, height,  dest_x, dest_y)
      Display *display;
      Drawable src, dest;
      GC gc;
      int src_x, src_y;
      unsigned int width, height;
      int dest_x, dest_y;
```

display	Specifies the connection to the X server.
src	
dest	Specify the source and destination rectangles to be combined.
gc	Specifies the GC.
src_x	
src_y	Specify the x and y coordinates, which are relative to the origin of the source rectangle and specify its upper-left corner.
width	
height	Specify the width and height, which are the dimensions of both the source and destination rectangles.
dest_x	
dest_y	Specify the x and y coordinates, which are relative to the origin of the destination rectangle and specify its upper-left corner.

The **XCopyArea** function combines the specified rectangle of src with the specified rectangle of dest. The drawables must have the same root and depth, or a **BadMatch** error results.

If regions of the source rectangle are obscured and have not been retained in backing store or if regions outside the boundaries of the source drawable are specified, those regions are not copied. Instead, the following occurs on all corresponding destination regions that are either visible or are retained in backing store. If the destination is a window with a background other than **None**, corresponding regions of the destination are tiled with that background (with plane-mask of all ones and **GXcopy** function). Regardless of tiling or whether the destination is a window or a pixmap, if graphics-exposures is **True**, then **GraphicsExpose** events for all corresponding destination regions are generated. If graphics-exposures is **True** but no **GraphicsExpose** events are generated, a **NoExpose** event is generated. Note that by default graphics-exposures is **True** in new GCs.

This function uses these GC components: function, plane-mask, subwindow-mode, graphics-exposures, clip-x-origin, clip-y-origin, and clip-mask.

XCopyArea can generate **BadDrawable**, **BadGC**, and **BadMatch** errors.

To copy a single bit plane of a given drawable, use **XCopyPlane**.

```
XCopyPlane(display, src, dest, gc, src_x, src_y, width, height, dest_x, dest_y, plane)
    Display *display;
    Drawable src, dest;
    GC gc;
    int src_x, src_y;
    unsigned int width, height;
    int dest_x, dest_y;
    unsigned long plane;
```

display	Specifies the connection to the X server.
src *dest*	Specify the source and destination rectangles to be combined.
gc	Specifies the GC.
src_x *src_y*	Specify the x and y coordinates, which are relative to the origin of the source rectangle and specify its upper-left corner.
width *height*	Specify the width and height, which are the dimensions of both the source and destination rectangles.
dest_x *dest_y*	Specify the x and y coordinates, which are relative to the origin of the destination rectangle and specify its upper-left corner.
plane	Specifies the bit plane. You must set exactly one bit to 1.

The **XCopyPlane** function uses a single bit plane of the specified source rectangle combined with the specified GC to modify the specified rectangle of dest. The drawables must have the same root but need not have the same depth. If the drawables do not have the same root, a **BadMatch** error results. If plane does not have exactly one bit set to 1 and the value of plane is not less than 2^n, where *n* is the depth of src, a **BadValue** error results.

Effectively, **XCopyPlane** forms a pixmap of the same depth as the rectangle of dest and with a size specified by the source region. It uses the foreground/background pixels in the GC (foreground everywhere the bit plane in src contains a bit set to 1, background everywhere the bit plane in src contains a bit set to 0) and the equivalent of a **CopyArea** protocol request is performed with all the same exposure semantics. This can also be thought of as using the specified region of the source bit plane as a stipple with a fill-style of **FillOpaqueStippled** for filling a rectangular area of the destination.

This function uses these GC components: function, plane-mask, foreground, background, subwindow-mode, graphics-exposures, clip-x-origin, clip-y-origin, and clip-mask.

XCopyPlane can generate **BadDrawable**, **BadGC**, **BadMatch**, and **BadValue** errors.

8.3. Drawing Points, Lines, Rectangles, and Arcs

Xlib provides functions that you can use to draw:

- A single point or multiple points
- A single line or multiple lines

- A single rectangle or multiple rectangles
- A single arc or multiple arcs

Some of the functions described in the following sections use these structures:

```
typedef struct {
        short x1, y1, x2, y2;
} XSegment;
```

```
typedef struct {
        short x, y;
} XPoint;
```

```
typedef struct {
        short x, y;
        unsigned short width, height;
} XRectangle;
```

```
typedef struct {
        short x, y;
        unsigned short width, height;
        short angle1, angle2;        /* Degrees * 64 */
} XArc;
```

All x and y members are signed integers. The width and height members are 16-bit unsigned integers. You should be careful not to generate coordinates and sizes out of the 16-bit ranges, because the protocol only has 16-bit fields for these values.

8.3.1. Drawing Single and Multiple Points

To draw a single point in a given drawable, use **XDrawPoint**.

```
XDrawPoint(display, d, gc, x, y)
      Display *display;
      Drawable d;
      GC gc;
      int x, y;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
x	
y	Specify the x and y coordinates where you want the point drawn.

To draw multiple points in a given drawable, use **XDrawPoints**.

```
XDrawPoints(display, d, gc, points, npoints, mode)
      Display *display;
      Drawable d;
      GC gc;
      XPoint *points;
      int npoints;
      int mode;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
points	Specifies an array of points.
npoints	Specifies the number of points in the array.
mode	Specifies the coordinate mode. You can pass **CoordModeOrigin** or **CoordModePrevious**.

The **XDrawPoint** function uses the foreground pixel and function components of the GC to draw a single point into the specified drawable; **XDrawPoints** draws multiple points this way. **CoordModeOrigin** treats all coordinates as relative to the origin, and **CoordModePrevious** treats all coordinates after the first as relative to the previous point. **XDrawPoints** draws the points in the order listed in the array.

Both functions use these GC components: function, plane-mask, foreground, subwindow-mode, clip-x-origin, clip-y-origin, and clip-mask.

XDrawPoint can generate **BadDrawable**, **BadGC**, and **BadMatch** errors. **XDrawPoints** can generate **BadDrawable**, **BadGC**, **BadMatch**, and **BadValue** errors.

8.3.2. Drawing Single and Multiple Lines

To draw a single line between two points in a given drawable, use **XDrawLine**.

```
XDrawLine(display, d, gc, x1, y1, x2, y2)
      Display *display;
      Drawable d;
      GC gc;
      int x1, y1, x2, y2;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
x1	
y1	
x2	
y2	Specify the points (x1, y1) and (x2, y2) to be connected.

To draw multiple lines in a given drawable, use **XDrawLines**.

```
XDrawLines(display, d, gc, points, npoints, mode)
      Display *display;
      Drawable d;
      GC gc;
      XPoint *points;
      int npoints;
      int mode;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
points	Specifies an array of points.
npoints	Specifies the number of points in the array.
mode	Specifies the coordinate mode. You can pass **CoordModeOrigin** or **CoordModePrevious**.

To draw multiple, unconnected lines in a given drawable, use **XDrawSegments**.

XDrawSegments(*display*, *d*, *gc*, *segments*, *nsegments*)
  Display **display*;
  Drawable *d*;
  GC *gc*;
  XSegment **segments*;
  int *nsegments*;

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
segments	Specifies an array of segments.
nsegments	Specifies the number of segments in the array.

The **XDrawLine** function uses the components of the specified GC to draw a line between the specified set of points (x1, y1) and (x2, y2). It does not perform joining at coincident endpoints. For any given line, **XDrawLine** does not draw a pixel more than once. If lines intersect, the intersecting pixels are drawn multiple times.

The **XDrawLines** function uses the components of the specified GC to draw npoints−1 lines between each pair of points (point[i], point[i+1]) in the array of **XPoint** structures. It draws the lines in the order listed in the array. The lines join correctly at all intermediate points, and if the first and last points coincide, the first and last lines also join correctly. For any given line, **XDrawLines** does not draw a pixel more than once. If thin (zero line-width) lines intersect, the intersecting pixels are drawn multiple times. If wide lines intersect, the intersecting pixels are drawn only once, as though the entire **PolyLine** protocol request were a single, filled shape. **CoordModeOrigin** treats all coordinates as relative to the origin, and **CoordModePrevious** treats all coordinates after the first as relative to the previous point.

The **XDrawSegments** function draws multiple, unconnected lines. For each segment, **XDrawSegments** draws a line between (x1, y1) and (x2, y2). It draws the lines in the order listed in the array of **XSegment** structures and does not perform joining at coincident endpoints. For any given line, **XDrawSegments** does not draw a pixel more than once. If lines intersect, the intersecting pixels are drawn multiple times.

All three functions use these GC components: function, plane-mask, line-width, line-style, cap-style, fill-style, subwindow-mode, clip-x-origin, clip-y-origin, and clip-mask. The **XDrawLines** function also uses the join-style GC component. All three functions also use these GC mode-dependent components: foreground, background, tile, stipple, tile-stipple-x-origin, tile-stipple-y-origin, dash-offset, and dash-list.

XDrawLine, **XDrawLines**, and **XDrawSegments** can generate **BadDrawable**, **BadGC**, and **BadMatch** errors. **XDrawLines** also can generate **BadValue** errors.

8.3.3. Drawing Single and Multiple Rectangles

To draw the outline of a single rectangle in a given drawable, use **XDrawRectangle**.

```
XDrawRectangle(display, d, gc, x, y, width, height)
    Display *display;
    Drawable d;
    GC gc;
    int x, y;
    unsigned int width, height;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
x	
y	Specify the x and y coordinates, which specify the upper-left corner of the rectangle.
width	
height	Specify the width and height, which specify the dimensions of the rectangle.

To draw the outline of multiple rectangles in a given drawable, use **XDrawRectangles**.

```
XDrawRectangles(display, d, gc, rectangles, nrectangles)
    Display *display;
    Drawable d;
    GC gc;
    XRectangle rectangles[];
    int nrectangles;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
rectangles	Specifies an array of rectangles.
nrectangles	Specifies the number of rectangles in the array.

The **XDrawRectangle** and **XDrawRectangles** functions draw the outlines of the specified rectangle or rectangles as if a five-point **PolyLine** protocol request were specified for each rectangle:

[x,y] [x+width,y] [x+width,y+height] [x,y+height] [x,y]

For the specified rectangle or rectangles, these functions do not draw a pixel more than once. **XDrawRectangles** draws the rectangles in the order listed in the array. If rectangles intersect, the intersecting pixels are drawn multiple times.

Both functions use these GC components: function, plane-mask, line-width, line-style, cap-style, join-style, fill-style, subwindow-mode, clip-x-origin, clip-y-origin, and clip-mask. They also use these GC mode-dependent components: foreground, background, tile, stipple, tile-stipple-x-origin, tile-stipple-y-origin, dash-offset, and dash-list.

XDrawRectangle and **XDrawRectangles** can generate **BadDrawable**, **BadGC**, and **BadMatch** errors.

8.3.4. Drawing Single and Multiple Arcs

To draw a single arc in a given drawable, use **XDrawArc**.

```
XDrawArc(display, d, gc, x, y, width, height, angle1, angle2)
      Display *display;
      Drawable d;
      GC gc;
      int x, y;
      unsigned int width, height;
      int angle1, angle2;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
x	
y	Specify the x and y coordinates, which are relative to the origin of the drawable and specify the upper-left corner of the bounding rectangle.
width	
height	Specify the width and height, which are the major and minor axes of the arc.
angle1	Specifies the start of the arc relative to the three-o'clock position from the center, in units of degrees * 64.
angle2	Specifies the path and extent of the arc relative to the start of the arc, in units of degrees * 64.

To draw multiple arcs in a given drawable, use **XDrawArcs**.

```
XDrawArcs(display, d, gc, arcs, narcs)
      Display *display;
      Drawable d;
      GC gc;
      XArc *arcs;
      int narcs;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
arcs	Specifies an array of arcs.
narcs	Specifies the number of arcs in the array.

XDrawArc draws a single circular or elliptical arc, and **XDrawArcs** draws multiple circular or elliptical arcs. Each arc is specified by a rectangle and two angles. The center of the circle or ellipse is the center of the rectangle, and the major and minor axes are specified by the width and height. Positive angles indicate counterclockwise motion, and negative angles indicate clockwise motion. If the magnitude of angle2 is greater than 360 degrees, **XDrawArc** or **XDrawArcs**

truncates it to 360 degrees.

For an arc specified as [x, y, $width$, $height$, $angle1$, $angle2$], the origin of the major and minor axes is at [$x + \frac{width}{2}$, $y + \frac{height}{2}$], and the infinitely thin path describing the entire circle or ellipse intersects the horizontal axis at [x, $y + \frac{height}{2}$] and [$x + width$, $y + \frac{height}{2}$] and intersects the vertical axis at [$x + \frac{width}{2}$, y] and [$x + \frac{width}{2}$, $y + height$]. These coordinates can be fractional and so are not truncated to discrete coordinates. The path should be defined by the ideal mathematical path. For a wide line with line-width lw, the bounding outlines for filling are given by the two infinitely thin paths consisting of all points whose perpendicular distance from the path of the circle/ellipse is equal to lw/2 (which may be a fractional value). The cap-style and join-style are applied the same as for a line corresponding to the tangent of the circle/ellipse at the endpoint.

For an arc specified as [x, y, $width$, $height$, $angle1$, $angle2$], the angles must be specified in the effectively skewed coordinate system of the ellipse (for a circle, the angles and coordinate systems are identical). The relationship between these angles and angles expressed in the normal coordinate system of the screen (as measured with a protractor) is as follows:

$$\text{skewed-angle} = atan\left(\tan(\text{normal-angle}) * \frac{width}{height}\right) + adjust$$

The skewed-angle and normal-angle are expressed in radians (rather than in degrees scaled by 64) in the range [0, 2π] and where atan returns a value in the range [$-\frac{\pi}{2}$, $\frac{\pi}{2}$] and adjust is:

0	for normal-angle in the range [0, $\frac{\pi}{2}$]
π	for normal-angle in the range [$\frac{\pi}{2}$, $\frac{3\pi}{2}$]
2π	for normal-angle in the range [$\frac{3\pi}{2}$, 2π]

For any given arc, **XDrawArc** and **XDrawArcs** do not draw a pixel more than once. If two arcs join correctly and if the line-width is greater than zero and the arcs intersect, **XDrawArc** and **XDrawArcs** do not draw a pixel more than once. Otherwise, the intersecting pixels of intersecting arcs are drawn multiple times. Specifying an arc with one endpoint and a clockwise extent draws the same pixels as specifying the other endpoint and an equivalent counterclockwise extent, except as it affects joins.

If the last point in one arc coincides with the first point in the following arc, the two arcs will join correctly. If the first point in the first arc coincides with the last point in the last arc, the two arcs will join correctly. By specifying one axis to be zero, a horizontal or vertical line can be drawn. Angles are computed based solely on the coordinate system and ignore the aspect ratio.

Both functions use these GC components: function, plane-mask, line-width, line-style, cap-style, join-style, fill-style, subwindow-mode, clip-x-origin, clip-y-origin, and clip-mask. They also use these GC mode-dependent components: foreground, background, tile, stipple, tile-stipple-x-origin, tile-stipple-y-origin, dash-offset, and dash-list.

XDrawArc and **XDrawArcs** can generate **BadDrawable**, **BadGC**, and **BadMatch** errors.

8.4. Filling Areas

Xlib provides functions that you can use to fill:

- A single rectangle or multiple rectangles
- A single polygon
- A single arc or multiple arcs

8.4.1. Filling Single and Multiple Rectangles

To fill a single rectangular area in a given drawable, use **XFillRectangle**.

```
XFillRectangle(display, d, gc, x, y, width, height)
      Display *display;
      Drawable d;
      GC gc;
      int x, y;
      unsigned int width, height;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
x *y*	Specify the x and y coordinates, which are relative to the origin of the drawable and specify the upper-left corner of the rectangle.
width *height*	Specify the width and height, which are the dimensions of the rectangle to be filled.

To fill multiple rectangular areas in a given drawable, use **XFillRectangles**.

```
XFillRectangles(display, d, gc, rectangles, nrectangles)
      Display *display;
      Drawable d;
      GC gc;
      XRectangle *rectangles;
      int nrectangles;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
rectangles	Specifies an array of rectangles.
nrectangles	Specifies the number of rectangles in the array.

The **XFillRectangle** and **XFillRectangles** functions fill the specified rectangle or rectangles as if a four-point **FillPolygon** protocol request were specified for each rectangle:

[x,y] [x+width,y] [x+width,y+height] [x,y+height]

Each function uses the x and y coordinates, width and height dimensions, and GC you specify.

XFillRectangles fills the rectangles in the order listed in the array. For any given rectangle, **XFillRectangle** and **XFillRectangles** do not draw a pixel more than once. If rectangles intersect, the intersecting pixels are drawn multiple times.

Both functions use these GC components: function, plane-mask, fill-style, subwindow-mode, clip-x-origin, clip-y-origin, and clip-mask. They also use these GC mode-dependent components: foreground, background, tile, stipple, tile-stipple-x-origin, and tile-stipple-y-origin.

XFillRectangle and **XFillRectangles** can generate **BadDrawable**, **BadGC**, and **BadMatch** errors.

8.4.2. Filling a Single Polygon

To fill a polygon area in a given drawable, use **XFillPolygon**.

```
XFillPolygon(display, d, gc, points, npoints, shape, mode)
    Display *display;
    Drawable d;
    GC gc;
    XPoint *points;
    int npoints;
    int shape;
    int mode;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
points	Specifies an array of points.
npoints	Specifies the number of points in the array.
shape	Specifies a shape that helps the server to improve performance. You can pass **Complex**, **Convex**, or **Nonconvex**.
mode	Specifies the coordinate mode. You can pass **CoordModeOrigin** or **CoordModePrevious**.

XFillPolygon fills the region closed by the specified path. The path is closed automatically if the last point in the list does not coincide with the first point. **XFillPolygon** does not draw a pixel of the region more than once. **CoordModeOrigin** treats all coordinates as relative to the origin, and **CoordModePrevious** treats all coordinates after the first as relative to the previous point.

Depending on the specified shape, the following occurs:

- If shape is **Complex**, the path may self-intersect. Note that contiguous coincident points in the path are not treated as self-intersection.
- If shape is **Convex**, for every pair of points inside the polygon, the line segment connecting them does not intersect the path. If known by the client, specifying **Convex** can improve performance. If you specify **Convex** for a path that is not convex, the graphics results are undefined.
- If shape is **Nonconvex**, the path does not self-intersect, but the shape is not wholly convex. If known by the client, specifying **Nonconvex** instead of **Complex** may improve

performance. If you specify **Nonconvex** for a self-intersecting path, the graphics results are undefined.

The fill-rule of the GC controls the filling behavior of self-intersecting polygons.

This function uses these GC components: function, plane-mask, fill-style, fill-rule, subwindow-mode, clip-x-origin, clip-y-origin, and clip-mask. It also uses these GC mode-dependent components: foreground, background, tile, stipple, tile-stipple-x-origin, and tile-stipple-y-origin.

XFillPolygon can generate **BadDrawable**, **BadGC**, **BadMatch**, and **BadValue** errors.

8.4.3. Filling Single and Multiple Arcs

To fill a single arc in a given drawable, use **XFillArc**.

```
XFillArc(display, d, gc,  x, y, width, height, angle1, angle2)
    Display *display;
    Drawable d;
    GC gc;
    int x, y;
    unsigned int width, height;
    int angle1, angle2;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
x *y*	Specify the x and y coordinates, which are relative to the origin of the drawable and specify the upper-left corner of the bounding rectangle.
width *height*	Specify the width and height, which are the major and minor axes of the arc.
angle1	Specifies the start of the arc relative to the three-o'clock position from the center, in units of degrees * 64.
angle2	Specifies the path and extent of the arc relative to the start of the arc, in units of degrees * 64.

To fill multiple arcs in a given drawable, use **XFillArcs**.

```
XFillArcs(display, d, gc, arcs, narcs)
      Display *display;
      Drawable d;
      GC gc;
      XArc *arcs;
      int narcs;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
arcs	Specifies an array of arcs.
narcs	Specifies the number of arcs in the array.

For each arc, **XFillArc** or **XFillArcs** fills the region closed by the infinitely thin path described by the specified arc and, depending on the arc-mode specified in the GC, one or two line segments. For **ArcChord**, the single line segment joining the endpoints of the arc is used. For **ArcPieSlice**, the two line segments joining the endpoints of the arc with the center point are used. **XFillArcs** fills the arcs in the order listed in the array. For any given arc, **XFillArc** and **XFillArcs** do not draw a pixel more than once. If regions intersect, the intersecting pixels are drawn multiple times.

Both functions use these GC components: function, plane-mask, fill-style, arc-mode, subwindow-mode, clip-x-origin, clip-y-origin, and clip-mask. They also use these GC mode-dependent components: foreground, background, tile, stipple, tile-stipple-x-origin, and tile-stipple-y-origin.

XFillArc and **XFillArcs** can generate **BadDrawable**, **BadGC**, and **BadMatch** errors.

8.5. Font Metrics

A font is a graphical description of a set of characters that are used to increase efficiency whenever a set of small, similar sized patterns are repeatedly used.

This section discusses how to:

- Load and free fonts
- Obtain and free font names
- Compute character string sizes
- Return logical extents
- Query character string sizes

The X server loads fonts whenever a program requests a new font. The server can cache fonts for quick lookup. Fonts are global across all screens in a server. Several levels are possible when dealing with fonts. Most applications simply use **XLoadQueryFont** to load a font and query the font metrics.

Characters in fonts are regarded as masks. Except for image text requests, the only pixels modified are those in which bits are set to 1 in the character. This means that it makes sense to draw text using stipples or tiles (for example, many menus gray-out unusable entries).

The **XFontStruct** structure contains all of the information for the font and consists of the font-specific information as well as a pointer to an array of **XCharStruct** structures for the characters contained in the font. The **XFontStruct**, **XFontProp**, and **XCharStruct** structures contain:

```
typedef struct {
        short lbearing;                     /* origin to left edge of raster */
        short rbearing;                     /* origin to right edge of raster */
        short width;                        /* advance to next char's origin */
        short ascent;                       /* baseline to top edge of raster */
        short descent;                      /* baseline to bottom edge of raster */
        unsigned short attributes;          /* per char flags (not predefined) */
} XCharStruct;

typedef struct {
        Atom    name;
        unsigned long card32;
} XFontProp;

typedef struct {                            /* normal 16 bit characters are two bytes */
   unsigned char byte1;
   unsigned char byte2;
} XChar2b;

typedef struct {
        XExtData *ext_data;                 /* hook for extension to hang data */
        Font fid;                           /* Font id for this font */
        unsigned direction;                 /* hint about the direction font is painted */
        unsigned min_char_or_byte2;         /* first character */
        unsigned max_char_or_byte2;         /* last character */
        unsigned min_byte1;                 /* first row that exists */
        unsigned max_byte1;                 /* last row that exists */
        Bool all_chars_exist;               /* flag if all characters have nonzero size */
        unsigned default_char;              /* char to print for undefined character */
        int n_properties;                   /* how many properties there are */
        XFontProp *properties;              /* pointer to array of additional properties */
        XCharStruct min_bounds;             /* minimum bounds over all existing char */
        XCharStruct max_bounds;             /* maximum bounds over all existing char */
        XCharStruct *per_char;              /* first_char to last_char information */
        int ascent;                         /* logical extent above baseline for spacing */
        int descent;                        /* logical decent below baseline for spacing */
} XFontStruct;
```

X supports single byte/character, two bytes/character matrix, and 16-bit character text operations. Note that any of these forms can be used with a font, but a single byte/character text request can only specify a single byte (that is, the first row of a 2-byte font). You should view 2-byte fonts as a two-dimensional matrix of defined characters: byte1 specifies the range of defined rows and byte2 defines the range of defined columns of the font. Single byte/character fonts have one row defined, and the byte2 range specified in the structure defines a range of characters.

The bounding box of a character is defined by the **XCharStruct** of that character. When characters are absent from a font, the default_char is used. When fonts have all characters of the same size, only the information in the **XFontStruct** min and max bounds are used.

The members of the **XFontStruct** have the following semantics:

- The direction member can be either **FontLeftToRight** or **FontRightToLeft**. It is just a hint as to whether most **XCharStruct** elements have a positive (**FontLeftToRight**) or a negative (**FontRightToLeft**) character width metric. The core protocol defines no support for vertical text.
- If the min_byte1 and max_byte1 members are both zero, min_char_or_byte2 specifies the linear character index corresponding to the first element of the per_char array, and max_char_or_byte2 specifies the linear character index of the last element.

  If either min_byte1 or max_byte1 are nonzero, both min_char_or_byte2 and max_char_or_byte2 are less than 256, and the 2-byte character index values corresponding to the per_char array element N (counting from 0) are:

  byte1 = N/D + min_byte1
  byte2 = N\D + min_char_or_byte2

  where:

  D = max_char_or_byte2 − min_char_or_byte2 + 1
  / = integer division
  \ = integer modulus
- If the per_char pointer is NULL, all glyphs between the first and last character indexes inclusive have the same information, as given by both min_bounds and max_bounds.
- If all_chars_exist is **True**, all characters in the per_char array have nonzero bounding boxes.
- The default_char member specifies the character that will be used when an undefined or nonexistent character is printed. The default_char is a 16-bit character (not a 2-byte character). For a font using 2-byte matrix format, the default_char has byte1 in the most-significant byte and byte2 in the least-significant byte. If the default_char itself specifies an undefined or nonexistent character, no printing is performed for an undefined or nonexistent character.
- The min_bounds and max_bounds members contain the most extreme values of each individual **XCharStruct** component over all elements of this array (and ignore nonexistent characters). The bounding box of the font (the smallest rectangle enclosing the shape obtained by superimposing all of the characters at the same origin [x,y]) has its upper-left coordinate at:

  [x + min_bounds.lbearing, y − max_bounds.ascent]

  Its width is:

  max_bounds.rbearing − min_bounds.lbearing

  Its height is:

  max_bounds.ascent + max_bounds.descent
- The ascent member is the logical extent of the font above the baseline that is used for determining line spacing. Specific characters may extend beyond this.

- The descent member is the logical extent of the font at or below the baseline that is used for determining line spacing. Specific characters may extend beyond this.
- If the baseline is at Y-coordinate y, the logical extent of the font is inclusive between the Y-coordinate values (y − font.ascent) and (y + font.descent − 1). Typically, the minimum interline spacing between rows of text is given by ascent + descent.

For a character origin at [x,y], the bounding box of a character (that is, the smallest rectangle that encloses the character's shape) described in terms of **XCharStruct** components is a rectangle with its upper-left corner at:

[x + lbearing, y − ascent]

Its width is:

rbearing − lbearing

Its height is:

ascent + descent

The origin for the next character is defined to be:

[x + width, y]

The lbearing member defines the extent of the left edge of the character ink from the origin. The rbearing member defines the extent of the right edge of the character ink from the origin. The ascent member defines the extent of the top edge of the character ink from the origin. The descent member defines the extent of the bottom edge of the character ink from the origin. The width member defines the logical width of the character.

Note that the baseline (the y position of the character origin) is logically viewed as being the scanline just below nondescending characters. When descent is zero, only pixels with Y-coordinates less than y are drawn, and the origin is logically viewed as being coincident with the left edge of a nonkerned character. When lbearing is zero, no pixels with X-coordinate less than x are drawn. Any of the **XCharStruct** metric members could be negative. If the width is negative, the next character will be placed to the left of the current origin.

The X protocol does not define the interpretation of the attributes member in the **XCharStruct** structure. A nonexistent character is represented with all members of its **XCharStruct** set to zero.

A font is not guaranteed to have any properties. The interpretation of the property value (for example, long or unsigned long) must be derived from *a priori* knowledge of the property. A basic set of font properties is specified in the X Consortium standard *X Logical Font Description Conventions*.

8.5.1. Loading and Freeing Fonts

Xlib provides functions that you can use to load fonts, get font information, unload fonts, and free font information. A few font functions use a **GContext** resource ID or a font ID interchangeably.

To load a given font, use **XLoadFont**.

```
Font XLoadFont(display, name)
      Display *display;
      char *name;
```

display	Specifies the connection to the X server.
name	Specifies the name of the font, which is a null-terminated string.

The **XLoadFont** function loads the specified font and returns its associated font ID. If the font name is not in the Host Portable Character Encoding, the result is implementation dependent. Use of uppercase or lowercase does not matter. When the characters "?" and "*" are used in a font name, a pattern match is performed and any matching font is used. In the pattern, the "?" character will match any single character, and the "*" character will match any number of characters. A structured format for font names is specified in the X Consortium standard *X Logical Font Description Conventions*. If **XLoadFont** was unsuccessful at loading the specified font, a **BadName** error results. Fonts are not associated with a particular screen and can be stored as a component of any GC. When the font is no longer needed, call **XUnloadFont**.

XLoadFont can generate **BadAlloc** and **BadName** errors.

To return information about an available font, use **XQueryFont**.

```
XFontStruct *XQueryFont(display, font_ID)
      Display *display;
      XID font_ID;
```

display	Specifies the connection to the X server.
font_ID	Specifies the font ID or the **GContext** ID.

The **XQueryFont** function returns a pointer to the **XFontStruct** structure, which contains information associated with the font. You can query a font or the font stored in a GC. The font ID stored in the **XFontStruct** structure will be the **GContext** ID, and you need to be careful when using this ID in other functions (see **XGContextFromGC**). If the font does not exist, **XQueryFont** returns NULL. To free this data, use **XFreeFontInfo**.

To perform a **XLoadFont** and **XQueryFont** in a single operation, use **XLoadQueryFont**.

```
XFontStruct *XLoadQueryFont(display, name)
      Display *display;
      char *name;
```

display	Specifies the connection to the X server.
name	Specifies the name of the font, which is a null-terminated string.

The **XLoadQueryFont** function provides the most common way for accessing a font. **XLoadQueryFont** both opens (loads) the specified font and returns a pointer to the appropriate **XFontStruct** structure. If the font name is not in the Host Portable Character Encoding, the result is implementation dependent. If the font does not exist, **XLoadQueryFont** returns NULL.

XLoadQueryFont can generate a **BadAlloc** error.

To unload the font and free the storage used by the font structure that was allocated by **XQueryFont** or **XLoadQueryFont**, use **XFreeFont**.

XFreeFont(*display*, *font_struct*)
    Display **display*;
    XFontStruct **font_struct*;

display	Specifies the connection to the X server.
font_struct	Specifies the storage associated with the font.

The **XFreeFont** function deletes the association between the font resource ID and the specified font and frees the **XFontStruct** structure. The font itself will be freed when no other resource references it. The data and the font should not be referenced again.

XFreeFont can generate a **BadFont** error.

To return a given font property, use **XGetFontProperty**.

Bool XGetFontProperty(*font_struct*, *atom*, *value_return*)
    XFontStruct **font_struct*;
    Atom *atom*;
    unsigned long **value_return*;

font_struct	Specifies the storage associated with the font.
atom	Specifies the atom for the property name you want returned.
value_return	Returns the value of the font property.

Given the atom for that property, the **XGetFontProperty** function returns the value of the specified font property. **XGetFontProperty** also returns **False** if the property was not defined or **True** if it was defined. A set of predefined atoms exists for font properties, which can be found in **<X11/Xatom.h>**. This set contains the standard properties associated with a font. Although it is not guaranteed, it is likely that the predefined font properties will be present.

To unload a font that was loaded by **XLoadFont**, use **XUnloadFont**.

XUnloadFont(*display*, *font*)
    Display **display*;
    Font *font*;

display	Specifies the connection to the X server.
font	Specifies the font.

The **XUnloadFont** function deletes the association between the font resource ID and the specified font. The font itself will be freed when no other resource references it. The font should not be referenced again.

XUnloadFont can generate a **BadFont** error.

8.5.2. Obtaining and Freeing Font Names and Information

You obtain font names and information by matching a wildcard specification when querying a font type for a list of available sizes and so on.

To return a list of the available font names, use **XListFonts**.

```
char **XListFonts(display, pattern, maxnames, actual_count_return)
      Display *display;
      char *pattern;
      int maxnames;
      int *actual_count_return;
```

display	Specifies the connection to the X server.
pattern	Specifies the null-terminated pattern string that can contain wildcard characters.
maxnames	Specifies the maximum number of names to be returned.
actual_count_return	Returns the actual number of font names.

The **XListFonts** function returns an array of available font names (as controlled by the font search path; see **XSetFontPath**) that match the string you passed to the pattern argument. The pattern string can contain any characters, but each asterisk (*) is a wildcard for any number of characters, and each question mark (?) is a wildcard for a single character. If the pattern string is not in the Host Portable Character Encoding, the result is implementation dependent. Use of uppercase or lowercase does not matter. Each returned string is null-terminated. If the data returned by the server is in the Latin Portable Character Encoding, then the returned strings are in the Host Portable Character Encoding. Otherwise, the result is implementation dependent. If there are no matching font names, **XListFonts** returns NULL. The client should call **XFreeFontNames** when finished with the result to free the memory.

To free a font name array, use **XFreeFontNames**.

```
XFreeFontNames(list)
      char *list[];
```

list	Specifies the array of strings you want to free.

The **XFreeFontNames** function frees the array and strings returned by **XListFonts** or **XListFontsWithInfo**.

To obtain the names and information about available fonts, use **XListFontsWithInfo**.

```
char **XListFontsWithInfo(display, pattern, maxnames, count_return, info_return)
      Display *display;
      char *pattern;
      int maxnames;
      int *count_return;
      XFontStruct **info_return;
```

display	Specifies the connection to the X server.
pattern	Specifies the null-terminated pattern string that can contain wildcard characters.
maxnames	Specifies the maximum number of names to be returned.
count_return	Returns the actual number of matched font names.
info_return	Returns the font information.

The **XListFontsWithInfo** function returns a list of font names that match the specified pattern and their associated font information. The list of names is limited to size specified by maxnames. The information returned for each font is identical to what **XLoadQueryFont** would return except that the per-character metrics are not returned. The pattern string can contain any characters, but each asterisk (*) is a wildcard for any number of characters, and each question mark (?) is a wildcard for a single character. If the pattern string is not in the Host Portable Character Encoding, the result is implementation dependent. Use of uppercase or lowercase does not matter. Each returned string is null-terminated. If the data returned by the server is in the Latin Portable Character Encoding, then the returned strings are in the Host Portable Character Encoding. Otherwise, the result is implementation dependent. If there are no matching font names, **XListFontsWithInfo** returns NULL.

To free only the allocated name array, the client should call **XFreeFontNames**. To free both the name array and the font information array or to free just the font information array, the client should call **XFreeFontInfo**.

To free font structures and font names, use **XFreeFontInfo**.

```
XFreeFontInfo(names, free_info, actual_count)
      char **names;
      XFontStruct *free_info;
      int actual_count;
```

names	Specifies the list of font names.
free_info	Specifies the font information.
actual_count	Specifies the actual number of font names.

The **XFreeFontInfo** function frees a font structure or an array of font structures, and optionally an array of font names. If NULL is passed for names, no font names are freed. If a font structure for an open font (returned by **XLoadQueryFont**) is passed, the structure is freed but the font is not closed; use **XUnloadFont** to close the font.

8.5.3. Computing Character String Sizes

Xlib provides functions that you can use to compute the width, the logical extents, and the server information about 8-bit and 2-byte text strings. The width is computed by adding the character widths of all the characters. It does not matter if the font is an 8-bit or 2-byte font. These functions return the sum of the character metrics, in pixels.

To determine the width of an 8-bit character string, use **XTextWidth**.

```
int XTextWidth(font_struct, string, count)
      XFontStruct *font_struct;
      char *string;
      int count;
```

font_struct	Specifies the font used for the width computation.
string	Specifies the character string.
count	Specifies the character count in the specified string.

To determine the width of a 2-byte character string, use **XTextWidth16**.

```
int XTextWidth16(font_struct, string, count)
      XFontStruct *font_struct;
      XChar2b *string;
      int count;
```

font_struct	Specifies the font used for the width computation.
string	Specifies the character string.
count	Specifies the character count in the specified string.

8.5.4. Computing Logical Extents

To compute the bounding box of an 8-bit character string in a given font, use **XTextExtents**.

```
XTextExtents(font_struct, string, nchars, direction_return, font_ascent_return,
        font_descent_return, overall_return)
    XFontStruct *font_struct;
    char *string;
    int nchars;
    int *direction_return;
    int *font_ascent_return, *font_descent_return;
    XCharStruct *overall_return;
```

font_struct	Specifies the **XFontStruct** structure.
string	Specifies the character string.
nchars	Specifies the number of characters in the character string.
direction_return	Returns the value of the direction hint (**FontLeftToRight** or **FontRightToLeft**).
font_ascent_return	Returns the font ascent.
font_descent_return	Returns the font descent.
overall_return	Returns the overall size in the specified **XCharStruct** structure.

To compute the bounding box of a 2-byte character string in a given font, use **XTextExtents16**.

```
XTextExtents16(font_struct, string, nchars, direction_return, font_ascent_return,
        font_descent_return, overall_return)
    XFontStruct *font_struct;
    XChar2b *string;
    int nchars;
    int *direction_return;
    int *font_ascent_return, *font_descent_return;
    XCharStruct *overall_return;
```

font_struct	Specifies the **XFontStruct** structure.
string	Specifies the character string.
nchars	Specifies the number of characters in the character string.
direction_return	Returns the value of the direction hint (**FontLeftToRight** or **FontRightToLeft**).
font_ascent_return	Returns the font ascent.
font_descent_return	Returns the font descent.
overall_return	Returns the overall size in the specified **XCharStruct** structure.

The **XTextExtents** and **XTextExtents16** functions perform the size computation locally and, thereby, avoid the round-trip overhead of **XQueryTextExtents** and **XQueryTextExtents16**. Both functions return an **XCharStruct** structure, whose members are set to the values as follows.

The ascent member is set to the maximum of the ascent metrics of all characters in the string. The descent member is set to the maximum of the descent metrics. The width member is set to the sum of the character-width metrics of all characters in the string. For each character in the string, let W be the sum of the character-width metrics of all characters preceding it in the string. Let L be the left-side-bearing metric of the character plus W. Let R be the right-side-bearing metric of the character plus W. The lbearing member is set to the minimum L of all characters in the string. The rbearing member is set to the maximum R.

For fonts defined with linear indexing rather than 2-byte matrix indexing, each **XChar2b** structure is interpreted as a 16-bit number with byte1 as the most-significant byte. If the font has no defined default character, undefined characters in the string are taken to have all zero metrics.

8.5.5. Querying Character String Sizes

To query the server for the bounding box of an 8-bit character string in a given font, use **XQueryTextExtents**.

```
XQueryTextExtents(display, font_ID, string, nchars, direction_return, font_ascent_return,
            font_descent_return, overall_return)
    Display *display;
    XID font_ID;
    char *string;
    int nchars;
    int *direction_return;
    int *font_ascent_return, *font_descent_return;
    XCharStruct *overall_return;
```

display	Specifies the connection to the X server.
font_ID	Specifies either the font ID or the **GContext** ID that contains the font.
string	Specifies the character string.
nchars	Specifies the number of characters in the character string.
direction_return	Returns the value of the direction hint (**FontLeftToRight** or **FontRightToLeft**).
font_ascent_return	Returns the font ascent.
font_descent_return	Returns the font descent.
overall_return	Returns the overall size in the specified **XCharStruct** structure.

To query the server for the bounding box of a 2-byte character string in a given font, use **XQueryTextExtents16**.

```
XQueryTextExtents16(display, font_ID, string, nchars, direction_return, font_ascent_return,
                font_descent_return, overall_return)
    Display *display;
    XID font_ID;
    XChar2b *string;
    int nchars;
    int *direction_return;
    int *font_ascent_return, *font_descent_return;
    XCharStruct *overall_return;
```

display	Specifies the connection to the X server.
font_ID	Specifies either the font ID or the **GContext** ID that contains the font.
string	Specifies the character string.
nchars	Specifies the number of characters in the character string.
direction_return	Returns the value of the direction hint (**FontLeftToRight** or **FontRightToLeft**).
font_ascent_return	Returns the font ascent.
font_descent_return	Returns the font descent.
overall_return	Returns the overall size in the specified **XCharStruct** structure.

The **XQueryTextExtents** and **XQueryTextExtents16** functions return the bounding box of the specified 8-bit and 16-bit character string in the specified font or the font contained in the specified GC. These functions query the X server and, therefore, suffer the round-trip overhead that is avoided by **XTextExtents** and **XTextExtents16**. Both functions return a **XCharStruct** structure, whose members are set to the values as follows.

The ascent member is set to the maximum of the ascent metrics of all characters in the string. The descent member is set to the maximum of the descent metrics. The width member is set to the sum of the character-width metrics of all characters in the string. For each character in the string, let W be the sum of the character-width metrics of all characters preceding it in the string. Let L be the left-side-bearing metric of the character plus W. Let R be the right-side-bearing metric of the character plus W. The lbearing member is set to the minimum L of all characters in the string. The rbearing member is set to the maximum R.

For fonts defined with linear indexing rather than 2-byte matrix indexing, each **XChar2b** structure is interpreted as a 16-bit number with byte1 as the most-significant byte. If the font has no defined default character, undefined characters in the string are taken to have all zero metrics.

Characters with all zero metrics are ignored. If the font has no defined default_char, the undefined characters in the string are also ignored.

XQueryTextExtents and **XQueryTextExtents16** can generate **BadFont** and **BadGC** errors.

8.6. Drawing Text

This section discusses how to draw:

- Complex text
- Text characters

- Image text characters

The fundamental text functions **XDrawText** and **XDrawText16** use the following structures:

```
typedef struct {
	char *chars;			/* pointer to string */
	int nchars;			/* number of characters */
	int delta;			/* delta between strings */
	Font font;			/* Font to print it in, None don’t change */
} XTextItem;

typedef struct {
	XChar2b *chars;			/* pointer to two-byte characters */
	int nchars;			/* number of characters */
	int delta;			/* delta between strings */
	Font font;			/* font to print it in, None don’t change */
} XTextItem16;
```

If the font member is not **None**, the font is changed before printing and also is stored in the GC. If an error was generated during text drawing, the previous items may have been drawn. The baseline of the characters are drawn starting at the x and y coordinates that you pass in the text drawing functions.

For example, consider the background rectangle drawn by **XDrawImageString**. If you want the upper-left corner of the background rectangle to be at pixel coordinate (x,y), pass the (x,y + ascent) as the baseline origin coordinates to the text functions. The ascent is the font ascent, as given in the **XFontStruct** structure. If you want the lower-left corner of the background rectangle to be at pixel coordinate (x,y), pass the (x,y − descent + 1) as the baseline origin coordinates to the text functions. The descent is the font descent, as given in the **XFontStruct** structure.

8.6.1. Drawing Complex Text

To draw 8-bit characters in a given drawable, use **XDrawText**.

```
XDrawText(display, d, gc, x, y, items, nitems)
    Display *display;
    Drawable d;
    GC gc;
    int x, y;
    XTextItem *items;
    int nitems;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
x	
y	Specify the x and y coordinates, which are relative to the origin of the specified drawable and define the origin of the first character.
items	Specifies an array of text items.
nitems	Specifies the number of text items in the array.

To draw 2-byte characters in a given drawable, use **XDrawText16**.

```
XDrawText16(display, d, gc, x, y, items, nitems)
    Display *display;
    Drawable d;
    GC gc;
    int x, y;
    XTextItem16 *items;
    int nitems;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
x	
y	Specify the x and y coordinates, which are relative to the origin of the specified drawable and define the origin of the first character.
items	Specifies an array of text items.
nitems	Specifies the number of text items in the array.

The **XDrawText16** function is similar to **XDrawText** except that it uses 2-byte or 16-bit characters. Both functions allow complex spacing and font shifts between counted strings.

Each text item is processed in turn. A font member other than **None** in an item causes the font to be stored in the GC and used for subsequent text. A text element delta specifies an additional change in the position along the x axis before the string is drawn. The delta is always added to the character origin and is not dependent on any characteristics of the font. Each character image, as defined by the font in the GC, is treated as an additional mask for a fill operation on the drawable. The drawable is modified only where the font character has a bit set to 1. If a text item generates a **BadFont** error, the previous text items may have been drawn.

For fonts defined with linear indexing rather than 2-byte matrix indexing, each **XChar2b** structure is interpreted as a 16-bit number with byte1 as the most-significant byte.

Both functions use these GC components: function, plane-mask, fill-style, font, subwindow-mode, clip-x-origin, clip-y-origin, and clip-mask. They also use these GC mode-dependent components: foreground, background, tile, stipple, tile-stipple-x-origin, and tile-stipple-y-origin.

XDrawText and **XDrawText16** can generate **BadDrawable**, **BadFont**, **BadGC**, and **BadMatch** errors.

8.6.2. Drawing Text Characters

To draw 8-bit characters in a given drawable, use **XDrawString**.

```
XDrawString(display, d, gc, x, y, string, length)
      Display *display;
      Drawable d;
      GC gc;
      int x, y;
      char *string;
      int length;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
x	
y	Specify the x and y coordinates, which are relative to the origin of the specified drawable and define the origin of the first character.
string	Specifies the character string.
length	Specifies the number of characters in the string argument.

To draw 2-byte characters in a given drawable, use **XDrawString16**.

```
XDrawString16(display, d, gc, x, y, string, length)
      Display *display;
      Drawable d;
      GC gc;
      int x, y;
      XChar2b *string;
      int length;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
x	
y	Specify the x and y coordinates, which are relative to the origin of the specified drawable and define the origin of the first character.
string	Specifies the character string.
length	Specifies the number of characters in the string argument.

Each character image, as defined by the font in the GC, is treated as an additional mask for a fill operation on the drawable. The drawable is modified only where the font character has a bit set to 1. For fonts defined with 2-byte matrix indexing and used with **XDrawString16**, each byte is used as a byte2 with a byte1 of zero.

Both functions use these GC components: function, plane-mask, fill-style, font, subwindow-mode, clip-x-origin, clip-y-origin, and clip-mask. They also use these GC mode-dependent components: foreground, background, tile, stipple, tile-stipple-x-origin, and tile-stipple-y-origin.

XDrawString and **XDrawString16** can generate **BadDrawable**, **BadGC**, and **BadMatch** errors.

8.6.3. Drawing Image Text Characters

Some applications, in particular terminal emulators, need to print image text in which both the foreground and background bits of each character are painted. This prevents annoying flicker on many displays.

To draw 8-bit image text characters in a given drawable, use **XDrawImageString**.

```
XDrawImageString(display, d, gc, x, y, string, length)
    Display *display;
    Drawable d;
    GC gc;
    int x, y;
    char *string;
    int length;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
x	
y	Specify the x and y coordinates, which are relative to the origin of the specified drawable and define the origin of the first character.
string	Specifies the character string.
length	Specifies the number of characters in the string argument.

To draw 2-byte image text characters in a given drawable, use **XDrawImageString16**.

```
XDrawImageString16(display, d, gc, x, y, string, length)
    Display *display;
    Drawable d;
    GC gc;
    int x, y;
    XChar2b *string;
    int length;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
x	
y	Specify the x and y coordinates, which are relative to the origin of the specified drawable and define the origin of the first character.
string	Specifies the character string.
length	Specifies the number of characters in the string argument.

The **XDrawImageString16** function is similar to **XDrawImageString** except that it uses 2-byte or 16-bit characters. Both functions also use both the foreground and background pixels of the GC in the destination.

The effect is first to fill a destination rectangle with the background pixel defined in the GC and then to paint the text with the foreground pixel. The upper-left corner of the filled rectangle is at:

[x, y − font-ascent]

The width is:

overall-width

The height is:

font-ascent + font-descent

The overall-width, font-ascent, and font-descent are as would be returned by **XQueryTextExtents** using gc and string. The function and fill-style defined in the GC are ignored for these functions. The effective function is **GXcopy**, and the effective fill-style is **FillSolid**.

For fonts defined with 2-byte matrix indexing and used with **XDrawImageString**, each byte is used as a byte2 with a byte1 of zero.

Both functions use these GC components: plane-mask, foreground, background, font, subwindow-mode, clip-x-origin, clip-y-origin, and clip-mask.

XDrawImageString and **XDrawImageString16** can generate **BadDrawable**, **BadGC**, and **BadMatch** errors.

8.7. Transferring Images between Client and Server

Xlib provides functions that you can use to transfer images between a client and the server. Because the server may require diverse data formats, Xlib provides an image object that fully describes the data in memory and that provides for basic operations on that data. You should reference the data through the image object rather than referencing the data directly. However, some implementations of the Xlib library may efficiently deal with frequently used data formats by replacing functions in the procedure vector with special case functions. Supported operations include destroying the image, getting a pixel, storing a pixel, extracting a subimage of an image, and adding a constant to an image (see section 16.8).

All the image manipulation functions discussed in this section make use of the **XImage** structure, which describes an image as it exists in the client's memory.

```
typedef struct _XImage {
        int width, height;                  /* size of image */
        int xoffset;                        /* number of pixels offset in X direction */
        int format;                         /* XYBitmap, XYPixmap, ZPixmap */
        char *data;                         /* pointer to image data */
        int byte_order;                     /* data byte order, LSBFirst, MSBFirst */
        int bitmap_unit;                    /* quant. of scanline 8, 16, 32 */
        int bitmap_bit_order;               /* LSBFirst, MSBFirst */
        int bitmap_pad;                     /* 8, 16, 32 either XY or ZPixmap */
        int depth;                          /* depth of image */
        int bytes_per_line;                 /* accelerator to next scanline */
        int bits_per_pixel;                 /* bits per pixel (ZPixmap) */
        unsigned long red_mask;             /* bits in z arrangement */
        unsigned long green_mask;
        unsigned long blue_mask;
        XPointer obdata;                    /* hook for the object routines to hang on */
        struct funcs {                      /* image manipulation routines */
                struct _XImage *(*create_image)();
                int (*destroy_image)();
                unsigned long (*get_pixel)();
                int (*put_pixel)();
                struct _XImage *(*sub_image)();
                int (*add_pixel)();
        } f;
} XImage;
```

To initialize the image manipulation routines of an image structure, use **XInitImage**.

```
Status XInitImage(image)
    XImage *image;
```

ximage Specifies the image.

The **XInitImage** function initializes the internal image manipulation routines of an image structure, based on the values of the various structure members. All fields other than the manipulation routines must already be initialized. If the bytes_per_line member is zero, **XInitImage** will assume the image data is contiguous in memory and set the bytes_per_line member to an appropriate value based on the other members; otherwise, the value of bytes_per_line is not changed. All of the manipulation routines are initialized to functions that other Xlib image manipulation functions need to operate on the the type of image specified by the rest of the structure.

This function must be called for any image constructed by the client before passing it to any other Xlib function. Image structures created or returned by Xlib do not need to be initialized in this fashion.

This function returns a nonzero status if initialization of the structure is successful. It returns zero if it detected some error or inconsistency in the structure, in which case the image is not changed.

To combine an image with a rectangle of a drawable on the display, use **XPutImage**.

XPutImage(*display*, *d*, *gc*, *image*, *src_x*, *src_y*, *dest_x*, *dest_y*, *width*, *height*)
Display **display*;
Drawable *d*;
GC *gc*;
XImage **image*;
int *src_x*, *src_y*;
int *dest_x*, *dest_y*;
unsigned int *width*, *height*;

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
image	Specifies the image you want combined with the rectangle.
src_x	Specifies the offset in X from the left edge of the image defined by the **XImage** structure.
src_y	Specifies the offset in Y from the top edge of the image defined by the **XImage** structure.
dest_x	
dest_y	Specify the x and y coordinates, which are relative to the origin of the drawable and are the coordinates of the subimage.
width	
height	Specify the width and height of the subimage, which define the dimensions of the rectangle.

The **XPutImage** function combines an image with a rectangle of the specified drawable. The section of the image defined by the src_x, src_y, width, and height arguments is drawn on the specified part of the drawable. If **XYBitmap** format is used, the depth of the image must be one, or a **BadMatch** error results. The foreground pixel in the GC defines the source for the one bits in the image, and the background pixel defines the source for the zero bits. For **XYPixmap** and **ZPixmap**, the depth of the image must match the depth of the drawable, or a **BadMatch** error results.

If the characteristics of the image (for example, byte_order and bitmap_unit) differ from what the server requires, **XPutImage** automatically makes the appropriate conversions.

This function uses these GC components: function, plane-mask, subwindow-mode, clip-x-origin, clip-y-origin, and clip-mask. It also uses these GC mode-dependent components: foreground and background.

XPutImage can generate **BadDrawable**, **BadGC**, **BadMatch**, and **BadValue** errors.

To return the contents of a rectangle in a given drawable on the display, use **XGetImage**. This function specifically supports rudimentary screen dumps.

```
XImage *XGetImage(display, d, x, y, width, height, plane_mask, format)
      Display *display;
      Drawable d;
      int x, y;
      unsigned int width, height;
      unsigned long plane_mask;
      int format;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
x	
y	Specify the x and y coordinates, which are relative to the origin of the drawable and define the upper-left corner of the rectangle.
width	
height	Specify the width and height of the subimage, which define the dimensions of the rectangle.
plane_mask	Specifies the plane mask.
format	Specifies the format for the image. You can pass **XYPixmap** or **ZPixmap**.

The **XGetImage** function returns a pointer to an **XImage** structure. This structure provides you with the contents of the specified rectangle of the drawable in the format you specify. If the format argument is **XYPixmap**, the image contains only the bit planes you passed to the plane_mask argument. If the plane_mask argument only requests a subset of the planes of the display, the depth of the returned image will be the number of planes requested. If the format argument is **ZPixmap**, **XGetImage** returns as zero the bits in all planes not specified in the plane_mask argument. The function performs no range checking on the values in plane_mask and ignores extraneous bits.

XGetImage returns the depth of the image to the depth member of the **XImage** structure. The depth of the image is as specified when the drawable was created, except when getting a subset of the planes in **XYPixmap** format, when the depth is given by the number of bits set to 1 in plane_mask.

If the drawable is a pixmap, the given rectangle must be wholly contained within the pixmap, or a **BadMatch** error results. If the drawable is a window, the window must be viewable, and it must be the case that if there were no inferiors or overlapping windows, the specified rectangle of the window would be fully visible on the screen and wholly contained within the outside edges of the window, or a **BadMatch** error results. Note that the borders of the window can be included and read with this request. If the window has backing-store, the backing-store contents are returned for regions of the window that are obscured by noninferior windows. If the window does not have backing-store, the returned contents of such obscured regions are undefined. The returned contents of visible regions of inferiors of a different depth than the specified window's depth are also undefined. The pointer cursor image is not included in the returned contents. If a problem occurs, **XGetImage** returns NULL.

XGetImage can generate **BadDrawable**, **BadMatch**, and **BadValue** errors.

To copy the contents of a rectangle on the display to a location within a preexisting image structure, use **XGetSubImage**.

```
XImage *XGetSubImage(display, d, x, y, width, height, plane_mask, format, dest_image, dest_x,
                dest_y)
    Display *display;
    Drawable d;
    int x, y;
    unsigned int width, height;
    unsigned long plane_mask;
    int format;
    XImage *dest_image;
    int dest_x, dest_y;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
x	
y	Specify the x and y coordinates, which are relative to the origin of the drawable and define the upper-left corner of the rectangle.
width	
height	Specify the width and height of the subimage, which define the dimensions of the rectangle.
plane_mask	Specifies the plane mask.
format	Specifies the format for the image. You can pass **XYPixmap** or **ZPixmap**.
dest_image	Specifies the destination image.
dest_x	
dest_y	Specify the x and y coordinates, which are relative to the origin of the destination rectangle, specify its upper-left corner, and determine where the subimage is placed in the destination image.

The **XGetSubImage** function updates dest_image with the specified subimage in the same manner as **XGetImage**. If the format argument is **XYPixmap**, the image contains only the bit planes you passed to the plane_mask argument. If the format argument is **ZPixmap**, **XGetSubImage** returns as zero the bits in all planes not specified in the plane_mask argument. The function performs no range checking on the values in plane_mask and ignores extraneous bits. As a convenience, **XGetSubImage** returns a pointer to the same **XImage** structure specified by dest_image.

The depth of the destination **XImage** structure must be the same as that of the drawable. If the specified subimage does not fit at the specified location on the destination image, the right and bottom edges are clipped. If the drawable is a pixmap, the given rectangle must be wholly contained within the pixmap, or a **BadMatch** error results. If the drawable is a window, the window must be viewable, and it must be the case that if there were no inferiors or overlapping windows, the specified rectangle of the window would be fully visible on the screen and wholly contained within the outside edges of the window, or a **BadMatch** error results. If the window has backing-store, then the backing-store contents are returned for regions of the window that are obscured by noninferior windows. If the window does not have backing-store, the returned contents of such obscured regions are undefined. The returned contents of visible regions of inferiors of a different depth than the specified window's depth are also undefined. If a problem occurs, **XGetSubImage** returns NULL.

XGetSubImage can generate **BadDrawable**, **BadGC**, **BadMatch**, and **BadValue** errors.

Chapter 9

Window and Session Manager Functions

Although it is difficult to categorize functions as exclusively for an application, a window manager, or a session manager, the functions in this chapter are most often used by window managers and session managers. It is not expected that these functions will be used by most application programs. Xlib provides management functions to:

- Change the parent of a window
- Control the lifetime of a window
- Manage installed colormaps
- Set and retrieve the font search path
- Grab the server
- Kill a client
- Control the screen saver
- Control host access

9.1. Changing the Parent of a Window

To change a window's parent to another window on the same screen, use **XReparentWindow**. There is no way to move a window between screens.

```
XReparentWindow(display, w, parent, x, y)
    Display *display;
    Window w;
    Window parent;
    int x, y;
```

display	Specifies the connection to the X server.
w	Specifies the window.
parent	Specifies the parent window.
x	
y	Specify the x and y coordinates of the position in the new parent window.

If the specified window is mapped, **XReparentWindow** automatically performs an **UnmapWindow** request on it, removes it from its current position in the hierarchy, and inserts it as the child of the specified parent. The window is placed in the stacking order on top with respect to sibling windows.

After reparenting the specified window, **XReparentWindow** causes the X server to generate a **ReparentNotify** event. The override_redirect member returned in this event is set to the window's corresponding attribute. Window manager clients usually should ignore this window if this member is set to **True**. Finally, if the specified window was originally mapped, the X server automatically performs a **MapWindow** request on it.

The X server performs normal exposure processing on formerly obscured windows. The X server might not generate **Expose** events for regions from the initial **UnmapWindow** request that are immediately obscured by the final **MapWindow** request. A **BadMatch** error results if:

- The new parent window is not on the same screen as the old parent window.
- The new parent window is the specified window or an inferior of the specified window.
- The new parent is **InputOnly**, and the window is not.
- The specified window has a **ParentRelative** background, and the new parent window is not the same depth as the specified window.

XReparentWindow can generate **BadMatch** and **BadWindow** errors.

9.2. Controlling the Lifetime of a Window

The save-set of a client is a list of other clients' windows that, if they are inferiors of one of the client's windows at connection close, should not be destroyed and should be remapped if they are unmapped. For further information about close-connection processing, see section 2.6. To allow an application's window to survive when a window manager that has reparented a window fails, Xlib provides the save-set functions that you can use to control the longevity of subwindows that are normally destroyed when the parent is destroyed. For example, a window manager that wants to add decoration to a window by adding a frame might reparent an application's window. When the frame is destroyed, the application's window should not be destroyed but be returned to its previous place in the window hierarchy.

The X server automatically removes windows from the save-set when they are destroyed.

To add or remove a window from the client's save-set, use **XChangeSaveSet**.

```
XChangeSaveSet(display, w, change_mode)
    Display *display;
    Window w;
    int change_mode;
```

display	Specifies the connection to the X server.
w	Specifies the window that you want to add to or delete from the client's save-set.
change_mode	Specifies the mode. You can pass **SetModeInsert** or **SetModeDelete**.

Depending on the specified mode, **XChangeSaveSet** either inserts or deletes the specified window from the client's save-set. The specified window must have been created by some other client, or a **BadMatch** error results.

XChangeSaveSet can generate **BadMatch**, **BadValue**, and **BadWindow** errors.

To add a window to the client's save-set, use **XAddToSaveSet**.

```
XAddToSaveSet(display, w)
      Display *display;
      Window w;
```

display	Specifies the connection to the X server.
w	Specifies the window that you want to add to the client's save-set.

The **XAddToSaveSet** function adds the specified window to the client's save-set. The specified window must have been created by some other client, or a **BadMatch** error results.

XAddToSaveSet can generate **BadMatch** and **BadWindow** errors.

To remove a window from the client's save-set, use **XRemoveFromSaveSet**.

```
XRemoveFromSaveSet(display, w)
      Display *display;
      Window w;
```

display	Specifies the connection to the X server.
w	Specifies the window that you want to delete from the client's save-set.

The **XRemoveFromSaveSet** function removes the specified window from the client's save-set. The specified window must have been created by some other client, or a **BadMatch** error results.

XRemoveFromSaveSet can generate **BadMatch** and **BadWindow** errors.

9.3. Managing Installed Colormaps

The X server maintains a list of installed colormaps. Windows using these colormaps are guaranteed to display with correct colors; windows using other colormaps may or may not display with correct colors. Xlib provides functions that you can use to install a colormap, uninstall a colormap, and obtain a list of installed colormaps.

At any time, there is a subset of the installed maps that is viewed as an ordered list and is called the required list. The length of the required list is at most M, where M is the minimum number of installed colormaps specified for the screen in the connection setup. The required list is maintained as follows. When a colormap is specified to **XInstallColormap**, it is added to the head of the list; the list is truncated at the tail, if necessary, to keep its length to at most M. When a colormap is specified to **XUninstallColormap** and it is in the required list, it is removed from the list. A colormap is not added to the required list when it is implicitly installed by the X server, and the X server cannot implicitly uninstall a colormap that is in the required list.

To install a colormap, use **XInstallColormap**.

```
XInstallColormap(display, colormap)
      Display *display;
      Colormap colormap;
```

display	Specifies the connection to the X server.
colormap	Specifies the colormap.

The **XInstallColormap** function installs the specified colormap for its associated screen. All windows associated with this colormap immediately display with true colors. You associated the windows with this colormap when you created them by calling **XCreateWindow**, **XCreateSimpleWindow**, **XChangeWindowAttributes**, or **XSetWindowColormap**.

If the specified colormap is not already an installed colormap, the X server generates a **ColormapNotify** event on each window that has that colormap. In addition, for every other colormap that is installed as a result of a call to **XInstallColormap**, the X server generates a **ColormapNotify** event on each window that has that colormap.

XInstallColormap can generate a **BadColor** error.

To uninstall a colormap, use **XUninstallColormap**.

```
XUninstallColormap(display, colormap)
      Display *display;
      Colormap colormap;
```

display	Specifies the connection to the X server.
colormap	Specifies the colormap.

The **XUninstallColormap** function removes the specified colormap from the required list for its screen. As a result, the specified colormap might be uninstalled, and the X server might implicitly install or uninstall additional colormaps. Which colormaps get installed or uninstalled is server-dependent except that the required list must remain installed.

If the specified colormap becomes uninstalled, the X server generates a **ColormapNotify** event on each window that has that colormap. In addition, for every other colormap that is installed or uninstalled as a result of a call to **XUninstallColormap**, the X server generates a **ColormapNotify** event on each window that has that colormap.

XUninstallColormap can generate a **BadColor** error.

To obtain a list of the currently installed colormaps for a given screen, use **XListInstalledColormaps**.

Colormap *XListInstalledColormaps(*display*, *w*, *num_return*)
  Display **display*;
  Window *w*;
  int **num_return*;

display	Specifies the connection to the X server.
w	Specifies the window that determines the screen.
num_return	Returns the number of currently installed colormaps.

The **XListInstalledColormaps** function returns a list of the currently installed colormaps for the screen of the specified window. The order of the colormaps in the list is not significant and is no explicit indication of the required list. When the allocated list is no longer needed, free it by using **XFree**.

XListInstalledColormaps can generate a **BadWindow** error.

9.4. Setting and Retrieving the Font Search Path

The set of fonts available from a server depends on a font search path. Xlib provides functions to set and retrieve the search path for a server.

To set the font search path, use **XSetFontPath**.

XSetFontPath(*display*, *directories*, *ndirs*)
  Display **display*;
  char ***directories*;
  int *ndirs*;

display	Specifies the connection to the X server.
directories	Specifies the directory path used to look for a font. Setting the path to the empty list restores the default path defined for the X server.
ndirs	Specifies the number of directories in the path.

The **XSetFontPath** function defines the directory search path for font lookup. There is only one search path per X server, not one per client. The encoding and interpretation of the strings is implementation dependent, but typically they specify directories or font servers to be searched in the order listed. An X server is permitted to cache font information internally; for example, it might cache an entire font from a file and not check on subsequent opens of that font to see if the underlying font file has changed. However, when the font path is changed, the X server is guaranteed to flush all cached information about fonts for which there currently are no explicit resource IDs allocated. The meaning of an error from this request is implementation dependent.

XSetFontPath can generate a **BadValue** error.

To get the current font search path, use **XGetFontPath**.

```
char **XGetFontPath(display, npaths_return)
      Display *display;
      int *npaths_return;
```

display	Specifies the connection to the X server.
npaths_return	Returns the number of strings in the font path array.

The **XGetFontPath** function allocates and returns an array of strings containing the search path. The contents of these strings are implementation dependent and are not intended to be interpreted by client applications. When it is no longer needed, the data in the font path should be freed by using **XFreeFontPath**.

To free data returned by **XGetFontPath**, use **XFreeFontPath**.

```
XFreeFontPath(list)
      char **list;
```

list	Specifies the array of strings you want to free.

The **XFreeFontPath** function frees the data allocated by **XGetFontPath**.

9.5. Server Grabbing

Xlib provides functions that you can use to grab and ungrab the server. These functions can be used to control processing of output on other connections by the window system server. While the server is grabbed, no processing of requests or close downs on any other connection will occur. A client closing its connection automatically ungrabs the server. Although grabbing the server is highly discouraged, it is sometimes necessary.

To grab the server, use **XGrabServer**.

```
XGrabServer(display)
      Display *display;
```

display	Specifies the connection to the X server.

The **XGrabServer** function disables processing of requests and close downs on all other connections than the one this request arrived on. You should not grab the X server any more than is absolutely necessary.

To ungrab the server, use **XUngrabServer**.

XUngrabServer(*display*)
    Display **display*;

display Specifies the connection to the X server.

The **XUngrabServer** function restarts processing of requests and close downs on other connections. You should avoid grabbing the X server as much as possible.

9.6. Killing Clients

Xlib provides a function to cause the connection to a client to be closed and its resources to be destroyed. To destroy a client, use **XKillClient**.

XKillClient(*display*, *resource*)
    Display **display*;
    XID *resource*;

display	Specifies the connection to the X server.
resource	Specifies any resource associated with the client that you want to destroy or **AllTemporary**.

The **XKillClient** function forces a close-down of the client that created the resource if a valid resource is specified. If the client has already terminated in either **RetainPermanent** or **RetainTemporary** mode, all of the client's resources are destroyed. If **AllTemporary** is specified, the resources of all clients that have terminated in **RetainTemporary** are destroyed (see section 2.5). This permits implementation of window manager facilities that aid debugging. A client can set its close-down mode to **RetainTemporary**. If the client then crashes, its windows would not be destroyed. The programmer can then inspect the application's window tree and use the window manager to destroy the zombie windows.

XKillClient can generate a **BadValue** error.

9.7. Screen Saver Control

Xlib provides functions that you can use to set or reset the mode of the screen saver, to force or activate the screen saver, or to obtain the current screen saver values.

To set the screen saver mode, use **XSetScreenSaver**.

```
XSetScreenSaver(display, timeout, interval, prefer_blanking, allow_exposures)
    Display *display;
    int timeout, interval;
    int prefer_blanking;
    int allow_exposures;
```

display	Specifies the connection to the X server.
timeout	Specifies the timeout, in seconds, until the screen saver turns on.
interval	Specifies the interval, in seconds, between screen saver alterations.
prefer_blanking	Specifies how to enable screen blanking. You can pass **DontPreferBlanking**, **PreferBlanking**, or **DefaultBlanking**.
allow_exposures	Specifies the screen save control values. You can pass **DontAllowExposures**, **AllowExposures**, or **DefaultExposures**.

Timeout and interval are specified in seconds. A timeout of 0 disables the screen saver (but an activated screen saver is not deactivated), and a timeout of −1 restores the default. Other negative values generate a **BadValue** error. If the timeout value is nonzero, **XSetScreenSaver** enables the screen saver. An interval of 0 disables the random-pattern motion. If no input from devices (keyboard, mouse, and so on) is generated for the specified number of timeout seconds once the screen saver is enabled, the screen saver is activated.

For each screen, if blanking is preferred and the hardware supports video blanking, the screen simply goes blank. Otherwise, if either exposures are allowed or the screen can be regenerated without sending **Expose** events to clients, the screen is tiled with the root window background tile randomly re-origined each interval seconds. Otherwise, the screens' state do not change, and the screen saver is not activated. The screen saver is deactivated, and all screen states are restored at the next keyboard or pointer input or at the next call to **XForceScreenSaver** with mode **ScreenSaverReset**.

If the server-dependent screen saver method supports periodic change, the interval argument serves as a hint about how long the change period should be, and zero hints that no periodic change should be made. Examples of ways to change the screen include scrambling the colormap periodically, moving an icon image around the screen periodically, or tiling the screen with the root window background tile, randomly re-origined periodically.

XSetScreenSaver can generate a **BadValue** error.

To force the screen saver on or off, use **XForceScreenSaver**.

```
XForceScreenSaver(display, mode)
    Display *display;
    int mode;
```

display	Specifies the connection to the X server.
mode	Specifies the mode that is to be applied. You can pass **ScreenSaverActive** or **ScreenSaverReset**.

If the specified mode is **ScreenSaverActive** and the screen saver currently is deactivated,

XForceScreenSaver activates the screen saver even if the screen saver had been disabled with a timeout of zero. If the specified mode is **ScreenSaverReset** and the screen saver currently is enabled, **XForceScreenSaver** deactivates the screen saver if it was activated, and the activation timer is reset to its initial state (as if device input had been received).

XForceScreenSaver can generate a **BadValue** error.

To activate the screen saver, use **XActivateScreenSaver**.

XActivateScreenSaver(*display*)
    Display **display*;

display	Specifies the connection to the X server.

To reset the screen saver, use **XResetScreenSaver**.

XResetScreenSaver(*display*)
    Display **display*;

display	Specifies the connection to the X server.

To get the current screen saver values, use **XGetScreenSaver**.

XGetScreenSaver(*display*, *timeout_return*, *interval_return*, *prefer_blanking_return*,
        allow_exposures_return)
    Display **display*;
    int **timeout_return*, **interval_return*;
    int **prefer_blanking_return*;
    int **allow_exposures_return*;

display	Specifies the connection to the X server.
timeout_return	Returns the timeout, in seconds, until the screen saver turns on.
interval_return	Returns the interval between screen saver invocations.
prefer_blanking_return	Returns the current screen blanking preference (**DontPreferBlanking**, **PreferBlanking**, or **DefaultBlanking**).
allow_exposures_return	Returns the current screen save control value (**DontAllowExposures**, **AllowExposures**, or **DefaultExposures**).

9.8. Controlling Host Access

This section discusses how to:

- Add, get, or remove hosts from the access control list

- Change, enable, or disable access

X does not provide any protection on a per-window basis. If you find out the resource ID of a resource, you can manipulate it. To provide some minimal level of protection, however, connections are permitted only from machines you trust. This is adequate on single-user workstations but obviously breaks down on timesharing machines. Although provisions exist in the X protocol for proper connection authentication, the lack of a standard authentication server leaves host-level access control as the only common mechanism.

The initial set of hosts allowed to open connections typically consists of:

- The host the window system is running on.
- On POSIX-conformant systems, each host listed in the **/etc/X?.hosts** file. The ? indicates the number of the display. This file should consist of host names separated by newlines. DECnet nodes must terminate in :: to distinguish them from Internet hosts.

If a host is not in the access control list when the access control mechanism is enabled and if the host attempts to establish a connection, the server refuses the connection. To change the access list, the client must reside on the same host as the server and/or must have been granted permission in the initial authorization at connection setup.

Servers also can implement other access control policies in addition to or in place of this host access facility. For further information about other access control implementations, see ‘‘X Window System Protocol.’’

9.8.1. Adding, Getting, or Removing Hosts

Xlib provides functions that you can use to add, get, or remove hosts from the access control list. All the host access control functions use the **XHostAddress** structure, which contains:

```
typedef struct {
        int family;                     /* for example FamilyInternet */
        int length;                     /* length of address, in bytes */
        char *address;                  /* pointer to where to find the address */
} XHostAddress;
```

The family member specifies which protocol address family to use (for example, TCP/IP or DECnet) and can be **FamilyInternet**, **FamilyDECnet**, or **FamilyChaos**. The length member specifies the length of the address in bytes. The address member specifies a pointer to the address.

For TCP/IP, the address should be in network byte order. For the DECnet family, the server performs no automatic swapping on the address bytes. A Phase IV address is two bytes long. The first byte contains the least-significant eight bits of the node number. The second byte contains the most-significant two bits of the node number in the least-significant two bits of the byte and the area in the most-significant six bits of the byte.

To add a single host, use **XAddHost**.

XAddHost(*display*, *host*)
  Display **display*;
  XHostAddress **host*;

display Specifies the connection to the X server.

host Specifies the host that is to be added.

The **XAddHost** function adds the specified host to the access control list for that display. The server must be on the same host as the client issuing the command, or a **BadAccess** error results.

XAddHost can generate **BadAccess** and **BadValue** errors.

To add multiple hosts at one time, use **XAddHosts**.

XAddHosts(*display*, *hosts*, *num_hosts*)
  Display **display*;
  XHostAddress **hosts*;
  int *num_hosts*;

display Specifies the connection to the X server.

hosts Specifies each host that is to be added.

num_hosts Specifies the number of hosts.

The **XAddHosts** function adds each specified host to the access control list for that display. The server must be on the same host as the client issuing the command, or a **BadAccess** error results.

XAddHosts can generate **BadAccess** and **BadValue** errors.

To obtain a host list, use **XListHosts**.

XHostAddress *XListHosts(*display*, *nhosts_return*, *state_return*)
  Display **display*;
  int **nhosts_return*;
  Bool **state_return*;

display Specifies the connection to the X server.

nhosts_return Returns the number of hosts currently in the access control list.

state_return Returns the state of the access control.

The **XListHosts** function returns the current access control list as well as whether the use of the list at connection setup was enabled or disabled. **XListHosts** allows a program to find out what machines can make connections. It also returns a pointer to a list of host structures that were allocated by the function. When no longer needed, this memory should be freed by calling **XFree**.

To remove a single host, use **XRemoveHost**.

XRemoveHost(*display*, *host*)
  Display **display*;
  XHostAddress **host*;

display	Specifies the connection to the X server.
host	Specifies the host that is to be removed.

The **XRemoveHost** function removes the specified host from the access control list for that display. The server must be on the same host as the client process, or a **BadAccess** error results. If you remove your machine from the access list, you can no longer connect to that server, and this operation cannot be reversed unless you reset the server.

XRemoveHost can generate **BadAccess** and **BadValue** errors.

To remove multiple hosts at one time, use **XRemoveHosts**.

XRemoveHosts(*display*, *hosts*, *num_hosts*)
  Display **display*;
  XHostAddress **hosts*;
  int *num_hosts*;

display	Specifies the connection to the X server.
hosts	Specifies each host that is to be removed.
num_hosts	Specifies the number of hosts.

The **XRemoveHosts** function removes each specified host from the access control list for that display. The X server must be on the same host as the client process, or a **BadAccess** error results. If you remove your machine from the access list, you can no longer connect to that server, and this operation cannot be reversed unless you reset the server.

XRemoveHosts can generate **BadAccess** and **BadValue** errors.

9.8.2. Changing, Enabling, or Disabling Access Control

Xlib provides functions that you can use to enable, disable, or change access control.

For these functions to execute successfully, the client application must reside on the same host as the X server and/or have been given permission in the initial authorization at connection setup.

To change access control, use **XSetAccessControl**.

XSetAccessControl(*display*, *mode*)
  Display **display*;
  int *mode*;

display	Specifies the connection to the X server.
mode	Specifies the mode. You can pass **EnableAccess** or **DisableAccess**.

The **XSetAccessControl** function either enables or disables the use of the access control list at each connection setup.

XSetAccessControl can generate **BadAccess** and **BadValue** errors.

To enable access control, use **XEnableAccessControl**.

XEnableAccessControl(*display*)
    Display **display*;

display Specifies the connection to the X server.

The **XEnableAccessControl** function enables the use of the access control list at each connection setup.

XEnableAccessControl can generate a **BadAccess** error.

To disable access control, use **XDisableAccessControl**.

XDisableAccessControl(*display*)
    Display **display*;

display Specifies the connection to the X server.

The **XDisableAccessControl** function disables the use of the access control list at each connection setup.

XDisableAccessControl can generate a **BadAccess** error.

Chapter 10

Events

A client application communicates with the X server through the connection you establish with the **XOpenDisplay** function. A client application sends requests to the X server over this connection. These requests are made by the Xlib functions that are called in the client application. Many Xlib functions cause the X server to generate events, and the user's typing or moving the pointer can generate events asynchronously. The X server returns events to the client on the same connection.

This chapter discusses the following topics associated with events:

- Event types
- Event structures
- Event mask
- Event processing

Functions for handling events are dealt with in the next chapter.

10.1. Event Types

An event is data generated asynchronously by the X server as a result of some device activity or as side effects of a request sent by an Xlib function. Device-related events propagate from the source window to ancestor windows until some client application has selected that event type or until the event is explicitly discarded. The X server generally sends an event to a client application only if the client has specifically asked to be informed of that event type, typically by setting the event-mask attribute of the window. The mask can also be set when you create a window or by changing the window's event-mask. You can also mask out events that would propagate to ancestor windows by manipulating the do-not-propagate mask of the window's attributes. However, **MappingNotify** events are always sent to all clients.

An event type describes a specific event generated by the X server. For each event type, a corresponding constant name is defined in **<X11/X.h>**, which is used when referring to an event type. The following table lists the event category and its associated event type or types. The processing associated with these events is discussed in section 10.5.

Event Category	**Event Type**
Keyboard events	**KeyPress**, **KeyRelease**
Pointer events	**ButtonPress**, **ButtonRelease**, **MotionNotify**
Window crossing events	**EnterNotify**, **LeaveNotify**
Input focus events	**FocusIn**, **FocusOut**
Keymap state notification event	**KeymapNotify**
Exposure events	**Expose**, **GraphicsExpose**, **NoExpose**

Event Category	**Event Type**
Structure control events	**CirculateRequest**, **ConfigureRequest**, **MapRequest**, **ResizeRequest**
Window state notification events	**CirculateNotify**, **ConfigureNotify**, **CreateNotify**, **DestroyNotify**, **GravityNotify**, **MapNotify**, **MappingNotify**, **ReparentNotify**, **UnmapNotify**, **VisibilityNotify**
Colormap state notification event	**ColormapNotify**
Client communication events	**ClientMessage**, **PropertyNotify**, **SelectionClear**, **SelectionNotify**, **SelectionRequest**

10.2. Event Structures

For each event type, a corresponding structure is declared in **<X11/Xlib.h>**. All the event structures have the following common members:

```
typedef struct {
        int type;
        unsigned long serial;           /* # of last request processed by server */
        Bool send_event;                /* true if this came from a SendEvent request */
        Display *display;               /* Display the event was read from */
        Window window;
} XAnyEvent;
```

The type member is set to the event type constant name that uniquely identifies it. For example, when the X server reports a **GraphicsExpose** event to a client application, it sends an **XGraphicsExposeEvent** structure with the type member set to **GraphicsExpose**. The display member is set to a pointer to the display the event was read on. The send_event member is set to **True** if the event came from a **SendEvent** protocol request. The serial member is set from the serial number reported in the protocol but expanded from the 16-bit least-significant bits to a full 32-bit value. The window member is set to the window that is most useful to toolkit dispatchers.

The X server can send events at any time in the input stream. Xlib stores any events received while waiting for a reply in an event queue for later use. Xlib also provides functions that allow you to check events in the event queue (see section 11.3).

In addition to the individual structures declared for each event type, the **XEvent** structure is a union of the individual structures declared for each event type. Depending on the type, you should access members of each event by using the **XEvent** union.

```
typedef union _XEvent {
        int type;                               /* must not be changed */
        XAnyEvent xany;
        XKeyEvent xkey;
        XButtonEvent xbutton;
        XMotionEvent xmotion;
        XCrossingEvent xcrossing;
        XFocusChangeEvent xfocus;
        XExposeEvent xexpose;
        XGraphicsExposeEvent xgraphicsexpose;
        XNoExposeEvent xnoexpose;
        XVisibilityEvent xvisibility;
        XCreateWindowEvent xcreatewindow;
        XDestroyWindowEvent xdestroywindow;
        XUnmapEvent xunmap;
        XMapEvent xmap;
        XMapRequestEvent xmaprequest;
        XReparentEvent xreparent;
        XConfigureEvent xconfigure;
        XGravityEvent xgravity;
        XResizeRequestEvent xresizerequest;
        XConfigureRequestEvent xconfigurerequest;
        XCirculateEvent xcirculate;
        XCirculateRequestEvent xcirculaterequest;
        XPropertyEvent xproperty;
        XSelectionClearEvent xselectionclear;
        XSelectionRequestEvent xselectionrequest;
        XSelectionEvent xselection;
        XColormapEvent xcolormap;
        XClientMessageEvent xclient;
        XMappingEvent xmapping;
        XErrorEvent xerror;
        XKeymapEvent xkeymap;
        long pad[24];
} XEvent;
```

An **XEvent** structure's first entry always is the type member, which is set to the event type. The second member always is the serial number of the protocol request that generated the event. The third member always is send_event, which is a **Bool** that indicates if the event was sent by a different client. The fourth member always is a display, which is the display that the event was read from. Except for keymap events, the fifth member always is a window, which has been carefully selected to be useful to toolkit dispatchers. To avoid breaking toolkits, the order of these first five entries is not to change. Most events also contain a time member, which is the time at which an event occurred. In addition, a pointer to the generic event must be cast before it is used to access any other information in the structure.

10.3. Event Masks

Clients select event reporting of most events relative to a window. To do this, pass an event mask to an Xlib event-handling function that takes an event_mask argument. The bits of the event mask are defined in **<X11/X.h>**. Each bit in the event mask maps to an event mask name, which describes the event or events you want the X server to return to a client application.

Unless the client has specifically asked for them, most events are not reported to clients when they are generated. Unless the client suppresses them by setting graphics-exposures in the GC to **False**, **GraphicsExpose** and **NoExpose** are reported by default as a result of **XCopyPlane** and **XCopyArea**. **SelectionClear**, **SelectionRequest**, **SelectionNotify**, or **ClientMessage** cannot be masked. Selection related events are only sent to clients cooperating with selections (see section 4.5). When the keyboard or pointer mapping is changed, **MappingNotify** is always sent to clients.

The following table lists the event mask constants you can pass to the event_mask argument and the circumstances in which you would want to specify the event mask:

Event Mask	Circumstances
NoEventMask	No events wanted
KeyPressMask	Keyboard down events wanted
KeyReleaseMask	Keyboard up events wanted
ButtonPressMask	Pointer button down events wanted
ButtonReleaseMask	Pointer button up events wanted
EnterWindowMask	Pointer window entry events wanted
LeaveWindowMask	Pointer window leave events wanted
PointerMotionMask	Pointer motion events wanted
PointerMotionHintMask	Pointer motion hints wanted
Button1MotionMask	Pointer motion while button 1 down
Button2MotionMask	Pointer motion while button 2 down
Button3MotionMask	Pointer motion while button 3 down
Button4MotionMask	Pointer motion while button 4 down
Button5MotionMask	Pointer motion while button 5 down
ButtonMotionMask	Pointer motion while any button down
KeymapStateMask	Keyboard state wanted at window entry and focus in
ExposureMask	Any exposure wanted
VisibilityChangeMask	Any change in visibility wanted
StructureNotifyMask	Any change in window structure wanted
ResizeRedirectMask	Redirect resize of this window
SubstructureNotifyMask	Substructure notification wanted
SubstructureRedirectMask	Redirect structure requests on children
FocusChangeMask	Any change in input focus wanted
PropertyChangeMask	Any change in property wanted
ColormapChangeMask	Any change in colormap wanted
OwnerGrabButtonMask	Automatic grabs should activate with owner_events set to **True**

10.4. Event Processing Overview

The event reported to a client application during event processing depends on which event masks you provide as the event-mask attribute for a window. For some event masks, there is a one-to-one correspondence between the event mask constant and the event type constant. For example, if you pass the event mask **ButtonPressMask**, the X server sends back only **ButtonPress** events. Most events contain a time member, which is the time at which an event occurred.

In other cases, one event mask constant can map to several event type constants. For example, if you pass the event mask **SubstructureNotifyMask**, the X server can send back **CirculateNotify**, **ConfigureNotify**, **CreateNotify**, **DestroyNotify**, **GravityNotify**, **MapNotify**, **ReparentNotify**, or **UnmapNotify** events.

In another case, two event masks can map to one event type. For example, if you pass either **PointerMotionMask** or **ButtonMotionMask**, the X server sends back a **MotionNotify** event.

The following table lists the event mask, its associated event type or types, and the structure name associated with the event type. Some of these structures actually are typedefs to a generic structure that is shared between two event types. Note that N.A. appears in columns for which the information is not applicable.

Event Mask	**Event Type**	**Structure**	**Generic Structure**
ButtonMotionMask Button1MotionMask Button2MotionMask Button3MotionMask Button4MotionMask Button5MotionMask	MotionNotify	XPointerMovedEvent	XMotionEvent
ButtonPressMask	ButtonPress	XButtonPressedEvent	XButtonEvent
ButtonReleaseMask	ButtonRelease	XButtonReleasedEvent	XButtonEvent
ColormapChangeMask	ColormapNotify	XColormapEvent	
EnterWindowMask	EnterNotify	XEnterWindowEvent	XCrossingEvent
LeaveWindowMask	LeaveNotify	XLeaveWindowEvent	XCrossingEvent
ExposureMask	Expose	XExposeEvent	
GCGraphicsExposures in GC	GraphicsExpose	XGraphicsExposeEvent	
	NoExpose	XNoExposeEvent	
FocusChangeMask	FocusIn	XFocusInEvent	XFocusChangeEvent
	FocusOut	XFocusOutEvent	XFocusChangeEvent
KeymapStateMask	KeymapNotify	XKeymapEvent	
KeyPressMask	KeyPress	XKeyPressedEvent	XKeyEvent
KeyReleaseMask	KeyRelease	XKeyReleasedEvent	XKeyEvent
OwnerGrabButtonMask	N.A.	N.A.	
PointerMotionMask	MotionNotify	XPointerMovedEvent	XMotionEvent
PointerMotionHintMask	N.A.	N.A.	
PropertyChangeMask	PropertyNotify	XPropertyEvent	
ResizeRedirectMask	ResizeRequest	XResizeRequestEvent	
StructureNotifyMask	CirculateNotify	XCirculateEvent	
	ConfigureNotify	XConfigureEvent	
	DestroyNotify	XDestroyWindowEvent	
	GravityNotify	XGravityEvent	
	MapNotify	XMapEvent	

Event Mask	Event Type	Structure	Generic Structure
	ReparentNotify	XReparentEvent	
	UnmapNotify	XUnmapEvent	
SubstructureNotifyMask	CirculateNotify	XCirculateEvent	
	ConfigureNotify	XConfigureEvent	
	CreateNotify	XCreateWindowEvent	
	DestroyNotify	XDestroyWindowEvent	
	GravityNotify	XGravityEvent	
	MapNotify	XMapEvent	
	ReparentNotify	XReparentEvent	
	UnmapNotify	XUnmapEvent	
SubstructureRedirectMask	CirculateRequest	XCirculateRequestEvent	
	ConfigureRequest	XConfigureRequestEvent	
	MapRequest	XMapRequestEvent	
N.A.	ClientMessage	XClientMessageEvent	
N.A.	MappingNotify	XMappingEvent	
N.A.	SelectionClear	XSelectionClearEvent	
N.A.	SelectionNotify	XSelectionEvent	
N.A.	SelectionRequest	XSelectionRequestEvent	
VisibilityChangeMask	VisibilityNotify	XVisibilityEvent	

The sections that follow describe the processing that occurs when you select the different event masks. The sections are organized according to these processing categories:

- Keyboard and pointer events
- Window crossing events
- Input focus events
- Keymap state notification events
- Exposure events
- Window state notification events
- Structure control events
- Colormap state notification events
- Client communication events

10.5. Keyboard and Pointer Events

This section discusses:

- Pointer button events
- Keyboard and pointer events

10.5.1. Pointer Button Events

The following describes the event processing that occurs when a pointer button press is processed with the pointer in some window w and when no active pointer grab is in progress.

The X server searches the ancestors of w from the root down, looking for a passive grab to activate. If no matching passive grab on the button exists, the X server automatically starts an active grab for the client receiving the event and sets the last-pointer-grab time to the current server time. The effect is essentially equivalent to an **XGrabButton** with these client passed arguments:

Argument	**Value**
w	The event window
event_mask	The client's selected pointer events on the event window
pointer_mode	**GrabModeAsync**
keyboard_mode	**GrabModeAsync**
owner_events	**True**, if the client has selected **OwnerGrabButtonMask** on the event window, otherwise **False**
confine_to	**None**
cursor	**None**

The active grab is automatically terminated when the logical state of the pointer has all buttons released. Clients can modify the active grab by calling **XUngrabPointer** and **XChangeActivePointerGrab**.

10.5.2. Keyboard and Pointer Events

This section discusses the processing that occurs for the keyboard events **KeyPress** and **KeyRelease** and the pointer events **ButtonPress**, **ButtonRelease**, and **MotionNotify**. For information about the keyboard event-handling utilities, see chapter 11.

The X server reports **KeyPress** or **KeyRelease** events to clients wanting information about keys that logically change state. Note that these events are generated for all keys, even those mapped to modifier bits. The X server reports **ButtonPress** or **ButtonRelease** events to clients wanting information about buttons that logically change state.

The X server reports **MotionNotify** events to clients wanting information about when the pointer logically moves. The X server generates this event whenever the pointer is moved and the pointer motion begins and ends in the window. The granularity of **MotionNotify** events is not guaranteed, but a client that selects this event type is guaranteed to receive at least one event when the pointer moves and then rests.

The generation of the logical changes lags the physical changes if device event processing is frozen.

To receive **KeyPress**, **KeyRelease**, **ButtonPress**, and **ButtonRelease** events, set **KeyPressMask**, **KeyReleaseMask**, **ButtonPressMask**, and **ButtonReleaseMask** bits in the event-mask attribute of the window.

To receive **MotionNotify** events, set one or more of the following event masks bits in the event-mask attribute of the window.

- **Button1MotionMask − Button5MotionMask**

  The client application receives **MotionNotify** events only when one or more of the specified buttons is pressed.

- **ButtonMotionMask**

  The client application receives **MotionNotify** events only when at least one button is pressed.

- **PointerMotionMask**

  The client application receives **MotionNotify** events independent of the state of the pointer buttons.

- **PointerMotionHintMask**

  If **PointerMotionHintMask** is selected in combination with one or more of the above masks, the X server is free to send only one **MotionNotify** event (with the is_hint member of the **XPointerMovedEvent** structure set to **NotifyHint**) to the client for the event window, until either the key or button state changes, the pointer leaves the event window, or the client calls **XQueryPointer** or **XGetMotionEvents**. The server still may send **MotionNotify** events without is_hint set to **NotifyHint**.

The source of the event is the viewable window that the pointer is in. The window used by the X server to report these events depends on the window's position in the window hierarchy and whether any intervening window prohibits the generation of these events. Starting with the source window, the X server searches up the window hierarchy until it locates the first window specified by a client as having an interest in these events. If one of the intervening windows has its do-not-propagate-mask set to prohibit generation of the event type, the events of those types will be suppressed. Clients can modify the actual window used for reporting by performing active grabs and, in the case of keyboard events, by using the focus window.

The structures for these event types contain:

```
typedef struct {
        int type;                           /* ButtonPress or ButtonRelease */
        unsigned long serial;               /* # of last request processed by server */
        Bool send_event;                    /* true if this came from a SendEvent request */
        Display *display;                   /* Display the event was read from */
        Window window;                      /* ‘‘event’’ window it is reported relative to */
        Window root;                        /* root window that the event occurred on */
        Window subwindow;                   /* child window */
        Time time;                          /* milliseconds */
        int x, y;                           /* pointer x, y coordinates in event window */
        int x_root, y_root;                 /* coordinates relative to root */
        unsigned int state;                 /* key or button mask */
        unsigned int button;                /* detail */
        Bool same_screen;                   /* same screen flag */
} XButtonEvent;
typedef XButtonEvent XButtonPressedEvent;
typedef XButtonEvent XButtonReleasedEvent;

typedef struct {
        int type;                           /* KeyPress or KeyRelease */
        unsigned long serial;               /* # of last request processed by server */
        Bool send_event;                    /* true if this came from a SendEvent request */
        Display *display;                   /* Display the event was read from */
        Window window;                      /* ‘‘event’’ window it is reported relative to */
        Window root;                        /* root window that the event occurred on */
        Window subwindow;                   /* child window */
        Time time;                          /* milliseconds */
        int x, y;                           /* pointer x, y coordinates in event window */
        int x_root, y_root;                 /* coordinates relative to root */
        unsigned int state;                 /* key or button mask */
        unsigned int keycode;               /* detail */
        Bool same_screen;                   /* same screen flag */
} XKeyEvent;
typedef XKeyEvent XKeyPressedEvent;
typedef XKeyEvent XKeyReleasedEvent;

typedef struct {
        int type;                           /* MotionNotify */
        unsigned long serial;               /* # of last request processed by server */
        Bool send_event;                    /* true if this came from a SendEvent request */
        Display *display;                   /* Display the event was read from */
        Window window;                      /* ‘‘event’’ window reported relative to */
        Window root;                        /* root window that the event occurred on */
        Window subwindow;                   /* child window */
        Time time;                          /* milliseconds */
        int x, y;                           /* pointer x, y coordinates in event window */
        int x_root, y_root;                 /* coordinates relative to root */
        unsigned int state;                 /* key or button mask */
        char is_hint;                       /* detail */
```

```
        Bool same_screen;                   /* same screen flag */
} XMotionEvent;
typedef XMotionEvent XPointerMovedEvent;
```

These structures have the following common members: window, root, subwindow, time, x, y, x_root, y_root, state, and same_screen. The window member is set to the window on which the event was generated and is referred to as the event window. As long as the conditions previously discussed are met, this is the window used by the X server to report the event. The root member is set to the source window's root window. The x_root and y_root members are set to the pointer's coordinates relative to the root window's origin at the time of the event.

The same_screen member is set to indicate whether the event window is on the same screen as the root window and can be either **True** or **False**. If **True**, the event and root windows are on the same screen. If **False**, the event and root windows are not on the same screen.

If the source window is an inferior of the event window, the subwindow member of the structure is set to the child of the event window that is the source window or the child of the event window that is an ancestor of the source window. Otherwise, the X server sets the subwindow member to **None**. The time member is set to the time when the event was generated and is expressed in milliseconds.

If the event window is on the same screen as the root window, the x and y members are set to the coordinates relative to the event window's origin. Otherwise, these members are set to zero.

The state member is set to indicate the logical state of the pointer buttons and modifier keys just prior to the event, which is the bitwise inclusive OR of one or more of the button or modifier key masks: **Button1Mask**, **Button2Mask**, **Button3Mask**, **Button4Mask**, **Button5Mask**, **ShiftMask**, **LockMask**, **ControlMask**, **Mod1Mask**, **Mod2Mask**, **Mod3Mask**, **Mod4Mask**, and **Mod5Mask**.

Each of these structures also has a member that indicates the detail. For the **XKeyPressedEvent** and **XKeyReleasedEvent** structures, this member is called keycode. It is set to a number that represents a physical key on the keyboard. The keycode is an arbitrary representation for any key on the keyboard (see sections 12.7 and 16.1).

For the **XButtonPressedEvent** and **XButtonReleasedEvent** structures, this member is called button. It represents the pointer button that changed state and can be the **Button1**, **Button2**, **Button3**, **Button4**, or **Button5** value. For the **XPointerMovedEvent** structure, this member is called is_hint. It can be set to **NotifyNormal** or **NotifyHint**.

Some of the symbols mentioned in this section have fixed values, as follows:

Symbol	**Value**
Button1MotionMask	(1L<<8)
Button2MotionMask	(1L<<9)
Button3MotionMask	(1L<<10)
Button4MotionMask	(1L<<11)
Button5MotionMask	(1L<<12)
Button1Mask	(1<<8)
Button2Mask	(1<<9)
Button3Mask	(1<<10)
Button4Mask	(1<<11)

Symbol	Value
Button5Mask	(1<<12)
ShiftMask	(1<<0)
LockMask	(1<<1)
ControlMask	(1<<2)
Mod1Mask	(1<<3)
Mod2Mask	(1<<4)
Mod3Mask	(1<<5)
Mod4Mask	(1<<6)
Mod5Mask	(1<<7)
Button1	1
Button2	2
Button3	3
Button4	4
Button5	5

10.6. Window Entry/Exit Events

This section describes the processing that occurs for the window crossing events **EnterNotify** and **LeaveNotify**. If a pointer motion or a window hierarchy change causes the pointer to be in a different window than before, the X server reports **EnterNotify** or **LeaveNotify** events to clients who have selected for these events. All **EnterNotify** and **LeaveNotify** events caused by a hierarchy change are generated after any hierarchy event (**UnmapNotify**, **MapNotify**, **ConfigureNotify**, **GravityNotify**, **CirculateNotify**) caused by that change; however, the X protocol does not constrain the ordering of **EnterNotify** and **LeaveNotify** events with respect to **FocusOut**, **VisibilityNotify**, and **Expose** events.

This contrasts with **MotionNotify** events, which are also generated when the pointer moves but only when the pointer motion begins and ends in a single window. An **EnterNotify** or **LeaveNotify** event also can be generated when some client application calls **XGrabPointer** and **XUngrabPointer**.

To receive **EnterNotify** or **LeaveNotify** events, set the **EnterWindowMask** or **LeaveWindowMask** bits of the event-mask attribute of the window.

The structure for these event types contains:

```
typedef struct {
        int type;                        /* EnterNotify or LeaveNotify */
        unsigned long serial;            /* # of last request processed by server */
        Bool send_event;                 /* true if this came from a SendEvent request */
        Display *display;                /* Display the event was read from */
        Window window;                   /* ‘‘event’’ window reported relative to */
        Window root;                     /* root window that the event occurred on */
        Window subwindow;                /* child window */
        Time time;                       /* milliseconds */
        int x, y;                        /* pointer x, y coordinates in event window */
        int x_root, y_root;              /* coordinates relative to root */
        int mode;                        /* NotifyNormal, NotifyGrab, NotifyUngrab */
        int detail;
                                         /*
                                         * NotifyAncestor, NotifyVirtual, NotifyInferior,
                                         * NotifyNonlinear,NotifyNonlinearVirtual
                                         */
        Bool same_screen;                /* same screen flag */
        Bool focus;                      /* boolean focus */
        unsigned int state;              /* key or button mask */
} XCrossingEvent;
typedef XCrossingEvent XEnterWindowEvent;
typedef XCrossingEvent XLeaveWindowEvent;
```

The window member is set to the window on which the **EnterNotify** or **LeaveNotify** event was generated and is referred to as the event window. This is the window used by the X server to report the event, and is relative to the root window on which the event occurred. The root member is set to the root window of the screen on which the event occurred.

For a **LeaveNotify** event, if a child of the event window contains the initial position of the pointer, the subwindow component is set to that child. Otherwise, the X server sets the subwindow member to **None**. For an **EnterNotify** event, if a child of the event window contains the final pointer position, the subwindow component is set to that child or **None**.

The time member is set to the time when the event was generated and is expressed in milliseconds. The x and y members are set to the coordinates of the pointer position in the event window. This position is always the pointer’s final position, not its initial position. If the event window is on the same screen as the root window, x and y are the pointer coordinates relative to the event window’s origin. Otherwise, x and y are set to zero. The x_root and y_root members are set to the pointer’s coordinates relative to the root window’s origin at the time of the event.

The same_screen member is set to indicate whether the event window is on the same screen as the root window and can be either **True** or **False**. If **True**, the event and root windows are on the same screen. If **False**, the event and root windows are not on the same screen.

The focus member is set to indicate whether the event window is the focus window or an inferior of the focus window. The X server can set this member to either **True** or **False**. If **True**, the event window is the focus window or an inferior of the focus window. If **False**, the event window is not the focus window or an inferior of the focus window.

The state member is set to indicate the state of the pointer buttons and modifier keys just prior to the event. The X server can set this member to the bitwise inclusive OR of one or more of the button or modifier key masks: **Button1Mask**, **Button2Mask**, **Button3Mask**, **Button4Mask**,

Button5Mask, **ShiftMask**, **LockMask**, **ControlMask**, **Mod1Mask**, **Mod2Mask**, **Mod3Mask**, **Mod4Mask**, **Mod5Mask**.

The mode member is set to indicate whether the events are normal events, pseudo-motion events when a grab activates, or pseudo-motion events when a grab deactivates. The X server can set this member to **NotifyNormal**, **NotifyGrab**, or **NotifyUngrab**.

The detail member is set to indicate the notify detail and can be **NotifyAncestor**, **NotifyVirtual**, **NotifyInferior**, **NotifyNonlinear**, or **NotifyNonlinearVirtual**.

10.6.1. Normal Entry/Exit Events

EnterNotify and **LeaveNotify** events are generated when the pointer moves from one window to another window. Normal events are identified by **XEnterWindowEvent** or **XLeaveWindowEvent** structures whose mode member is set to **NotifyNormal**.

- When the pointer moves from window A to window B and A is an inferior of B, the X server does the following:
  - It generates a **LeaveNotify** event on window A, with the detail member of the **XLeaveWindowEvent** structure set to **NotifyAncestor**.
  - It generates a **LeaveNotify** event on each window between window A and window B, exclusive, with the detail member of each **XLeaveWindowEvent** structure set to **NotifyVirtual**.
  - It generates an **EnterNotify** event on window B, with the detail member of the **XEnterWindowEvent** structure set to **NotifyInferior**.
- When the pointer moves from window A to window B and B is an inferior of A, the X server does the following:
  - It generates a **LeaveNotify** event on window A, with the detail member of the **XLeaveWindowEvent** structure set to **NotifyInferior**.
  - It generates an **EnterNotify** event on each window between window A and window B, exclusive, with the detail member of each **XEnterWindowEvent** structure set to **NotifyVirtual**.
  - It generates an **EnterNotify** event on window B, with the detail member of the **XEnterWindowEvent** structure set to **NotifyAncestor**.
- When the pointer moves from window A to window B and window C is their least common ancestor, the X server does the following:
  - It generates a **LeaveNotify** event on window A, with the detail member of the **XLeaveWindowEvent** structure set to **NotifyNonlinear**.
  - It generates a **LeaveNotify** event on each window between window A and window C, exclusive, with the detail member of each **XLeaveWindowEvent** structure set to **NotifyNonlinearVirtual**.
  - It generates an **EnterNotify** event on each window between window C and window B, exclusive, with the detail member of each **XEnterWindowEvent** structure set to **NotifyNonlinearVirtual**.
  - It generates an **EnterNotify** event on window B, with the detail member of the **XEnterWindowEvent** structure set to **NotifyNonlinear**.
- When the pointer moves from window A to window B on different screens, the X server does the following:

  - It generates a **LeaveNotify** event on window A, with the detail member of the **XLeaveWindowEvent** structure set to **NotifyNonlinear**.
  - If window A is not a root window, it generates a **LeaveNotify** event on each window above window A up to and including its root, with the detail member of each **XLeaveWindowEvent** structure set to **NotifyNonlinearVirtual**.
  - If window B is not a root window, it generates an **EnterNotify** event on each window from window B's root down to but not including window B, with the detail member of each **XEnterWindowEvent** structure set to **NotifyNonlinearVirtual**.
  - It generates an **EnterNotify** event on window B, with the detail member of the **XEnterWindowEvent** structure set to **NotifyNonlinear**.

10.6.2. Grab and Ungrab Entry/Exit Events

Pseudo-motion mode **EnterNotify** and **LeaveNotify** events are generated when a pointer grab activates or deactivates. Events in which the pointer grab activates are identified by **XEnterWindowEvent** or **XLeaveWindowEvent** structures whose mode member is set to **NotifyGrab**. Events in which the pointer grab deactivates are identified by **XEnterWindowEvent** or **XLeaveWindowEvent** structures whose mode member is set to **NotifyUngrab** (see **XGrabPointer**).

- When a pointer grab activates after any initial warp into a confine_to window and before generating any actual **ButtonPress** event that activates the grab, G is the grab_window for the grab, and P is the window the pointer is in, the X server does the following:
  - It generates **EnterNotify** and **LeaveNotify** events (see section 10.6.1) with the mode members of the **XEnterWindowEvent** and **XLeaveWindowEvent** structures set to **NotifyGrab**. These events are generated as if the pointer were to suddenly warp from its current position in P to some position in G. However, the pointer does not warp, and the X server uses the pointer position as both the initial and final positions for the events.
- When a pointer grab deactivates after generating any actual **ButtonRelease** event that deactivates the grab, G is the grab_window for the grab, and P is the window the pointer is in, the X server does the following:
  - It generates **EnterNotify** and **LeaveNotify** events (see section 10.6.1) with the mode members of the **XEnterWindowEvent** and **XLeaveWindowEvent** structures set to **NotifyUngrab**. These events are generated as if the pointer were to suddenly warp from some position in G to its current position in P. However, the pointer does not warp, and the X server uses the current pointer position as both the initial and final positions for the events.

10.7. Input Focus Events

This section describes the processing that occurs for the input focus events **FocusIn** and **FocusOut**. The X server can report **FocusIn** or **FocusOut** events to clients wanting information about when the input focus changes. The keyboard is always attached to some window (typically, the root window or a top-level window), which is called the focus window. The focus window and the position of the pointer determine the window that receives keyboard input. Clients may need to know when the input focus changes to control highlighting of areas on the screen.

To receive **FocusIn** or **FocusOut** events, set the **FocusChangeMask** bit in the event-mask attribute of the window.

The structure for these event types contains:

```
typedef struct {
        int type;                       /* FocusIn or FocusOut */
        unsigned long serial;           /* # of last request processed by server */
        Bool send_event;                /* true if this came from a SendEvent request */
        Display *display;               /* Display the event was read from */
        Window window;                  /* window of event */
        int mode;                       /* NotifyNormal, NotifyGrab, NotifyUngrab */
        int detail;
                                        /*
                                        * NotifyAncestor, NotifyVirtual, NotifyInferior,
                                        * NotifyNonlinear,NotifyNonlinearVirtual, NotifyPointer,
                                        * NotifyPointerRoot, NotifyDetailNone
                                        */
} XFocusChangeEvent;
typedef XFocusChangeEvent XFocusInEvent;
typedef XFocusChangeEvent XFocusOutEvent;
```

The window member is set to the window on which the **FocusIn** or **FocusOut** event was generated. This is the window used by the X server to report the event. The mode member is set to indicate whether the focus events are normal focus events, focus events while grabbed, focus events when a grab activates, or focus events when a grab deactivates. The X server can set the mode member to **NotifyNormal**, **NotifyWhileGrabbed**, **NotifyGrab**, or **NotifyUngrab**.

All **FocusOut** events caused by a window unmap are generated after any **UnmapNotify** event; however, the X protocol does not constrain the ordering of **FocusOut** events with respect to generated **EnterNotify**, **LeaveNotify**, **VisibilityNotify**, and **Expose** events.

Depending on the event mode, the detail member is set to indicate the notify detail and can be **NotifyAncestor**, **NotifyVirtual**, **NotifyInferior**, **NotifyNonlinear**, **NotifyNonlinearVirtual**, **NotifyPointer**, **NotifyPointerRoot**, or **NotifyDetailNone**.

10.7.1. Normal Focus Events and Focus Events While Grabbed

Normal focus events are identified by **XFocusInEvent** or **XFocusOutEvent** structures whose mode member is set to **NotifyNormal**. Focus events while grabbed are identified by **XFocusInEvent** or **XFocusOutEvent** structures whose mode member is set to **NotifyWhileGrabbed**. The X server processes normal focus and focus events while grabbed according to the following:

- When the focus moves from window A to window B, A is an inferior of B, and the pointer is in window P, the X server does the following:
    - It generates a **FocusOut** event on window A, with the detail member of the **XFocusOutEvent** structure set to **NotifyAncestor**.
    - It generates a **FocusOut** event on each window between window A and window B, exclusive, with the detail member of each **XFocusOutEvent** structure set to **NotifyVirtual**.
    - It generates a **FocusIn** event on window B, with the detail member of the **XFocusOutEvent** structure set to **NotifyInferior**.

  - If window P is an inferior of window B but window P is not window A or an inferior or ancestor of window A, it generates a **FocusIn** event on each window below window B, down to and including window P, with the detail member of each **XFocusInEvent** structure set to **NotifyPointer**.
- When the focus moves from window A to window B, B is an inferior of A, and the pointer is in window P, the X server does the following:
  - If window P is an inferior of window A but P is not an inferior of window B or an ancestor of B, it generates a **FocusOut** event on each window from window P up to but not including window A, with the detail member of each **XFocusOutEvent** structure set to **NotifyPointer**.
  - It generates a **FocusOut** event on window A, with the detail member of the **XFocusOutEvent** structure set to **NotifyInferior**.
  - It generates a **FocusIn** event on each window between window A and window B, exclusive, with the detail member of each **XFocusInEvent** structure set to **NotifyVirtual**.
  - It generates a **FocusIn** event on window B, with the detail member of the **XFocusInEvent** structure set to **NotifyAncestor**.
- When the focus moves from window A to window B, window C is their least common ancestor, and the pointer is in window P, the X server does the following:
  - If window P is an inferior of window A, it generates a **FocusOut** event on each window from window P up to but not including window A, with the detail member of the **XFocusOutEvent** structure set to **NotifyPointer**.
  - It generates a **FocusOut** event on window A, with the detail member of the **XFocusOutEvent** structure set to **NotifyNonlinear**.
  - It generates a **FocusOut** event on each window between window A and window C, exclusive, with the detail member of each **XFocusOutEvent** structure set to **NotifyNonlinearVirtual**.
  - It generates a **FocusIn** event on each window between C and B, exclusive, with the detail member of each **XFocusInEvent** structure set to **NotifyNonlinearVirtual**.
  - It generates a **FocusIn** event on window B, with the detail member of the **XFocusInEvent** structure set to **NotifyNonlinear**.
  - If window P is an inferior of window B, it generates a **FocusIn** event on each window below window B down to and including window P, with the detail member of the **XFocusInEvent** structure set to **NotifyPointer**.
- When the focus moves from window A to window B on different screens and the pointer is in window P, the X server does the following:
  - If window P is an inferior of window A, it generates a **FocusOut** event on each window from window P up to but not including window A, with the detail member of each **XFocusOutEvent** structure set to **NotifyPointer**.
  - It generates a **FocusOut** event on window A, with the detail member of the **XFocusOutEvent** structure set to **NotifyNonlinear**.
  - If window A is not a root window, it generates a **FocusOut** event on each window above window A up to and including its root, with the detail member of each **XFocusOutEvent** structure set to **NotifyNonlinearVirtual**.

  - If window B is not a root window, it generates a **FocusIn** event on each window from window B's root down to but not including window B, with the detail member of each **XFocusInEvent** structure set to **NotifyNonlinearVirtual**.
  - It generates a **FocusIn** event on window B, with the detail member of each **XFocusInEvent** structure set to **NotifyNonlinear**.
  - If window P is an inferior of window B, it generates a **FocusIn** event on each window below window B down to and including window P, with the detail member of each **XFocusInEvent** structure set to **NotifyPointer**.
- When the focus moves from window A to **PointerRoot** (events sent to the window under the pointer) or **None** (discard), and the pointer is in window P, the X server does the following:
  - If window P is an inferior of window A, it generates a **FocusOut** event on each window from window P up to but not including window A, with the detail member of each **XFocusOutEvent** structure set to **NotifyPointer**.
  - It generates a **FocusOut** event on window A, with the detail member of the **XFocusOutEvent** structure set to **NotifyNonlinear**.
  - If window A is not a root window, it generates a **FocusOut** event on each window above window A up to and including its root, with the detail member of each **XFocusOutEvent** structure set to **NotifyNonlinearVirtual**.
  - It generates a **FocusIn** event on the root window of all screens, with the detail member of each **XFocusInEvent** structure set to **NotifyPointerRoot** (or **NotifyDetailNone**).
  - If the new focus is **PointerRoot**, it generates a **FocusIn** event on each window from window P's root down to and including window P, with the detail member of each **XFocusInEvent** structure set to **NotifyPointer**.
- When the focus moves from **PointerRoot** (events sent to the window under the pointer) or **None** to window A, and the pointer is in window P, the X server does the following:
  - If the old focus is **PointerRoot**, it generates a **FocusOut** event on each window from window P up to and including window P's root, with the detail member of each **XFocusOutEvent** structure set to **NotifyPointer**.
  - It generates a **FocusOut** event on all root windows, with the detail member of each **XFocusOutEvent** structure set to **NotifyPointerRoot** (or **NotifyDetailNone**).
  - If window A is not a root window, it generates a **FocusIn** event on each window from window A's root down to but not including window A, with the detail member of each **XFocusInEvent** structure set to **NotifyNonlinearVirtual**.
  - It generates a **FocusIn** event on window A, with the detail member of the **XFocusInEvent** structure set to **NotifyNonlinear**.
  - If window P is an inferior of window A, it generates a **FocusIn** event on each window below window A down to and including window P, with the detail member of each **XFocusInEvent** structure set to **NotifyPointer**.
- When the focus moves from **PointerRoot** (events sent to the window under the pointer) to **None** (or vice versa), and the pointer is in window P, the X server does the following:
  - If the old focus is **PointerRoot**, it generates a **FocusOut** event on each window from window P up to and including window P's root, with the detail member of each **XFocusOutEvent** structure set to **NotifyPointer**.

  - It generates a **FocusOut** event on all root windows, with the detail member of each **XFocusOutEvent** structure set to either **NotifyPointerRoot** or **NotifyDetailNone**.
  - It generates a **FocusIn** event on all root windows, with the detail member of each **XFocusInEvent** structure set to **NotifyDetailNone** or **NotifyPointerRoot**.
  - If the new focus is **PointerRoot**, it generates a **FocusIn** event on each window from window P's root down to and including window P, with the detail member of each **XFocusInEvent** structure set to **NotifyPointer**.

10.7.2. Focus Events Generated by Grabs

Focus events in which the keyboard grab activates are identified by **XFocusInEvent** or **XFocusOutEvent** structures whose mode member is set to **NotifyGrab**. Focus events in which the keyboard grab deactivates are identified by **XFocusInEvent** or **XFocusOutEvent** structures whose mode member is set to **NotifyUngrab** (see **XGrabKeyboard**).

- When a keyboard grab activates before generating any actual **KeyPress** event that activates the grab, G is the grab_window, and F is the current focus, the X server does the following:
  - It generates **FocusIn** and **FocusOut** events, with the mode members of the **XFocusInEvent** and **XFocusOutEvent** structures set to **NotifyGrab**. These events are generated as if the focus were to change from F to G.
- When a keyboard grab deactivates after generating any actual **KeyRelease** event that deactivates the grab, G is the grab_window, and F is the current focus, the X server does the following:
  - It generates **FocusIn** and **FocusOut** events, with the mode members of the **XFocusInEvent** and **XFocusOutEvent** structures set to **NotifyUngrab**. These events are generated as if the focus were to change from G to F.

10.8. Key Map State Notification Events

The X server can report **KeymapNotify** events to clients that want information about changes in their keyboard state.

To receive **KeymapNotify** events, set the **KeymapStateMask** bit in the event-mask attribute of the window. The X server generates this event immediately after every **EnterNotify** and **FocusIn** event.

The structure for this event type contains:

```
/* generated on EnterWindow and FocusIn when KeymapState selected */
typedef struct {
        int type;                        /* KeymapNotify */
        unsigned long serial;            /* # of last request processed by server */
        Bool send_event;                 /* true if this came from a SendEvent request */
        Display *display;                /* Display the event was read from */
        Window window;
        char key_vector[32];
} XKeymapEvent;
```

The window member is not used but is present to aid some toolkits. The key_vector member is set to the bit vector of the keyboard. Each bit set to 1 indicates that the corresponding key is currently pressed. The vector is represented as 32 bytes. Byte N (from 0) contains the bits for keys

8N to 8N + 7 with the least-significant bit in the byte representing key 8N.

10.9. Exposure Events

The X protocol does not guarantee to preserve the contents of window regions when the windows are obscured or reconfigured. Some implementations may preserve the contents of windows. Other implementations are free to destroy the contents of windows when exposed. X expects client applications to assume the responsibility for restoring the contents of an exposed window region. (An exposed window region describes a formerly obscured window whose region becomes visible.) Therefore, the X server sends **Expose** events describing the window and the region of the window that has been exposed. A naive client application usually redraws the entire window. A more sophisticated client application redraws only the exposed region.

10.9.1. Expose Events

The X server can report **Expose** events to clients wanting information about when the contents of window regions have been lost. The circumstances in which the X server generates **Expose** events are not as definite as those for other events. However, the X server never generates **Expose** events on windows whose class you specified as **InputOnly**. The X server can generate **Expose** events when no valid contents are available for regions of a window and either the regions are visible, the regions are viewable and the server is (perhaps newly) maintaining backing store on the window, or the window is not viewable but the server is (perhaps newly) honoring the window's backing-store attribute of **Always** or **WhenMapped**. The regions decompose into an (arbitrary) set of rectangles, and an **Expose** event is generated for each rectangle. For any given window, the X server guarantees to report contiguously all of the regions exposed by some action that causes **Expose** events, such as raising a window.

To receive **Expose** events, set the **ExposureMask** bit in the event-mask attribute of the window.

The structure for this event type contains:

```
typedef struct {
        int type;                       /* Expose */
        unsigned long serial;           /* # of last request processed by server */
        Bool send_event;                /* true if this came from a SendEvent request */
        Display *display;               /* Display the event was read from */
        Window window;
        int x, y;
        int width, height;
        int count;                      /* if nonzero, at least this many more */
} XExposeEvent;
```

The window member is set to the exposed (damaged) window. The x and y members are set to the coordinates relative to the window's origin and indicate the upper-left corner of the rectangle. The width and height members are set to the size (extent) of the rectangle. The count member is set to the number of **Expose** events that are to follow. If count is zero, no more **Expose** events follow for this window. However, if count is nonzero, at least that number of **Expose** events (and possibly more) follow for this window. Simple applications that do not want to optimize redisplay by distinguishing between subareas of its window can just ignore all **Expose** events with nonzero counts and perform full redisplays on events with zero counts.

10.9.2. GraphicsExpose and NoExpose Events

The X server can report **GraphicsExpose** events to clients wanting information about when a destination region could not be computed during certain graphics requests: **XCopyArea** or **XCopyPlane**. The X server generates this event whenever a destination region could not be computed due to an obscured or out-of-bounds source region. In addition, the X server guarantees to report contiguously all of the regions exposed by some graphics request (for example, copying an area of a drawable to a destination drawable).

The X server generates a **NoExpose** event whenever a graphics request that might produce a **GraphicsExpose** event does not produce any. In other words, the client is really asking for a **GraphicsExpose** event but instead receives a **NoExpose** event.

To receive **GraphicsExpose** or **NoExpose** events, you must first set the graphics-exposure attribute of the graphics context to **True**. You also can set the graphics-expose attribute when creating a graphics context using **XCreateGC** or by calling **XSetGraphicsExposures**.

The structures for these event types contain:

```
typedef struct {
        int type;                       /* GraphicsExpose */
        unsigned long serial;           /* # of last request processed by server */
        Bool send_event;                /* true if this came from a SendEvent request */
        Display *display;               /* Display the event was read from */
        Drawable drawable;
        int x, y;
        int width, height;
        int count;                      /* if nonzero, at least this many more */
        int major_code;                 /* core is CopyArea or CopyPlane */
        int minor_code;                 /* not defined in the core */
} XGraphicsExposeEvent;

typedef struct {
        int type;                       /* NoExpose */
        unsigned long serial;           /* # of last request processed by server */
        Bool send_event;                /* true if this came from a SendEvent request */
        Display *display;               /* Display the event was read from */
        Drawable drawable;
        int major_code;                 /* core is CopyArea or CopyPlane */
        int minor_code;                 /* not defined in the core */
} XNoExposeEvent;
```

Both structures have these common members: drawable, major_code, and minor_code. The drawable member is set to the drawable of the destination region on which the graphics request was to be performed. The major_code member is set to the graphics request initiated by the client and can be either **X_CopyArea** or **X_CopyPlane**. If it is **X_CopyArea**, a call to **XCopyArea** initiated the request. If it is **X_CopyPlane**, a call to **XCopyPlane** initiated the request. These constants are defined in **<X11/Xproto.h>**. The minor_code member, like the major_code member, indicates which graphics request was initiated by the client. However, the minor_code member is not defined by the core X protocol and will be zero in these cases, although it may be used by an extension.

The **XGraphicsExposeEvent** structure has these additional members: x, y, width, height, and count. The x and y members are set to the coordinates relative to the drawable's origin and indicate the upper-left corner of the rectangle. The width and height members are set to the size (extent) of the rectangle. The count member is set to the number of **GraphicsExpose** events to follow. If count is zero, no more **GraphicsExpose** events follow for this window. However, if count is nonzero, at least that number of **GraphicsExpose** events (and possibly more) are to follow for this window.

10.10. Window State Change Events

The following sections discuss:

- **CirculateNotify** events
- **ConfigureNotify** events
- **CreateNotify** events
- **DestroyNotify** events
- **GravityNotify** events
- **MapNotify** events
- **MappingNotify** events
- **ReparentNotify** events
- **UnmapNotify** events
- **VisibilityNotify** events

10.10.1. CirculateNotify Events

The X server can report **CirculateNotify** events to clients wanting information about when a window changes its position in the stack. The X server generates this event type whenever a window is actually restacked as a result of a client application calling **XCirculateSubwindows**, **XCirculateSubwindowsUp**, or **XCirculateSubwindowsDown**.

To receive **CirculateNotify** events, set the **StructureNotifyMask** bit in the event-mask attribute of the window or the **SubstructureNotifyMask** bit in the event-mask attribute of the parent window (in which case, circulating any child generates an event).

The structure for this event type contains:

```
typedef struct {
        int type;                         /* CirculateNotify */
        unsigned long serial;             /* # of last request processed by server */
        Bool send_event;                  /* true if this came from a SendEvent request */
        Display *display;                 /* Display the event was read from */
        Window event;
        Window window;
        int place;                        /* PlaceOnTop, PlaceOnBottom */
} XCirculateEvent;
```

The event member is set either to the restacked window or to its parent, depending on whether **StructureNotify** or **SubstructureNotify** was selected. The window member is set to the window that was restacked. The place member is set to the window's position after the restack occurs and is either **PlaceOnTop** or **PlaceOnBottom**. If it is **PlaceOnTop**, the window is now on top of all siblings. If it is **PlaceOnBottom**, the window is now below all siblings.

10.10.2. ConfigureNotify Events

The X server can report **ConfigureNotify** events to clients wanting information about actual changes to a window's state, such as size, position, border, and stacking order. The X server generates this event type whenever one of the following configure window requests made by a client application actually completes:

- A window's size, position, border, and/or stacking order is reconfigured by calling **XConfigureWindow**.
- The window's position in the stacking order is changed by calling **XLowerWindow**, **XRaiseWindow**, or **XRestackWindows**.
- A window is moved by calling **XMoveWindow**.
- A window's size is changed by calling **XResizeWindow**.
- A window's size and location is changed by calling **XMoveResizeWindow**.
- A window is mapped and its position in the stacking order is changed by calling **XMapRaised**.
- A window's border width is changed by calling **XSetWindowBorderWidth**.

To receive **ConfigureNotify** events, set the **StructureNotifyMask** bit in the event-mask attribute of the window or the **SubstructureNotifyMask** bit in the event-mask attribute of the parent window (in which case, configuring any child generates an event).

The structure for this event type contains:

```
typedef struct {
        int type;                       /* ConfigureNotify */
        unsigned long serial;           /* # of last request processed by server */
        Bool send_event;                /* true if this came from a SendEvent request */
        Display *display;               /* Display the event was read from */
        Window event;
        Window window;
        int x, y;
        int width, height;
        int border_width;
        Window above;
        Bool override_redirect;
} XConfigureEvent;
```

The event member is set either to the reconfigured window or to its parent, depending on whether **StructureNotify** or **SubstructureNotify** was selected. The window member is set to the window whose size, position, border, and/or stacking order was changed.

The x and y members are set to the coordinates relative to the parent window's origin and indicate the position of the upper-left outside corner of the window. The width and height members are set to the inside size of the window, not including the border. The border_width member is set to the width of the window's border, in pixels.

The above member is set to the sibling window and is used for stacking operations. If the X server sets this member to **None**, the window whose state was changed is on the bottom of the stack with respect to sibling windows. However, if this member is set to a sibling window, the window whose state was changed is placed on top of this sibling window.

The override_redirect member is set to the override-redirect attribute of the window. Window manager clients normally should ignore this window if the override_redirect member is **True**.

10.10.3. CreateNotify Events

The X server can report **CreateNotify** events to clients wanting information about creation of windows. The X server generates this event whenever a client application creates a window by calling **XCreateWindow** or **XCreateSimpleWindow**.

To receive **CreateNotify** events, set the **SubstructureNotifyMask** bit in the event-mask attribute of the window. Creating any children then generates an event.

The structure for the event type contains:

```
typedef struct {
        int type;                        /* CreateNotify */
        unsigned long serial;            /* # of last request processed by server */
        Bool send_event;                 /* true if this came from a SendEvent request */
        Display *display;                /* Display the event was read from */
        Window parent;                   /* parent of the window */
        Window window;                   /* window id of window created */
        int x, y;                        /* window location */
        int width, height;               /* size of window */
        int border_width;                /* border width */
        Bool override_redirect;          /* creation should be overridden */
} XCreateWindowEvent;
```

The parent member is set to the created window's parent. The window member specifies the created window. The x and y members are set to the created window's coordinates relative to the parent window's origin and indicate the position of the upper-left outside corner of the created window. The width and height members are set to the inside size of the created window (not including the border) and are always nonzero. The border_width member is set to the width of the created window's border, in pixels. The override_redirect member is set to the override-redirect attribute of the window. Window manager clients normally should ignore this window if the override_redirect member is **True**.

10.10.4. DestroyNotify Events

The X server can report **DestroyNotify** events to clients wanting information about which windows are destroyed. The X server generates this event whenever a client application destroys a window by calling **XDestroyWindow** or **XDestroySubwindows**.

The ordering of the **DestroyNotify** events is such that for any given window, **DestroyNotify** is generated on all inferiors of the window before being generated on the window itself. The X protocol does not constrain the ordering among siblings and across subhierarchies.

To receive **DestroyNotify** events, set the **StructureNotifyMask** bit in the event-mask attribute of the window or the **SubstructureNotifyMask** bit in the event-mask attribute of the parent window (in which case, destroying any child generates an event).

The structure for this event type contains:

```
typedef struct {
        int type;                       /* DestroyNotify */
        unsigned long serial;           /* # of last request processed by server */
        Bool send_event;                /* true if this came from a SendEvent request */
        Display *display;               /* Display the event was read from */
        Window event;
        Window window;
} XDestroyWindowEvent;
```

The event member is set either to the destroyed window or to its parent, depending on whether **StructureNotify** or **SubstructureNotify** was selected. The window member is set to the window that is destroyed.

10.10.5. GravityNotify Events

The X server can report **GravityNotify** events to clients wanting information about when a window is moved because of a change in the size of its parent. The X server generates this event whenever a client application actually moves a child window as a result of resizing its parent by calling **XConfigureWindow**, **XMoveResizeWindow**, or **XResizeWindow**.

To receive **GravityNotify** events, set the **StructureNotifyMask** bit in the event-mask attribute of the window or the **SubstructureNotifyMask** bit in the event-mask attribute of the parent window (in which case, any child that is moved because its parent has been resized generates an event).

The structure for this event type contains:

```
typedef struct {
        int type;                       /* GravityNotify */
        unsigned long serial;           /* # of last request processed by server */
        Bool send_event;                /* true if this came from a SendEvent request */
        Display *display;               /* Display the event was read from */
        Window event;
        Window window;
        int x, y;
} XGravityEvent;
```

The event member is set either to the window that was moved or to its parent, depending on whether **StructureNotify** or **SubstructureNotify** was selected. The window member is set to the child window that was moved. The x and y members are set to the coordinates relative to the new parent window's origin and indicate the position of the upper-left outside corner of the window.

10.10.6. MapNotify Events

The X server can report **MapNotify** events to clients wanting information about which windows are mapped. The X server generates this event type whenever a client application changes the window's state from unmapped to mapped by calling **XMapWindow**, **XMapRaised**, **XMapSubwindows**, **XReparentWindow**, or as a result of save-set processing.

To receive **MapNotify** events, set the **StructureNotifyMask** bit in the event-mask attribute of the window or the **SubstructureNotifyMask** bit in the event-mask attribute of the parent window (in which case, mapping any child generates an event).

The structure for this event type contains:

```
typedef struct {
        int type;                         /* MapNotify */
        unsigned long serial;             /* # of last request processed by server */
        Bool send_event;                  /* true if this came from a SendEvent request */
        Display *display;                 /* Display the event was read from */
        Window event;
        Window window;
        Bool override_redirect;           /* boolean, is override set... */
} XMapEvent;
```

The event member is set either to the window that was mapped or to its parent, depending on whether **StructureNotify** or **SubstructureNotify** was selected. The window member is set to the window that was mapped. The override_redirect member is set to the override-redirect attribute of the window. Window manager clients normally should ignore this window if the override-redirect attribute is **True**, because these events usually are generated from pop-ups, which override structure control.

10.10.7. MappingNotify Events

The X server reports **MappingNotify** events to all clients. There is no mechanism to express disinterest in this event. The X server generates this event type whenever a client application successfully calls:

- **XSetModifierMapping** to indicate which KeyCodes are to be used as modifiers
- **XChangeKeyboardMapping** to change the keyboard mapping
- **XSetPointerMapping** to set the pointer mapping

The structure for this event type contains:

```
typedef struct {
        int type;                         /* MappingNotify */
        unsigned long serial;             /* # of last request processed by server */
        Bool send_event;                  /* true if this came from a SendEvent request */
        Display *display;                 /* Display the event was read from */
        Window window;                    /* unused */
        int request;                      /* one of MappingModifier, MappingKeyboard,
                                             MappingPointer */
        int first_keycode;                /* first keycode */
        int count;                        /* defines range of change w. first_keycode*/
} XMappingEvent;
```

The request member is set to indicate the kind of mapping change that occurred and can be **MappingModifier**, **MappingKeyboard**, **MappingPointer**. If it is **MappingModifier**, the modifier mapping was changed. If it is **MappingKeyboard**, the keyboard mapping was changed. If it is **MappingPointer**, the pointer button mapping was changed. The first_keycode and count members are set only if the request member was set to **MappingKeyboard**. The number in first_keycode represents the first number in the range of the altered mapping, and count represents the number of keycodes altered.

To update the client application's knowledge of the keyboard, you should call **XRefreshKeyboardMapping**.

10.10.8. ReparentNotify Events

The X server can report **ReparentNotify** events to clients wanting information about changing a window's parent. The X server generates this event whenever a client application calls **XReparentWindow** and the window is actually reparented.

To receive **ReparentNotify** events, set the **StructureNotifyMask** bit in the event-mask attribute of the window or the **SubstructureNotifyMask** bit in the event-mask attribute of either the old or the new parent window (in which case, reparenting any child generates an event).

The structure for this event type contains:

```
typedef struct {
        int type;                         /* ReparentNotify */
        unsigned long serial;             /* # of last request processed by server */
        Bool send_event;                  /* true if this came from a SendEvent request */
        Display *display;                 /* Display the event was read from */
        Window event;
        Window window;
        Window parent;
        int x, y;
        Bool override_redirect;
} XReparentEvent;
```

The event member is set either to the reparented window or to the old or the new parent, depending on whether **StructureNotify** or **SubstructureNotify** was selected. The window member is set to the window that was reparented. The parent member is set to the new parent window. The x and y members are set to the reparented window's coordinates relative to the new parent window's origin and define the upper-left outer corner of the reparented window. The override_redirect member is set to the override-redirect attribute of the window specified by the window member. Window manager clients normally should ignore this window if the override_redirect member is **True**.

10.10.9. UnmapNotify Events

The X server can report **UnmapNotify** events to clients wanting information about which windows are unmapped. The X server generates this event type whenever a client application changes the window's state from mapped to unmapped.

To receive **UnmapNotify** events, set the **StructureNotifyMask** bit in the event-mask attribute of the window or the **SubstructureNotifyMask** bit in the event-mask attribute of the parent window (in which case, unmapping any child window generates an event).

The structure for this event type contains:

```
typedef struct {
        int type;                          /* UnmapNotify */
        unsigned long serial;              /* # of last request processed by server */
        Bool send_event;                   /* true if this came from a SendEvent request */
        Display *display;                  /* Display the event was read from */
        Window event;
        Window window;
        Bool from_configure;
} XUnmapEvent;
```

The event member is set either to the unmapped window or to its parent, depending on whether **StructureNotify** or **SubstructureNotify** was selected. This is the window used by the X server to report the event. The window member is set to the window that was unmapped. The from_configure member is set to **True** if the event was generated as a result of a resizing of the window's parent when the window itself had a win_gravity of **UnmapGravity**.

10.10.10. VisibilityNotify Events

The X server can report **VisibilityNotify** events to clients wanting any change in the visibility of the specified window. A region of a window is visible if someone looking at the screen can actually see it. The X server generates this event whenever the visibility changes state. However, this event is never generated for windows whose class is **InputOnly**.

All **VisibilityNotify** events caused by a hierarchy change are generated after any hierarchy event (**UnmapNotify**, **MapNotify**, **ConfigureNotify**, **GravityNotify**, **CirculateNotify**) caused by that change. Any **VisibilityNotify** event on a given window is generated before any **Expose** events on that window, but it is not required that all **VisibilityNotify** events on all windows be generated before all **Expose** events on all windows. The X protocol does not constrain the ordering of **VisibilityNotify** events with respect to **FocusOut**, **EnterNotify**, and **LeaveNotify** events.

To receive **VisibilityNotify** events, set the **VisibilityChangeMask** bit in the event-mask attribute of the window.

The structure for this event type contains:

```
typedef struct {
        int type;                          /* VisibiltyNotify */
        unsigned long serial;              /* # of last request processed by server */
        Bool send_event;                   /* true if this came from a SendEvent request */
        Display *display;                  /* Display the event was read from */
        Window window;
        int state;
} XVisibilityEvent;
```

The window member is set to the window whose visibility state changes. The state member is set to the state of the window's visibility and can be **VisibilityUnobscured**, **VisibilityPartiallyObscured**, or **VisibilityFullyObscured**. The X server ignores all of a window's subwindows when determining the visibility state of the window and processes **VisibilityNotify** events according to the following:

- When the window changes state from partially obscured, fully obscured, or not viewable to viewable and completely unobscured, the X server generates the event with the state member of the **XVisibilityEvent** structure set to **VisibilityUnobscured**.
- When the window changes state from viewable and completely unobscured or not viewable to viewable and partially obscured, the X server generates the event with the state member of the **XVisibilityEvent** structure set to **VisibilityPartiallyObscured**.
- When the window changes state from viewable and completely unobscured, viewable and partially obscured, or not viewable to viewable and fully obscured, the X server generates the event with the state member of the **XVisibilityEvent** structure set to **VisibilityFullyObscured**.

10.11. Structure Control Events

This section discusses:

- **CirculateRequest** events
- **ConfigureRequest** events
- **MapRequest** events
- **ResizeRequest** events

10.11.1. CirculateRequest Events

The X server can report **CirculateRequest** events to clients wanting information about when another client initiates a circulate window request on a specified window. The X server generates this event type whenever a client initiates a circulate window request on a window and a subwindow actually needs to be restacked. The client initiates a circulate window request on the window by calling **XCirculateSubwindows**, **XCirculateSubwindowsUp**, or **XCirculateSubwindowsDown**.

To receive **CirculateRequest** events, set the **SubstructureRedirectMask** in the event-mask attribute of the window. Then, in the future, the circulate window request for the specified window is not executed, and thus, any subwindow's position in the stack is not changed. For example, suppose a client application calls **XCirculateSubwindowsUp** to raise a subwindow to the top of the stack. If you had selected **SubstructureRedirectMask** on the window, the X server reports to you a **CirculateRequest** event and does not raise the subwindow to the top of the stack.

The structure for this event type contains:

```
typedef struct {
        int type;                       /* CirculateRequest */
        unsigned long serial;           /* # of last request processed by server */
        Bool send_event;                /* true if this came from a SendEvent request */
        Display *display;               /* Display the event was read from */
        Window parent;
        Window window;
        int place;                      /* PlaceOnTop, PlaceOnBottom */
} XCirculateRequestEvent;
```

The parent member is set to the parent window. The window member is set to the subwindow to be restacked. The place member is set to what the new position in the stacking order should be and is either **PlaceOnTop** or **PlaceOnBottom**. If it is **PlaceOnTop**, the subwindow should be on top of all siblings. If it is **PlaceOnBottom**, the subwindow should be below all siblings.

10.11.2. ConfigureRequest Events

The X server can report **ConfigureRequest** events to clients wanting information about when a different client initiates a configure window request on any child of a specified window. The configure window request attempts to reconfigure a window's size, position, border, and stacking order. The X server generates this event whenever a different client initiates a configure window request on a window by calling **XConfigureWindow**, **XLowerWindow**, **XRaiseWindow**, **XMapRaised**, **XMoveResizeWindow**, **XMoveWindow**, **XResizeWindow**, **XRestackWindows**, or **XSetWindowBorderWidth**.

To receive **ConfigureRequest** events, set the **SubstructureRedirectMask** bit in the event-mask attribute of the window. **ConfigureRequest** events are generated when a **ConfigureWindow** protocol request is issued on a child window by another client. For example, suppose a client application calls **XLowerWindow** to lower a window. If you had selected **SubstructureRedirectMask** on the parent window and if the override-redirect attribute of the window is set to **False**, the X server reports a **ConfigureRequest** event to you and does not lower the specified window.

The structure for this event type contains:

```
typedef struct {
        int type;                       /* ConfigureRequest */
        unsigned long serial;           /* # of last request processed by server */
        Bool send_event;                /* true if this came from a SendEvent request */
        Display *display;               /* Display the event was read from */
        Window parent;
        Window window;
        int x, y;
        int width, height;
        int border_width;
        Window above;
        int detail;                     /* Above, Below, TopIf, BottomIf, Opposite */
        unsigned long value_mask;
} XConfigureRequestEvent;
```

The parent member is set to the parent window. The window member is set to the window whose size, position, border width, and/or stacking order is to be reconfigured. The value_mask member indicates which components were specified in the **ConfigureWindow** protocol request. The corresponding values are reported as given in the request. The remaining values are filled in from the current geometry of the window, except in the case of above (sibling) and detail (stack-mode), which are reported as **None** and **Above**, respectively, if they are not given in the request.

10.11.3. MapRequest Events

The X server can report **MapRequest** events to clients wanting information about a different client's desire to map windows. A window is considered mapped when a map window request completes. The X server generates this event whenever a different client initiates a map window request on an unmapped window whose override_redirect member is set to **False**. Clients initiate map window requests by calling **XMapWindow**, **XMapRaised**, or **XMapSubwindows**.

To receive **MapRequest** events, set the **SubstructureRedirectMask** bit in the event-mask attribute of the window. This means another client's attempts to map a child window by calling one of the map window request functions is intercepted, and you are sent a **MapRequest** instead. For example, suppose a client application calls **XMapWindow** to map a window. If you (usually a window manager) had selected **SubstructureRedirectMask** on the parent window and if the override-redirect attribute of the window is set to **False**, the X server reports a **MapRequest** event to you and does not map the specified window. Thus, this event gives your window manager client the ability to control the placement of subwindows.

The structure for this event type contains:

```
typedef struct {
        int type;                       /* MapRequest */
        unsigned long serial;           /* # of last request processed by server */
        Bool send_event;                /* true if this came from a SendEvent request */
        Display *display;               /* Display the event was read from */
        Window parent;
        Window window;
} XMapRequestEvent;
```

The parent member is set to the parent window. The window member is set to the window to be mapped.

10.11.4. ResizeRequest Events

The X server can report **ResizeRequest** events to clients wanting information about another client's attempts to change the size of a window. The X server generates this event whenever some other client attempts to change the size of the specified window by calling **XConfigureWindow**, **XResizeWindow**, or **XMoveResizeWindow**.

To receive **ResizeRequest** events, set the **ResizeRedirect** bit in the event-mask attribute of the window. Any attempts to change the size by other clients are then redirected.

The structure for this event type contains:

```
typedef struct {
        int type;                       /* ResizeRequest */
        unsigned long serial;           /* # of last request processed by server */
        Bool send_event;                /* true if this came from a SendEvent request */
        Display *display;               /* Display the event was read from */
        Window window;
        int width, height;
} XResizeRequestEvent;
```

The window member is set to the window whose size another client attempted to change. The width and height members are set to the inside size of the window, excluding the border.

10.12. Colormap State Change Events

The X server can report **ColormapNotify** events to clients wanting information about when the colormap changes and when a colormap is installed or uninstalled. The X server generates this event type whenever a client application:

- Changes the colormap member of the **XSetWindowAttributes** structure by calling **XChangeWindowAttributes**, **XFreeColormap**, or **XSetWindowColormap**
- Installs or uninstalls the colormap by calling **XInstallColormap** or **XUninstallColormap**

To receive **ColormapNotify** events, set the **ColormapChangeMask** bit in the event-mask attribute of the window.

The structure for this event type contains:

```
typedef struct {
        int type;                          /* ColormapNotify */
        unsigned long serial;              /* # of last request processed by server */
        Bool send_event;                   /* true if this came from a SendEvent request */
        Display *display;                  /* Display the event was read from */
        Window window;
        Colormap colormap;                 /* colormap or None */
        Bool new;
        int state;                         /* ColormapInstalled, ColormapUninstalled */
} XColormapEvent;
```

The window member is set to the window whose associated colormap is changed, installed, or uninstalled. For a colormap that is changed, installed, or uninstalled, the colormap member is set to the colormap associated with the window. For a colormap that is changed by a call to **XFreeColormap**, the colormap member is set to **None**. The new member is set to indicate whether the colormap for the specified window was changed or installed or uninstalled and can be **True** or **False**. If it is **True**, the colormap was changed. If it is **False**, the colormap was installed or uninstalled. The state member is always set to indicate whether the colormap is installed or uninstalled and can be **ColormapInstalled** or **ColormapUninstalled**.

10.13. Client Communication Events

This section discusses:

- **ClientMessage** events
- **PropertyNotify** events
- **SelectionClear** events
- **SelectionNotify** events
- **SelectionRequest** events

10.13.1. ClientMessage Events

The X server generates **ClientMessage** events only when a client calls the function **XSendEvent**.

The structure for this event type contains:

```
typedef struct {
        int type;                        /* ClientMessage */
        unsigned long serial;            /* # of last request processed by server */
        Bool send_event;                 /* true if this came from a SendEvent request */
        Display *display;                /* Display the event was read from */
        Window window;
        Atom message_type;
        int format;
        union {
                char b[20];
                short s[10];
                long l[5];
             } data;
} XClientMessageEvent;
```

The message_type member is set to an atom that indicates how the data should be interpreted by the receiving client. The format member is set to 8, 16, or 32 and specifies whether the data should be viewed as a list of bytes, shorts, or longs. The data member is a union that contains the members b, s, and l. The b, s, and l members represent data of 20 8-bit values, 10 16-bit values, and 5 32-bit values. Particular message types might not make use of all these values. The X server places no interpretation on the values in the window, message_type, or data members.

10.13.2. PropertyNotify Events

The X server can report **PropertyNotify** events to clients wanting information about property changes for a specified window.

To receive **PropertyNotify** events, set the **PropertyChangeMask** bit in the event-mask attribute of the window.

The structure for this event type contains:

```
typedef struct {
        int type;                        /* PropertyNotify */
        unsigned long serial;            /* # of last request processed by server */
        Bool send_event;                 /* true if this came from a SendEvent request */
        Display *display;                /* Display the event was read from */
        Window window;
        Atom atom;
        Time time;
        int state;                       /* PropertyNewValue or PropertyDelete */
} XPropertyEvent;
```

The window member is set to the window whose associated property was changed. The atom member is set to the property's atom and indicates which property was changed or desired. The time member is set to the server time when the property was changed. The state member is set to indicate whether the property was changed to a new value or deleted and can be **PropertyNewValue** or **PropertyDelete**. The state member is set to **PropertyNewValue** when a property of the window is changed using **XChangeProperty** or **XRotateWindowProperties** (even when adding zero-length data using **XChangeProperty**) and when replacing all or part of a property with identical data using **XChangeProperty** or **XRotateWindowProperties**. The state member is set to **PropertyDelete** when a property of the window is deleted using **XDeleteProperty** or, if the delete argument is **True**, **XGetWindowProperty**.

10.13.3. SelectionClear Events

The X server reports **SelectionClear** events to the client losing ownership of a selection. The X server generates this event type when another client asserts ownership of the selection by calling **XSetSelectionOwner**.

The structure for this event type contains:

```
typedef struct {
        int type;                       /* SelectionClear */
        unsigned long serial;           /* # of last request processed by server */
        Bool send_event;                /* true if this came from a SendEvent request */
        Display *display;               /* Display the event was read from */
        Window window;
        Atom selection;
        Time time;
} XSelectionClearEvent;
```

The selection member is set to the selection atom. The time member is set to the last change time recorded for the selection. The window member is the window that was specified by the current owner (the owner losing the selection) in its **XSetSelectionOwner** call.

10.13.4. SelectionRequest Events

The X server reports **SelectionRequest** events to the owner of a selection. The X server generates this event whenever a client requests a selection conversion by calling **XConvertSelection** for the owned selection.

The structure for this event type contains:

```
typedef struct {
        int type;                       /* SelectionRequest */
        unsigned long serial;           /* # of last request processed by server */
        Bool send_event;                /* true if this came from a SendEvent request */
        Display *display;               /* Display the event was read from */
        Window owner;
        Window requestor;
        Atom selection;
        Atom target;
        Atom property;
        Time time;
} XSelectionRequestEvent;
```

The owner member is set to the window that was specified by the current owner in its **XSetSelectionOwner** call. The requestor member is set to the window requesting the selection. The selection member is set to the atom that names the selection. For example, PRIMARY is used to indicate the primary selection. The target member is set to the atom that indicates the type the selection is desired in. The property member can be a property name or **None**. The time member is set to the timestamp or **CurrentTime** value from the **ConvertSelection** request.

The owner should convert the selection based on the specified target type and send a **SelectionNotify** event back to the requestor. A complete specification for using selections is given in the X Consortium standard *Inter-Client Communication Conventions Manual.*

10.13.5. SelectionNotify Events

This event is generated by the X server in response to a **ConvertSelection** protocol request when there is no owner for the selection. When there is an owner, it should be generated by the owner of the selection by using **XSendEvent**. The owner of a selection should send this event to a requestor when a selection has been converted and stored as a property or when a selection conversion could not be performed (which is indicated by setting the property member to **None**).

If **None** is specified as the property in the **ConvertSelection** protocol request, the owner should choose a property name, store the result as that property on the requestor window, and then send a **SelectionNotify** giving that actual property name.

The structure for this event type contains:

```
typedef struct {
        int type;                     /* SelectionNotify */
        unsigned long serial;         /* # of last request processed by server */
        Bool send_event;              /* true if this came from a SendEvent request */
        Display *display;             /* Display the event was read from */
        Window requestor;
        Atom selection;
        Atom target;
        Atom property;                /* atom or None */
        Time time;
} XSelectionEvent;
```

The requestor member is set to the window associated with the requestor of the selection. The selection member is set to the atom that indicates the selection. For example, PRIMARY is used for the primary selection. The target member is set to the atom that indicates the converted type. For example, PIXMAP is used for a pixmap. The property member is set to the atom that indicates which property the result was stored on. If the conversion failed, the property member is set to **None**. The time member is set to the time the conversion took place and can be a timestamp or **CurrentTime**.

Chapter 11

Event Handling Functions

This chapter discusses the Xlib functions you can use to:

- Select events
- Handle the output buffer and the event queue
- Select events from the event queue
- Send and get events
- Handle protocol errors

Note

> Some toolkits use their own event-handling functions and do not allow you to interchange these event-handling functions with those in Xlib. For further information, see the documentation supplied with the toolkit.

Most applications simply are event loops: they wait for an event, decide what to do with it, execute some amount of code that results in changes to the display, and then wait for the next event.

11.1. Selecting Events

There are two ways to select the events you want reported to your client application. One way is to set the event_mask member of the **XSetWindowAttributes** structure when you call **XCreateWindow** and **XChangeWindowAttributes**. Another way is to use **XSelectInput**.

```
XSelectInput(display, w, event_mask)
      Display *display;
      Window w;
      long event_mask;
```

display	Specifies the connection to the X server.
w	Specifies the window whose events you are interested in.
event_mask	Specifies the event mask.

The **XSelectInput** function requests that the X server report the events associated with the specified event mask. Initially, X will not report any of these events. Events are reported relative to a window. If a window is not interested in a device event, it usually propagates to the closest ancestor that is interested, unless the do_not_propagate mask prohibits it.

Setting the event-mask attribute of a window overrides any previous call for the same window but not for other clients. Multiple clients can select for the same events on the same window with the following restrictions:

- Multiple clients can select events on the same window because their event masks are disjoint. When the X server generates an event, it reports it to all interested clients.

- Only one client at a time can select **CirculateRequest**, **ConfigureRequest**, or **MapRequest** events, which are associated with the event mask **SubstructureRedirectMask**.
- Only one client at a time can select a **ResizeRequest** event, which is associated with the event mask **ResizeRedirectMask**.
- Only one client at a time can select a **ButtonPress** event, which is associated with the event mask **ButtonPressMask**.

The server reports the event to all interested clients.

XSelectInput can generate a **BadWindow** error.

11.2. Handling the Output Buffer

The output buffer is an area used by Xlib to store requests. The functions described in this section flush the output buffer if the function would block or not return an event. That is, all requests residing in the output buffer that have not yet been sent are transmitted to the X server. These functions differ in the additional tasks they might perform.

To flush the output buffer, use **XFlush**.

XFlush(*display*)
    Display **display*;

display	Specifies the connection to the X server.

The **XFlush** function flushes the output buffer. Most client applications need not use this function because the output buffer is automatically flushed as needed by calls to **XPending**, **XNextEvent**, and **XWindowEvent**. Events generated by the server may be enqueued into the library's event queue.

To flush the output buffer and then wait until all requests have been processed, use **XSync**.

XSync(*display*, *discard*)
    Display **display*;
    Bool *discard*;

display	Specifies the connection to the X server.
discard	Specifies a Boolean value that indicates whether **XSync** discards all events on the event queue.

The **XSync** function flushes the output buffer and then waits until all requests have been received and processed by the X server. Any errors generated must be handled by the error handler. For each protocol error received by Xlib, **XSync** calls the client application's error handling routine (see section 11.8.2). Any events generated by the server are enqueued into the library's event queue.

Finally, if you passed **False**, **XSync** does not discard the events in the queue. If you passed **True**, **XSync** discards all events in the queue, including those events that were on the queue before **XSync** was called. Client applications seldom need to call **XSync**.

11.3. Event Queue Management

Xlib maintains an event queue. However, the operating system also may be buffering data in its network connection that is not yet read into the event queue.

To check the number of events in the event queue, use **XEventsQueued**.

```
int XEventsQueued(display, mode)
    Display *display;
    int mode;
```

display	Specifies the connection to the X server.
mode	Specifies the mode. You can pass **QueuedAlready**, **QueuedAfterFlush**, or **QueuedAfterReading**.

If mode is **QueuedAlready**, **XEventsQueued** returns the number of events already in the event queue (and never performs a system call). If mode is **QueuedAfterFlush**, **XEventsQueued** returns the number of events already in the queue if the number is nonzero. If there are no events in the queue, **XEventsQueued** flushes the output buffer, attempts to read more events out of the application's connection, and returns the number read. If mode is **QueuedAfterReading**, **XEventsQueued** returns the number of events already in the queue if the number is nonzero. If there are no events in the queue, **XEventsQueued** attempts to read more events out of the application's connection without flushing the output buffer and returns the number read.

XEventsQueued always returns immediately without I/O if there are events already in the queue. **XEventsQueued** with mode **QueuedAfterFlush** is identical in behavior to **XPending**. **XEventsQueued** with mode **QueuedAlready** is identical to the **XQLength** function.

To return the number of events that are pending, use **XPending**.

```
int XPending(display)
     Display *display;
```

display	Specifies the connection to the X server.

The **XPending** function returns the number of events that have been received from the X server but have not been removed from the event queue. **XPending** is identical to **XEventsQueued** with the mode **QueuedAfterFlush** specified.

11.4. Manipulating the Event Queue

Xlib provides functions that let you manipulate the event queue. This section discusses how to:

- Obtain events, in order, and remove them from the queue
- Peek at events in the queue without removing them
- Obtain events that match the event mask or the arbitrary predicate procedures that you provide

11.4.1. Returning the Next Event

To get the next event and remove it from the queue, use **XNextEvent**.

XNextEvent(*display*, *event_return*)
    Display **display*;
    XEvent **event_return*;

display	Specifies the connection to the X server.
event_return	Returns the next event in the queue.

The **XNextEvent** function copies the first event from the event queue into the specified **XEvent** structure and then removes it from the queue. If the event queue is empty, **XNextEvent** flushes the output buffer and blocks until an event is received.

To peek at the event queue, use **XPeekEvent**.

XPeekEvent(*display*, *event_return*)
    Display **display*;
    XEvent **event_return*;

display	Specifies the connection to the X server.
event_return	Returns a copy of the matched event's associated structure.

The **XPeekEvent** function returns the first event from the event queue, but it does not remove the event from the queue. If the queue is empty, **XPeekEvent** flushes the output buffer and blocks until an event is received. It then copies the event into the client-supplied **XEvent** structure without removing it from the event queue.

11.4.2. Selecting Events Using a Predicate Procedure

Each of the functions discussed in this section requires you to pass a predicate procedure that determines if an event matches what you want. Your predicate procedure must decide if the event is useful without calling any Xlib functions. If the predicate directly or indirectly causes the state of the event queue to change, the result is not defined. If Xlib has been initialized for threads, the predicate is called with the display locked and the result of a call by the predicate to any Xlib function that locks the display is not defined unless the caller has first called **XLockDisplay**.

The predicate procedure and its associated arguments are:

Bool (**predicate*)(*display*, *event*, *arg*)
    Display **display*;
    XEvent **event*;
    XPointer *arg*;

display	Specifies the connection to the X server.
event	Specifies the **XEvent** structure.
arg	Specifies the argument passed in from the **XIfEvent**, **XCheckIfEvent**, or **XPeekIfEvent** function.

The predicate procedure is called once for each event in the queue until it finds a match. After finding a match, the predicate procedure must return **True**. If it did not find a match, it must return **False**.

To check the event queue for a matching event and, if found, remove the event from the queue, use **XIfEvent**.

```
XIfEvent(display, event_return, predicate, arg)
    Display *display;
    XEvent *event_return;
    Bool (*predicate)();
    XPointer arg;
```

display	Specifies the connection to the X server.
event_return	Returns the matched event's associated structure.
predicate	Specifies the procedure that is to be called to determine if the next event in the queue matches what you want.
arg	Specifies the user-supplied argument that will be passed to the predicate procedure.

The **XIfEvent** function completes only when the specified predicate procedure returns **True** for an event, which indicates an event in the queue matches. **XIfEvent** flushes the output buffer if it blocks waiting for additional events. **XIfEvent** removes the matching event from the queue and copies the structure into the client-supplied **XEvent** structure.

To check the event queue for a matching event without blocking, use **XCheckIfEvent**.

```
Bool XCheckIfEvent(display, event_return, predicate, arg)
    Display *display;
    XEvent *event_return;
    Bool (*predicate)();
    XPointer arg;
```

display	Specifies the connection to the X server.
event_return	Returns a copy of the matched event's associated structure.
predicate	Specifies the procedure that is to be called to determine if the next event in the queue matches what you want.
arg	Specifies the user-supplied argument that will be passed to the predicate procedure.

When the predicate procedure finds a match, **XCheckIfEvent** copies the matched event into the client-supplied **XEvent** structure and returns **True**. (This event is removed from the queue.) If the predicate procedure finds no match, **XCheckIfEvent** returns **False**, and the output buffer will have been flushed. All earlier events stored in the queue are not discarded.

To check the event queue for a matching event without removing the event from the queue, use **XPeekIfEvent**.

XPeekIfEvent(*display*, *event_return*, *predicate*, *arg*)
  Display **display*;
  XEvent **event_return*;
  Bool (**predicate*)( );
  XPointer *arg*;

display	Specifies the connection to the X server.
event_return	Returns a copy of the matched event's associated structure.
predicate	Specifies the procedure that is to be called to determine if the next event in the queue matches what you want.
arg	Specifies the user-supplied argument that will be passed to the predicate procedure.

The **XPeekIfEvent** function returns only when the specified predicate procedure returns **True** for an event. After the predicate procedure finds a match, **XPeekIfEvent** copies the matched event into the client-supplied **XEvent** structure without removing the event from the queue. **XPeekIfEvent** flushes the output buffer if it blocks waiting for additional events.

11.4.3. Selecting Events Using a Window or Event Mask

The functions discussed in this section let you select events by window or event types, allowing you to process events out of order.

To remove the next event that matches both a window and an event mask, use **XWindowEvent**.

XWindowEvent(*display*, *w*, *event_mask*, *event_return*)
  Display **display*;
  Window *w*;
  long *event_mask*;
  XEvent **event_return*;

display	Specifies the connection to the X server.
w	Specifies the window whose events you are interested in.
event_mask	Specifies the event mask.
event_return	Returns the matched event's associated structure.

The **XWindowEvent** function searches the event queue for an event that matches both the specified window and event mask. When it finds a match, **XWindowEvent** removes that event from the queue and copies it into the specified **XEvent** structure. The other events stored in the queue are not discarded. If a matching event is not in the queue, **XWindowEvent** flushes the output buffer and blocks until one is received.

To remove the next event that matches both a window and an event mask (if any), use **XCheckWindowEvent**. This function is similar to **XWindowEvent** except that it never blocks and it returns a **Bool** indicating if the event was returned.

```
Bool XCheckWindowEvent(display, w, event_mask, event_return)
      Display *display;
      Window w;
      long event_mask;
      XEvent *event_return;
```

display	Specifies the connection to the X server.
w	Specifies the window whose events you are interested in.
event_mask	Specifies the event mask.
event_return	Returns the matched event's associated structure.

The **XCheckWindowEvent** function searches the event queue and then the events available on the server connection for the first event that matches the specified window and event mask. If it finds a match, **XCheckWindowEvent** removes that event, copies it into the specified **XEvent** structure, and returns **True**. The other events stored in the queue are not discarded. If the event you requested is not available, **XCheckWindowEvent** returns **False**, and the output buffer will have been flushed.

To remove the next event that matches an event mask, use **XMaskEvent**.

```
XMaskEvent(display, event_mask, event_return)
      Display *display;
      long event_mask;
      XEvent *event_return;
```

display	Specifies the connection to the X server.
event_mask	Specifies the event mask.
event_return	Returns the matched event's associated structure.

The **XMaskEvent** function searches the event queue for the events associated with the specified mask. When it finds a match, **XMaskEvent** removes that event and copies it into the specified **XEvent** structure. The other events stored in the queue are not discarded. If the event you requested is not in the queue, **XMaskEvent** flushes the output buffer and blocks until one is received.

To return and remove the next event that matches an event mask (if any), use **XCheckMaskEvent**. This function is similar to **XMaskEvent** except that it never blocks and it returns a **Bool** indicating if the event was returned.

```
Bool XCheckMaskEvent(display, event_mask, event_return)
      Display *display;
      long event_mask;
      XEvent *event_return;
```

display	Specifies the connection to the X server.
event_mask	Specifies the event mask.
event_return	Returns the matched event's associated structure.

The **XCheckMaskEvent** function searches the event queue and then any events available on the server connection for the first event that matches the specified mask. If it finds a match, **XCheckMaskEvent** removes that event, copies it into the specified **XEvent** structure, and returns **True**. The other events stored in the queue are not discarded. If the event you requested is not available, **XCheckMaskEvent** returns **False**, and the output buffer will have been flushed.

To return and remove the next event in the queue that matches an event type, use **XCheckTypedEvent**.

```
Bool XCheckTypedEvent(display, event_type, event_return)
      Display *display;
      int event_type;
      XEvent *event_return;
```

display	Specifies the connection to the X server.
event_type	Specifies the event type to be compared.
event_return	Returns the matched event's associated structure.

The **XCheckTypedEvent** function searches the event queue and then any events available on the server connection for the first event that matches the specified type. If it finds a match, **XCheckTypedEvent** removes that event, copies it into the specified **XEvent** structure, and returns **True**. The other events in the queue are not discarded. If the event is not available, **XCheckTypedEvent** returns **False**, and the output buffer will have been flushed.

To return and remove the next event in the queue that matches an event type and a window, use **XCheckTypedWindowEvent**.

```
Bool XCheckTypedWindowEvent(display, w, event_type, event_return)
      Display *display;
      Window w;
      int event_type;
      XEvent *event_return;
```

display	Specifies the connection to the X server.
w	Specifies the window.
event_type	Specifies the event type to be compared.
event_return	Returns the matched event's associated structure.

The **XCheckTypedWindowEvent** function searches the event queue and then any events available on the server connection for the first event that matches the specified type and window. If it finds a match, **XCheckTypedWindowEvent** removes the event from the queue, copies it into the specified **XEvent** structure, and returns **True**. The other events in the queue are not discarded. If the event is not available, **XCheckTypedWindowEvent** returns **False**, and the output buffer will have been flushed.

11.5. Putting an Event Back into the Queue

To push an event back into the event queue, use **XPutBackEvent**.

```
XPutBackEvent(display, event)
      Display *display;
      XEvent *event;
```

display	Specifies the connection to the X server.
event	Specifies the event.

The **XPutBackEvent** function pushes an event back onto the head of the display's event queue by copying the event into the queue. This can be useful if you read an event and then decide that you would rather deal with it later. There is no limit to the number of times in succession that you can call **XPutBackEvent**.

11.6. Sending Events to Other Applications

To send an event to a specified window, use **XSendEvent**. This function is often used in selection processing. For example, the owner of a selection should use **XSendEvent** to send a **SelectionNotify** event to a requestor when a selection has been converted and stored as a property.

```
Status XSendEvent(display, w, propagate, event_mask, event_send)
      Display *display;
      Window w;
      Bool propagate;
      long event_mask;
      XEvent *event_send;
```

display	Specifies the connection to the X server.
w	Specifies the window the event is to be sent to, or **PointerWindow**, or **InputFocus**.
propagate	Specifies a Boolean value.
event_mask	Specifies the event mask.
event_send	Specifies the event that is to be sent.

The **XSendEvent** function identifies the destination window, determines which clients should receive the specified events, and ignores any active grabs. This function requires you to pass an event mask. For a discussion of the valid event mask names, see section 10.3. This function uses the w argument to identify the destination window as follows:

- If w is **PointerWindow**, the destination window is the window that contains the pointer.
- If w is **InputFocus** and if the focus window contains the pointer, the destination window is the window that contains the pointer; otherwise, the destination window is the focus window.

To determine which clients should receive the specified events, **XSendEvent** uses the propagate argument as follows:

- If event_mask is the empty set, the event is sent to the client that created the destination window. If that client no longer exists, no event is sent.
- If propagate is **False**, the event is sent to every client selecting on destination any of the event types in the event_mask argument.
- If propagate is **True** and no clients have selected on destination any of the event types in event-mask, the destination is replaced with the closest ancestor of destination for which some client has selected a type in event-mask and for which no intervening window has that type in its do-not-propagate-mask. If no such window exists or if the window is an ancestor of the focus window and **InputFocus** was originally specified as the destination, the event is not sent to any clients. Otherwise, the event is reported to every client selecting on the final destination any of the types specified in event_mask.

The event in the **XEvent** structure must be one of the core events or one of the events defined by an extension (or a **BadValue** error results) so that the X server can correctly byte-swap the contents as necessary. The contents of the event are otherwise unaltered and unchecked by the X server except to force send_event to **True** in the forwarded event and to set the serial number in the event correctly; therefore these fields and the display field are ignored by **XSendEvent**.

XSendEvent returns zero if the conversion to wire protocol format failed and returns nonzero otherwise.

XSendEvent can generate **BadValue** and **BadWindow** errors.

11.7. Getting Pointer Motion History

Some X server implementations will maintain a more complete history of pointer motion than is reported by event notification. The pointer position at each pointer hardware interrupt may be stored in a buffer for later retrieval. This buffer is called the motion history buffer. For example, a few applications, such as paint programs, want to have a precise history of where the pointer traveled. However, this historical information is highly excessive for most applications.

To determine the approximate maximum number of elements in the motion buffer, use **XDisplayMotionBufferSize**.

```
unsigned long XDisplayMotionBufferSize(display)
      Display *display;
```

display	Specifies the connection to the X server.

The server may retain the recent history of the pointer motion and do so to a finer granularity than is reported by **MotionNotify** events. The **XGetMotionEvents** function makes this history available.

To get the motion history for a specified window and time, use **XGetMotionEvents**.

```
XTimeCoord *XGetMotionEvents(display, w, start, stop, nevents_return)
     Display *display;
     Window w;
     Time start, stop;
     int *nevents_return;
```

display	Specifies the connection to the X server.
w	Specifies the window.
start	
stop	Specify the time interval in which the events are returned from the motion history buffer. You can pass a timestamp or **CurrentTime**.
nevents_return	Returns the number of events from the motion history buffer.

The **XGetMotionEvents** function returns all events in the motion history buffer that fall between the specified start and stop times, inclusive, and that have coordinates that lie within the specified window (including its borders) at its present placement. If the server does not support motion history, if the start time is later than the stop time, or if the start time is in the future, no events are returned; **XGetMotionEvents** returns NULL. If the stop time is in the future, it is equivalent to specifying **CurrentTime**. The return type for this function is a structure defined as follows:

```
typedef struct {
        Time time;
        short x, y;
} XTimeCoord;
```

The time member is set to the time, in milliseconds. The x and y members are set to the coordinates of the pointer and are reported relative to the origin of the specified window. To free the data returned from this call, use **XFree**.

XGetMotionEvents can generate a **BadWindow** error.

11.8. Handling Protocol Errors

Xlib provides functions that you can use to enable or disable synchronization and to use the default error handlers.

11.8.1. Enabling or Disabling Synchronization

When debugging X applications, it often is very convenient to require Xlib to behave synchronously so that errors are reported as they occur. The following function lets you disable or enable synchronous behavior. Note that graphics may occur 30 or more times more slowly when synchronization is enabled. On POSIX-conformant systems, there is also a global variable **_Xdebug** that, if set to nonzero before starting a program under a debugger, will force synchronous library behavior.

After completing their work, all Xlib functions that generate protocol requests call what is known as an after function. **XSetAfterFunction** sets which function is to be called.

```
int (*XSetAfterFunction(display, procedure))()
    Display *display;
    int (*procedure)();
```

display	Specifies the connection to the X server.
procedure	Specifies the procedure to be called.

The specified procedure is called with only a display pointer. **XSetAfterFunction** returns the previous after function.

To enable or disable synchronization, use **XSynchronize**.

```
int (*XSynchronize(display, onoff))()
    Display *display;
    Bool onoff;
```

display	Specifies the connection to the X server.
onoff	Specifies a Boolean value that indicates whether to enable or disable synchronization.

The **XSynchronize** function returns the previous after function. If onoff is **True**, **XSynchronize** turns on synchronous behavior. If onoff is **False**, **XSynchronize** turns off synchronous behavior.

11.8.2. Using the Default Error Handlers

There are two default error handlers in Xlib: one to handle typically fatal conditions (for example, the connection to a display server dying because a machine crashed) and one to handle protocol errors from the X server. These error handlers can be changed to user-supplied routines if you prefer your own error handling and can be changed as often as you like. If either function is passed a NULL pointer, it will reinvoke the default handler. The action of the default handlers is to print an explanatory message and exit.

To set the error handler, use **XSetErrorHandler**.

```
int (*XSetErrorHandler(handler))()
     int (*handler)(Display *, XErrorEvent *)
```

handler	Specifies the program's supplied error handler.

Xlib generally calls the program's supplied error handler whenever an error is received. It is not called on **BadName** errors from **OpenFont**, **LookupColor**, or **AllocNamedColor** protocol requests or on **BadFont** errors from a **QueryFont** protocol request. These errors generally are reflected back to the program through the procedural interface. Because this condition is not assumed to be fatal, it is acceptable for your error handler to return; the returned value is ignored. However, the error handler should not call any functions (directly or indirectly) on the display that will generate protocol requests or that will look for input events. The previous error handler is returned.

The **XErrorEvent** structure contains:

```
typedef struct {
        int type;
        Display *display;              /* Display the event was read from */
        unsigned long serial;          /* serial number of failed request */
        unsigned char error_code;      /* error code of failed request */
        unsigned char request_code;    /* Major op-code of failed request */
        unsigned char minor_code;      /* Minor op-code of failed request */
        XID resourceid;                /* resource id */
} XErrorEvent;
```

The serial member is the number of requests, starting from one, sent over the network connection since it was opened. It is the number that was the value of **NextRequest** immediately before the failing call was made. The request_code member is a protocol request of the procedure that failed, as defined in **<X11/Xproto.h>**. The following error codes can be returned by the functions described in this chapter:

Error Code	**Description**

Error Code	Description
BadAccess	A client attempts to grab a key/button combination already grabbed by another client. A client attempts to free a colormap entry that it had not already allocated or to free an entry in a colormap that was created with all entries writable. A client attempts to store into a read-only or unallocated colormap entry. A client attempts to modify the access control list from other than the local (or otherwise authorized) host. A client attempts to select an event type that another client has already selected.
BadAlloc	The server fails to allocate the requested resource. Note that the explicit listing of **BadAlloc** errors in requests only covers allocation errors at a very coarse level and is not intended to (nor can it in practice hope to) cover all cases of a server running out of allocation space in the middle of service. The semantics when a server runs out of allocation space are left unspecified, but a server may generate a **BadAlloc** error on any request for this reason, and clients should be prepared to receive such errors and handle or discard them.
BadAtom	A value for an atom argument does not name a defined atom.
BadColor	A value for a colormap argument does not name a defined colormap.
BadCursor	A value for a cursor argument does not name a defined cursor.
BadDrawable	A value for a drawable argument does not name a defined window or pixmap.
BadFont	A value for a font argument does not name a defined font (or, in some cases, **GContext**).
BadGC	A value for a **GContext** argument does not name a defined **GContext**.
BadIDChoice	The value chosen for a resource identifier either is not included in the range assigned to the client or is already in use. Under normal circumstances, this cannot occur and should be considered a server or Xlib error.
BadImplementation	The server does not implement some aspect of the request. A server that generates this error for a core request is deficient. As such, this error is not listed for any of the requests, but clients should be prepared to receive such errors and handle or discard them.
BadLength	The length of a request is shorter or longer than that required to contain the arguments. This is an internal Xlib or server error. The length of a request exceeds the maximum length accepted by the server.

Error Code	Description
BadMatch	In a graphics request, the root and depth of the graphics context does not match that of the drawable. An **InputOnly** window is used as a drawable. Some argument or pair of arguments has the correct type and range, but it fails to match in some other way required by the request. An **InputOnly** window lacks this attribute.
BadName	A font or color of the specified name does not exist.
BadPixmap	A value for a pixmap argument does not name a defined pixmap.
BadRequest	The major or minor opcode does not specify a valid request. This usually is an Xlib or server error.
BadValue	Some numeric value falls outside of the range of values accepted by the request. Unless a specific range is specified for an argument, the full range defined by the argument's type is accepted. Any argument defined as a set of alternatives typically can generate this error (due to the encoding).
BadWindow	A value for a window argument does not name a defined window.

Note

> The **BadAtom**, **BadColor**, **BadCursor**, **BadDrawable**, **BadFont**, **BadGC**, **BadPixmap**, and **BadWindow** errors are also used when the argument type is extended by a set of fixed alternatives.

To obtain textual descriptions of the specified error code, use **XGetErrorText**.

XGetErrorText(*display*, *code*, *buffer_return*, *length*)
  Display **display*;
  int *code*;
  char **buffer_return*;
  int *length*;

display	Specifies the connection to the X server.
code	Specifies the error code for which you want to obtain a description.
buffer_return	Returns the error description.
length	Specifies the size of the buffer.

The **XGetErrorText** function copies a null-terminated string describing the specified error code into the specified buffer. The returned text is in the encoding of the current locale. It is recommended that you use this function to obtain an error description because extensions to Xlib may define their own error codes and error strings.

To obtain error messages from the error database, use **XGetErrorDatabaseText**.

```
XGetErrorDatabaseText(display, name, message, default_string, buffer_return, length)
    Display *display;
    char *name, *message;
    char *default_string;
    char *buffer_return;
    int length;
```

display	Specifies the connection to the X server.
name	Specifies the name of the application.
message	Specifies the type of the error message.
default_string	Specifies the default error message if none is found in the database.
buffer_return	Returns the error description.
length	Specifies the size of the buffer.

The **XGetErrorDatabaseText** function returns a null-terminated message (or the default message) from the error message database. Xlib uses this function internally to look up its error messages. The text in the default_string argument is assumed to be in the encoding of the current locale, and the text stored in the buffer_return argument is in the encoding of the current locale.

The name argument should generally be the name of your application. The message argument should indicate which type of error message you want. If the name and message are not in the Host Portable Character Encoding, the result is implementation dependent. Xlib uses three predefined “application names” to report errors. In these names, uppercase and lowercase matter.

XProtoError	The protocol error number is used as a string for the message argument.
XlibMessage	These are the message strings that are used internally by the library.
XRequest	For a core protocol request, the major request protocol number is used for the message argument. For an extension request, the extension name (as given by **InitExtension**) followed by a period (.) and the minor request protocol number is used for the message argument. If no string is found in the error database, the default_string is returned to the buffer argument.

To report an error to the user when the requested display does not exist, use **XDisplayName**.

```
char *XDisplayName(string)
    char *string;
```

string	Specifies the character string.

The **XDisplayName** function returns the name of the display that **XOpenDisplay** would attempt to use. If a NULL string is specified, **XDisplayName** looks in the environment for the display and returns the display name that **XOpenDisplay** would attempt to use. This makes it easier to report to the user precisely which display the program attempted to open when the initial connection attempt failed.

To handle fatal I/O errors, use **XSetIOErrorHandler**.

```
int (*XSetIOErrorHandler(handler))()
     int (*handler)(Display *);
```

handler	Specifies the program's supplied error handler.

The **XSetIOErrorHandler** sets the fatal I/O error handler. Xlib calls the program's supplied error handler if any sort of system call error occurs (for example, the connection to the server was lost). This is assumed to be a fatal condition, and the called routine should not return. If the I/O error handler does return, the client process exits.

Note that the previous error handler is returned.

Chapter 12

Input Device Functions

You can use the Xlib input device functions to:

- Grab the pointer and individual buttons on the pointer
- Grab the keyboard and individual keys on the keyboard
- Move the pointer
- Set the input focus
- Manipulate the keyboard and pointer settings
- Manipulate the keyboard encoding

12.1. Pointer Grabbing

Xlib provides functions that you can use to control input from the pointer, which usually is a mouse. Usually, as soon as keyboard and mouse events occur, the X server delivers them to the appropriate client, which is determined by the window and input focus. The X server provides sufficient control over event delivery to allow window managers to support mouse ahead and various other styles of user interface. Many of these user interfaces depend upon synchronous delivery of events. The delivery of pointer and keyboard events can be controlled independently.

When mouse buttons or keyboard keys are grabbed, events will be sent to the grabbing client rather than the normal client who would have received the event. If the keyboard or pointer is in asynchronous mode, further mouse and keyboard events will continue to be processed. If the keyboard or pointer is in synchronous mode, no further events are processed until the grabbing client allows them (see **XAllowEvents**). The keyboard or pointer is considered frozen during this interval. The event that triggered the grab can also be replayed.

Note that the logical state of a device (as seen by client applications) may lag the physical state if device event processing is frozen.

There are two kinds of grabs: active and passive. An active grab occurs when a single client grabs the keyboard and/or pointer explicitly (see **XGrabPointer** and **XGrabKeyboard**). A passive grab occurs when clients grab a particular keyboard key or pointer button in a window, and the grab will activate when the key or button is actually pressed. Passive grabs are convenient for implementing reliable pop-up menus. For example, you can guarantee that the pop-up is mapped before the up pointer button event occurs by grabbing a button requesting synchronous behavior. The down event will trigger the grab and freeze further processing of pointer events until you have the chance to map the pop-up window. You can then allow further event processing. The up event will then be correctly processed relative to the pop-up window.

For many operations, there are functions that take a time argument. The X server includes a timestamp in various events. One special time, called **CurrentTime**, represents the current server time. The X server maintains the time when the input focus was last changed, when the keyboard was last grabbed, when the pointer was last grabbed, or when a selection was last changed. Your application may be slow reacting to an event. You often need some way to specify that your request should not occur if another application has in the meanwhile taken control of the keyboard, pointer, or selection. By providing the timestamp from the event in the request, you can arrange that the operation not take effect if someone else has performed an operation in the meanwhile.

A timestamp is a time value, expressed in milliseconds. It typically is the time since the last server reset. Timestamp values wrap around (after about 49.7 days). The server, given its current time is represented by timestamp T, always interprets timestamps from clients by treating half of the timestamp space as being later in time than T. One timestamp value, named **CurrentTime**, is never generated by the server. This value is reserved for use in requests to represent the current server time.

For many functions in this section, you pass pointer event mask bits. The valid pointer event mask bits are: **ButtonPressMask**, **ButtonReleaseMask**, **EnterWindowMask**, **LeaveWindowMask**, **PointerMotionMask**, **PointerMotionHintMask**, **Button1MotionMask**, **Button2MotionMask**, **Button3MotionMask**, **Button4MotionMask**, **Button5MotionMask**, **ButtonMotionMask**, and **KeyMapStateMask**. For other functions in this section, you pass keymask bits. The valid keymask bits are: **ShiftMask**, **LockMask**, **ControlMask**, **Mod1Mask**, **Mod2Mask**, **Mod3Mask**, **Mod4Mask**, and **Mod5Mask**.

To grab the pointer, use **XGrabPointer**.

int XGrabPointer(*display*, *grab_window*, *owner_events*, *event_mask*, *pointer_mode*,
keyboard_mode, *confine_to*, *cursor*, *time*)
Display **display*;
Window *grab_window*;
Bool *owner_events*;
unsigned int *event_mask*;
int *pointer_mode*, *keyboard_mode*;
Window *confine_to*;
Cursor *cursor*;
Time *time*;

display	Specifies the connection to the X server.
grab_window	Specifies the grab window.
owner_events	Specifies a Boolean value that indicates whether the pointer events are to be reported as usual or reported with respect to the grab window if selected by the event mask.
event_mask	Specifies which pointer events are reported to the client. The mask is the bitwise inclusive OR of the valid pointer event mask bits.
pointer_mode	Specifies further processing of pointer events. You can pass **GrabModeSync** or **GrabModeAsync**.
keyboard_mode	Specifies further processing of keyboard events. You can pass **GrabModeSync** or **GrabModeAsync**.
confine_to	Specifies the window to confine the pointer in or **None**.
cursor	Specifies the cursor that is to be displayed during the grab or **None**.
time	Specifies the time. You can pass either a timestamp or **CurrentTime**.

The **XGrabPointer** function actively grabs control of the pointer and returns **GrabSuccess** if the grab was successful. Further pointer events are reported only to the grabbing client. **XGrabPointer** overrides any active pointer grab by this client. If owner_events is **False**, all generated pointer events are reported with respect to grab_window and are reported only if selected by event_mask. If owner_events is **True** and if a generated pointer event would normally be reported to this client, it is reported as usual. Otherwise, the event is reported with respect to the grab_window and is reported only if selected by event_mask. For either value of owner_events, unreported events are discarded.

If the pointer_mode is **GrabModeAsync**, pointer event processing continues as usual. If the pointer is currently frozen by this client, the processing of events for the pointer is resumed. If the pointer_mode is **GrabModeSync**, the state of the pointer, as seen by client applications, appears to freeze, and the X server generates no further pointer events until the grabbing client calls **XAllowEvents** or until the pointer grab is released. Actual pointer changes are not lost while the pointer is frozen; they are simply queued in the server for later processing.

If the keyboard_mode is **GrabModeAsync**, keyboard event processing is unaffected by activation of the grab. If the keyboard_mode is **GrabModeSync**, the state of the keyboard, as seen by client applications, appears to freeze, and the X server generates no further keyboard events until the grabbing client calls **XAllowEvents** or until the pointer grab is released. Actual keyboard changes are not lost while the pointer is frozen; they are simply queued in the server for later processing.

If a cursor is specified, it is displayed regardless of what window the pointer is in. If **None** is specified, the normal cursor for that window is displayed when the pointer is in grab_window or one of its subwindows; otherwise, the cursor for grab_window is displayed.

If a confine_to window is specified, the pointer is restricted to stay contained in that window. The confine_to window need have no relationship to the grab_window. If the pointer is not initially in the confine_to window, it is warped automatically to the closest edge just before the grab activates and enter/leave events are generated as usual. If the confine_to window is subsequently reconfigured, the pointer is warped automatically, as necessary, to keep it contained in the window.

The time argument allows you to avoid certain circumstances that come up if applications take a long time to respond or if there are long network delays. Consider a situation where you have two applications, both of which normally grab the pointer when clicked on. If both applications specify the timestamp from the event, the second application may wake up faster and successfully grab the pointer before the first application. The first application then will get an indication that the other application grabbed the pointer before its request was processed.

XGrabPointer generates **EnterNotify** and **LeaveNotify** events.

Either if grab_window or confine_to window is not viewable or if the confine_to window lies completely outside the boundaries of the root window, **XGrabPointer** fails and returns **GrabNotViewable**. If the pointer is actively grabbed by some other client, it fails and returns **AlreadyGrabbed**. If the pointer is frozen by an active grab of another client, it fails and returns **GrabFrozen**. If the specified time is earlier than the last-pointer-grab time or later than the current X server time, it fails and returns **GrabInvalidTime**. Otherwise, the last-pointer-grab time is set to the specified time (**CurrentTime** is replaced by the current X server time).

XGrabPointer can generate **BadCursor**, **BadValue**, and **BadWindow** errors.

To ungrab the pointer, use **XUngrabPointer**.

```
XUngrabPointer(display, time)
    Display *display;
    Time time;
```

display	Specifies the connection to the X server.
time	Specifies the time. You can pass either a timestamp or **CurrentTime**.

The **XUngrabPointer** function releases the pointer and any queued events if this client has actively grabbed the pointer from **XGrabPointer**, **XGrabButton**, or from a normal button press. **XUngrabPointer** does not release the pointer if the specified time is earlier than the last-pointer-grab time or is later than the current X server time. It also generates **EnterNotify** and **LeaveNotify** events. The X server performs an **UngrabPointer** request automatically if the event window or confine_to window for an active pointer grab becomes not viewable or if window reconfiguration causes the confine_to window to lie completely outside the boundaries of the root window.

To change an active pointer grab, use **XChangeActivePointerGrab**.

```
XChangeActivePointerGrab(display, event_mask, cursor, time)
    Display *display;
    unsigned int event_mask;
    Cursor cursor;
    Time time;
```

display	Specifies the connection to the X server.
event_mask	Specifies which pointer events are reported to the client. The mask is the bitwise inclusive OR of the valid pointer event mask bits.
cursor	Specifies the cursor that is to be displayed or **None**.
time	Specifies the time. You can pass either a timestamp or **CurrentTime**.

The **XChangeActivePointerGrab** function changes the specified dynamic parameters if the pointer is actively grabbed by the client and if the specified time is no earlier than the last-pointer-grab time and no later than the current X server time. This function has no effect on the passive parameters of a **XGrabButton**. The interpretation of event_mask and cursor is the same as described in **XGrabPointer**.

XChangeActivePointerGrab can generate **BadCursor** and **BadValue** errors.

To grab a pointer button, use **XGrabButton**.

```
XGrabButton(display, button, modifiers, grab_window, owner_events, event_mask,
            pointer_mode, keyboard_mode, confine_to, cursor)
    Display *display;
    unsigned int button;
    unsigned int modifiers;
    Window grab_window;
    Bool owner_events;
    unsigned int event_mask;
    int pointer_mode, keyboard_mode;
    Window confine_to;
    Cursor cursor;
```

display	Specifies the connection to the X server.
button	Specifies the pointer button that is to be grabbed or **AnyButton**.
modifiers	Specifies the set of keymasks or **AnyModifier**. The mask is the bitwise inclusive OR of the valid keymask bits.
grab_window	Specifies the grab window.
owner_events	Specifies a Boolean value that indicates whether the pointer events are to be reported as usual or reported with respect to the grab window if selected by the event mask.
event_mask	Specifies which pointer events are reported to the client. The mask is the bitwise inclusive OR of the valid pointer event mask bits.
pointer_mode	Specifies further processing of pointer events. You can pass **GrabModeSync** or **GrabModeAsync**.
keyboard_mode	Specifies further processing of keyboard events. You can pass **GrabModeSync** or **GrabModeAsync**.
confine_to	Specifies the window to confine the pointer in or **None**.
cursor	Specifies the cursor that is to be displayed or **None**.

The **XGrabButton** function establishes a passive grab. In the future, the pointer is actively grabbed (as for **XGrabPointer**), the last-pointer-grab time is set to the time at which the button was pressed (as transmitted in the **ButtonPress** event), and the **ButtonPress** event is reported if all of the following conditions are true:

- The pointer is not grabbed, and the specified button is logically pressed when the specified modifier keys are logically down, and no other buttons or modifier keys are logically down.
- The grab_window contains the pointer.
- The confine_to window (if any) is viewable.
- A passive grab on the same button/key combination does not exist on any ancestor of grab_window.

The interpretation of the remaining arguments is as for **XGrabPointer**. The active grab is terminated automatically when the logical state of the pointer has all buttons released (independent of the state of the logical modifier keys).

Note that the logical state of a device (as seen by client applications) may lag the physical state if device event processing is frozen.

This request overrides all previous grabs by the same client on the same button/key combinations on the same window. A modifiers of **AnyModifier** is equivalent to issuing the grab request for all possible modifier combinations (including the combination of no modifiers). It is not required that all modifiers specified have currently assigned KeyCodes. A button of **AnyButton** is equivalent to issuing the request for all possible buttons. Otherwise, it is not required that the specified button currently be assigned to a physical button.

If some other client has already issued a **XGrabButton** with the same button/key combination on the same window, a **BadAccess** error results. When using **AnyModifier** or **AnyButton**, the request fails completely, and a **BadAccess** error results (no grabs are established) if there is a conflicting grab for any combination. **XGrabButton** has no effect on an active grab.

XGrabButton can generate **BadCursor**, **BadValue**, and **BadWindow** errors.

To ungrab a pointer button, use **XUngrabButton**.

```
XUngrabButton(display, button, modifiers, grab_window)
      Display *display;
      unsigned int button;
      unsigned int modifiers;
      Window grab_window;
```

display	Specifies the connection to the X server.
button	Specifies the pointer button that is to be released or **AnyButton**.
modifiers	Specifies the set of keymasks or **AnyModifier**. The mask is the bitwise inclusive OR of the valid keymask bits.
grab_window	Specifies the grab window.

The **XUngrabButton** function releases the passive button/key combination on the specified window if it was grabbed by this client. A modifiers of **AnyModifier** is equivalent to issuing the ungrab request for all possible modifier combinations, including the combination of no modifiers. A button of **AnyButton** is equivalent to issuing the request for all possible buttons. **XUngrabButton** has no effect on an active grab.

XUngrabButton can generate **BadValue** and **BadWindow** errors.

12.2. Keyboard Grabbing

Xlib provides functions that you can use to grab or ungrab the keyboard as well as allow events.

For many functions in this section, you pass keymask bits. The valid keymask bits are: **ShiftMask**, **LockMask**, **ControlMask**, **Mod1Mask**, **Mod2Mask**, **Mod3Mask**, **Mod4Mask**, and **Mod5Mask**.

To grab the keyboard, use **XGrabKeyboard**.

```
int XGrabKeyboard(display, grab_window, owner_events, pointer_mode, keyboard_mode, time)
      Display *display;
      Window grab_window;
      Bool owner_events;
      int pointer_mode, keyboard_mode;
      Time time;
```

display	Specifies the connection to the X server.
grab_window	Specifies the grab window.
owner_events	Specifies a Boolean value that indicates whether the keyboard events are to be reported as usual.
pointer_mode	Specifies further processing of pointer events. You can pass **GrabModeSync** or **GrabModeAsync**.
keyboard_mode	Specifies further processing of keyboard events. You can pass **GrabModeSync** or **GrabModeAsync**.
time	Specifies the time. You can pass either a timestamp or **CurrentTime**.

The **XGrabKeyboard** function actively grabs control of the keyboard and generates **FocusIn** and **FocusOut** events. Further key events are reported only to the grabbing client. **XGrabKeyboard** overrides any active keyboard grab by this client. If owner_events is **False**, all generated key events are reported with respect to grab_window. If owner_events is **True** and if a generated key event would normally be reported to this client, it is reported normally; otherwise, the event is reported with respect to the grab_window. Both **KeyPress** and **KeyRelease** events are always reported, independent of any event selection made by the client.

If the keyboard_mode argument is **GrabModeAsync**, keyboard event processing continues as usual. If the keyboard is currently frozen by this client, then processing of keyboard events is resumed. If the keyboard_mode argument is **GrabModeSync**, the state of the keyboard (as seen by client applications) appears to freeze, and the X server generates no further keyboard events until the grabbing client issues a releasing **XAllowEvents** call or until the keyboard grab is released. Actual keyboard changes are not lost while the keyboard is frozen; they are simply queued in the server for later processing.

If pointer_mode is **GrabModeAsync**, pointer event processing is unaffected by activation of the grab. If pointer_mode is **GrabModeSync**, the state of the pointer (as seen by client applications) appears to freeze, and the X server generates no further pointer events until the grabbing client issues a releasing **XAllowEvents** call or until the keyboard grab is released. Actual pointer changes are not lost while the pointer is frozen; they are simply queued in the server for later processing.

If the keyboard is actively grabbed by some other client, **XGrabKeyboard** fails and returns **AlreadyGrabbed**. If grab_window is not viewable, it fails and returns **GrabNotViewable**. If the keyboard is frozen by an active grab of another client, it fails and returns **GrabFrozen**. If the specified time is earlier than the last-keyboard-grab time or later than the current X server time, it fails and returns **GrabInvalidTime**. Otherwise, the last-keyboard-grab time is set to the specified time (**CurrentTime** is replaced by the current X server time).

XGrabKeyboard can generate **BadValue** and **BadWindow** errors.

To ungrab the keyboard, use **XUngrabKeyboard**.

```
XUngrabKeyboard(display, time)
      Display *display;
      Time time;
```

display	Specifies the connection to the X server.
time	Specifies the time. You can pass either a timestamp or **CurrentTime**.

The **XUngrabKeyboard** function releases the keyboard and any queued events if this client has it actively grabbed from either **XGrabKeyboard** or **XGrabKey**. **XUngrabKeyboard** does not release the keyboard and any queued events if the specified time is earlier than the last-keyboard-grab time or is later than the current X server time. It also generates **FocusIn** and **FocusOut** events. The X server automatically performs an **UngrabKeyboard** request if the event window for an active keyboard grab becomes not viewable.

To passively grab a single key of the keyboard, use **XGrabKey**.

```
XGrabKey(display, keycode, modifiers, grab_window, owner_events, pointer_mode,
            keyboard_mode)
      Display *display;
      int keycode;
      unsigned int modifiers;
      Window grab_window;
      Bool owner_events;
      int pointer_mode, keyboard_mode;
```

display	Specifies the connection to the X server.
keycode	Specifies the KeyCode or **AnyKey**.
modifiers	Specifies the set of keymasks or **AnyModifier**. The mask is the bitwise inclusive OR of the valid keymask bits.
grab_window	Specifies the grab window.
owner_events	Specifies a Boolean value that indicates whether the keyboard events are to be reported as usual.
pointer_mode	Specifies further processing of pointer events. You can pass **GrabModeSync** or **GrabModeAsync**.
keyboard_mode	Specifies further processing of keyboard events. You can pass **GrabModeSync** or **GrabModeAsync**.

The **XGrabKey** function establishes a passive grab on the keyboard. In the future, the keyboard is actively grabbed (as for **XGrabKeyboard**), the last-keyboard-grab time is set to the time at which the key was pressed (as transmitted in the **KeyPress** event), and the **KeyPress** event is reported if all of the following conditions are true:

- The keyboard is not grabbed and the specified key (which can itself be a modifier key) is logically pressed when the specified modifier keys are logically down, and no other modifier keys are logically down.
- Either the grab_window is an ancestor of (or is) the focus window, or the grab_window is a descendant of the focus window and contains the pointer.

- A passive grab on the same key combination does not exist on any ancestor of grab_window.

The interpretation of the remaining arguments is as for **XGrabKeyboard**. The active grab is terminated automatically when the logical state of the keyboard has the specified key released (independent of the logical state of the modifier keys).

Note that the logical state of a device (as seen by client applications) may lag the physical state if device event processing is frozen.

A modifiers argument of **AnyModifier** is equivalent to issuing the request for all possible modifier combinations (including the combination of no modifiers). It is not required that all modifiers specified have currently assigned KeyCodes. A keycode argument of **AnyKey** is equivalent to issuing the request for all possible KeyCodes. Otherwise, the specified keycode must be in the range specified by min_keycode and max_keycode in the connection setup, or a **BadValue** error results.

If some other client has issued a **XGrabKey** with the same key combination on the same window, a **BadAccess** error results. When using **AnyModifier** or **AnyKey**, the request fails completely, and a **BadAccess** error results (no grabs are established) if there is a conflicting grab for any combination.

XGrabKey can generate **BadAccess**, **BadValue**, and **BadWindow** errors.

To ungrab a key, use **XUngrabKey**.

XUngrabKey(*display*, *keycode*, *modifiers*, *grab_window*)
    Display **display*;
    int *keycode*;
    unsigned int *modifiers*;
    Window *grab_window*;

display	Specifies the connection to the X server.
keycode	Specifies the KeyCode or **AnyKey**.
modifiers	Specifies the set of keymasks or **AnyModifier**. The mask is the bitwise inclusive OR of the valid keymask bits.
grab_window	Specifies the grab window.

The **XUngrabKey** function releases the key combination on the specified window if it was grabbed by this client. It has no effect on an active grab. A modifiers of **AnyModifier** is equivalent to issuing the request for all possible modifier combinations (including the combination of no modifiers). A keycode argument of **AnyKey** is equivalent to issuing the request for all possible key codes.

XUngrabKey can generate **BadValue** and **BadWindow** errors.

12.3. Resuming Event Processing

The previous sections discussed grab mechanisms with which processing of events by the server can be temporarily suspended. This section describes the mechanism for resuming event processing.

To allow further events to be processed when the device has been frozen, use **XAllowEvents**.

```
XAllowEvents(display, event_mode, time)
    Display *display;
    int event_mode;
    Time time;
```

display	Specifies the connection to the X server.
event_mode	Specifies the event mode. You can pass **AsyncPointer**, **SyncPointer**, **AsyncKeyboard**, **SyncKeyboard**, **ReplayPointer**, **ReplayKeyboard**, **AsyncBoth**, or **SyncBoth**.
time	Specifies the time. You can pass either a timestamp or **CurrentTime**.

The **XAllowEvents** function releases some queued events if the client has caused a device to freeze. It has no effect if the specified time is earlier than the last-grab time of the most recent active grab for the client or if the specified time is later than the current X server time. Depending on the event_mode argument, the following occurs:

AsyncPointer	If the pointer is frozen by the client, pointer event processing continues as usual. If the pointer is frozen twice by the client on behalf of two separate grabs, **AsyncPointer** thaws for both. **AsyncPointer** has no effect if the pointer is not frozen by the client, but the pointer need not be grabbed by the client.
SyncPointer	If the pointer is frozen and actively grabbed by the client, pointer event processing continues as usual until the next **ButtonPress** or **ButtonRelease** event is reported to the client. At this time, the pointer again appears to freeze. However, if the reported event causes the pointer grab to be released, the pointer does not freeze. **SyncPointer** has no effect if the pointer is not frozen by the client or if the pointer is not grabbed by the client.
ReplayPointer	If the pointer is actively grabbed by the client and is frozen as the result of an event having been sent to the client (either from the activation of a **XGrabButton** or from a previous **XAllowEvents** with mode **SyncPointer** but not from a **XGrabPointer**), the pointer grab is released and that event is completely reprocessed. This time, however, the function ignores any passive grabs at or above (towards the root of) the grab_window of the grab just released. The request has no effect if the pointer is not grabbed by the client or if the pointer is not frozen as the result of an event.
AsyncKeyboard	If the keyboard is frozen by the client, keyboard event processing continues as usual. If the keyboard is frozen twice by the client on behalf of two separate grabs, **AsyncKeyboard** thaws for both. **AsyncKeyboard** has no effect if the keyboard is not frozen by the client, but the keyboard need not be grabbed by the client.

SyncKeyboard	If the keyboard is frozen and actively grabbed by the client, keyboard event processing continues as usual until the next **KeyPress** or **KeyRelease** event is reported to the client. At this time, the keyboard again appears to freeze. However, if the reported event causes the keyboard grab to be released, the keyboard does not freeze. **SyncKeyboard** has no effect if the keyboard is not frozen by the client or if the keyboard is not grabbed by the client.
ReplayKeyboard	If the keyboard is actively grabbed by the client and is frozen as the result of an event having been sent to the client (either from the activation of a **XGrabKey** or from a previous **XAllowEvents** with mode **SyncKeyboard** but not from a **XGrabKeyboard**), the keyboard grab is released and that event is completely reprocessed. This time, however, the function ignores any passive grabs at or above (towards the root of) the grab_window of the grab just released. The request has no effect if the keyboard is not grabbed by the client or if the keyboard is not frozen as the result of an event.
SyncBoth	If both pointer and keyboard are frozen by the client, event processing for both devices continues as usual until the next **ButtonPress**, **ButtonRelease**, **KeyPress**, or **KeyRelease** event is reported to the client for a grabbed device (button event for the pointer, key event for the keyboard), at which time the devices again appear to freeze. However, if the reported event causes the grab to be released, then the devices do not freeze (but if the other device is still grabbed, then a subsequent event for it will still cause both devices to freeze). **SyncBoth** has no effect unless both pointer and keyboard are frozen by the client. If the pointer or keyboard is frozen twice by the client on behalf of two separate grabs, **SyncBoth** thaws for both (but a subsequent freeze for **SyncBoth** will only freeze each device once).
AsyncBoth	If the pointer and the keyboard are frozen by the client, event processing for both devices continues as usual. If a device is frozen twice by the client on behalf of two separate grabs, **AsyncBoth** thaws for both. **AsyncBoth** has no effect unless both pointer and keyboard are frozen by the client.

AsyncPointer, **SyncPointer**, and **ReplayPointer** have no effect on the processing of keyboard events. **AsyncKeyboard**, **SyncKeyboard**, and **ReplayKeyboard** have no effect on the processing of pointer events. It is possible for both a pointer grab and a keyboard grab (by the same or different clients) to be active simultaneously. If a device is frozen on behalf of either grab, no event processing is performed for the device. It is possible for a single device to be frozen because of both grabs. In this case, the freeze must be released on behalf of both grabs before events can again be processed. If a device is frozen twice by a single client, then a single **AllowEvents** releases both.

XAllowEvents can generate a **BadValue** error.

12.4. Moving the Pointer

Although movement of the pointer normally should be left to the control of the end user, sometimes it is necessary to move the pointer to a new position under program control.

To move the pointer to an arbitrary point in a window, use **XWarpPointer**.

```
XWarpPointer(display, src_w, dest_w, src_x, src_y, src_width, src_height, dest_x,
        dest_y)
    Display *display;
    Window src_w, dest_w;
    int src_x, src_y;
    unsigned int src_width, src_height;
    int dest_x, dest_y;
```

display	Specifies the connection to the X server.
src_w	Specifies the source window or **None**.
dest_w	Specifies the destination window or **None**.
src_x	
src_y	
src_width	
src_height	Specify a rectangle in the source window.
dest_x	
dest_y	Specify the x and y coordinates within the destination window.

If dest_w is **None**, **XWarpPointer** moves the pointer by the offsets (dest_x, dest_y) relative to the current position of the pointer. If dest_w is a window, **XWarpPointer** moves the pointer to the offsets (dest_x, dest_y) relative to the origin of dest_w. However, if src_w is a window, the move only takes place if the window src_w contains the pointer and if the specified rectangle of src_w contains the pointer.

The src_x and src_y coordinates are relative to the origin of src_w. If src_height is zero, it is replaced with the current height of src_w minus src_y. If src_width is zero, it is replaced with the current width of src_w minus src_x.

There is seldom any reason for calling this function. The pointer should normally be left to the user. If you do use this function, however, it generates events just as if the user had instantaneously moved the pointer from one position to another. Note that you cannot use **XWarpPointer** to move the pointer outside the confine_to window of an active pointer grab. An attempt to do so will only move the pointer as far as the closest edge of the confine_to window.

XWarpPointer can generate a **BadWindow** error.

12.5. Controlling Input Focus

Xlib provides functions that you can use to set and get the input focus. The input focus is a shared resource, and cooperation among clients is required for correct interaction. See the *Inter-Client Communication Conventions Manual* for input focus policy.

To set the input focus, use **XSetInputFocus**.

XSetInputFocus(*display*, *focus*, *revert_to*, *time*)
  Display **display*;
  Window *focus*;
  int *revert_to*;
  Time *time*;

display	Specifies the connection to the X server.
focus	Specifies the window, **PointerRoot**, or **None**.
revert_to	Specifies where the input focus reverts to if the window becomes not viewable. You can pass **RevertToParent**, **RevertToPointerRoot**, or **RevertToNone**.
time	Specifies the time. You can pass either a timestamp or **CurrentTime**.

The **XSetInputFocus** function changes the input focus and the last-focus-change time. It has no effect if the specified time is earlier than the current last-focus-change time or is later than the current X server time. Otherwise, the last-focus-change time is set to the specified time (**CurrentTime** is replaced by the current X server time). **XSetInputFocus** causes the X server to generate **FocusIn** and **FocusOut** events.

Depending on the focus argument, the following occurs:

- If focus is **None**, all keyboard events are discarded until a new focus window is set, and the revert_to argument is ignored.
- If focus is a window, it becomes the keyboard's focus window. If a generated keyboard event would normally be reported to this window or one of its inferiors, the event is reported as usual. Otherwise, the event is reported relative to the focus window.
- If focus is **PointerRoot**, the focus window is dynamically taken to be the root window of whatever screen the pointer is on at each keyboard event. In this case, the revert_to argument is ignored.

The specified focus window must be viewable at the time **XSetInputFocus** is called, or a **BadMatch** error results. If the focus window later becomes not viewable, the X server evaluates the revert_to argument to determine the new focus window as follows:

- If revert_to is **RevertToParent**, the focus reverts to the parent (or the closest viewable ancestor), and the new revert_to value is taken to be **RevertToNone**.
- If revert_to is **RevertToPointerRoot** or **RevertToNone**, the focus reverts to **PointerRoot** or **None**, respectively. When the focus reverts, the X server generates **FocusIn** and **FocusOut** events, but the last-focus-change time is not affected.

XSetInputFocus can generate **BadMatch**, **BadValue**, and **BadWindow** errors.

To obtain the current input focus, use **XGetInputFocus**.

XGetInputFocus(*display*, *focus_return*, *revert_to_return*)
  Display **display*;
  Window **focus_return*;
  int **revert_to_return*;

display	Specifies the connection to the X server.
focus_return	Returns the focus window, **PointerRoot**, or **None**.
revert_to_return	Returns the current focus state (**RevertToParent**, **RevertToPointerRoot**, or **RevertToNone**).

The **XGetInputFocus** function returns the focus window and the current focus state.

12.6. Keyboard and Pointer Settings

Xlib provides functions that you can use to change the keyboard control, obtain a list of the auto-repeat keys, turn keyboard auto-repeat on or off, ring the bell, set or obtain the pointer button or keyboard mapping, and obtain a bit vector for the keyboard.

This section discusses the user-preference options of bell, key click, pointer behavior, and so on. The default values for many of these options are server dependent. Not all implementations will actually be able to control all of these parameters.

The **XChangeKeyboardControl** function changes control of a keyboard and operates on a **XKeyboardControl** structure:

```
/* Mask bits for ChangeKeyboardControl */

#define     KBKeyClickPercent                    (1L<<0)
#define     KBBellPercent                        (1L<<1)
#define     KBBellPitch                          (1L<<2)
#define     KBBellDuration                       (1L<<3)
#define     KBLed                                (1L<<4)
#define     KBLedMode                            (1L<<5)
#define     KBKey                                (1L<<6)
#define     KBAutoRepeatMode                     (1L<<7)

/* Values */

typedef struct {
        int key_click_percent;
        int bell_percent;
        int bell_pitch;
        int bell_duration;
        int led;
        int led_mode;                  /* LedModeOn, LedModeOff */
        int key;
        int auto_repeat_mode;          /* AutoRepeatModeOff, AutoRepeatModeOn,
                                       AutoRepeatModeDefault */
} XKeyboardControl;
```

The key_click_percent member sets the volume for key clicks between 0 (off) and 100 (loud) inclusive, if possible. A setting of −1 restores the default. Other negative values generate a **BadValue** error.

The bell_percent sets the base volume for the bell between 0 (off) and 100 (loud) inclusive, if possible. A setting of −1 restores the default. Other negative values generate a **BadValue** error. The bell_pitch member sets the pitch (specified in Hz) of the bell, if possible. A setting of −1 restores the default. Other negative values generate a **BadValue** error. The bell_duration member sets the duration of the bell specified in milliseconds, if possible. A setting of −1 restores the default. Other negative values generate a **BadValue** error.

If both the led_mode and led members are specified, the state of that LED is changed, if possible. The led_mode member can be set to **LedModeOn** or **LedModeOff**. If only led_mode is specified, the state of all LEDs are changed, if possible. At most 32 LEDs numbered from one are supported. No standard interpretation of LEDs is defined. If led is specified without led_mode, a **BadMatch** error results.

If both the auto_repeat_mode and key members are specified, the auto_repeat_mode of that key is changed (according to **AutoRepeatModeOn**, **AutoRepeatModeOff**, or **AutoRepeatModeDefault**), if possible. If only auto_repeat_mode is specified, the global auto_repeat_mode for the entire keyboard is changed, if possible, and does not affect the per key settings. If a key is specified without an auto_repeat_mode, a **BadMatch** error results. Each key has an individual mode of whether or not it should auto-repeat and a default setting for the mode. In addition, there is a global mode of whether auto-repeat should be enabled or not and a default setting for that mode. When global mode is **AutoRepeatModeOn**, keys should obey their individual auto-repeat modes. When global mode is **AutoRepeatModeOff**, no keys should auto-repeat. An auto-repeating key generates alternating **KeyPress** and **KeyRelease** events. When a key is used as a modifier, it is desirable for the key not to auto-repeat, regardless of its auto-repeat setting.

A bell generator connected with the console but not directly on a keyboard is treated as if it were part of the keyboard. The order in which controls are verified and altered is server-dependent. If an error is generated, a subset of the controls may have been altered.

```
XChangeKeyboardControl(display, value_mask, values)
    Display *display;
    unsigned long value_mask;
    XKeyboardControl *values;
```

display	Specifies the connection to the X server.
value_mask	Specifies which controls to change. This mask is the bitwise inclusive OR of the valid control mask bits.
values	Specifies one value for each bit set to 1 in the mask.

The **XChangeKeyboardControl** function controls the keyboard characteristics defined by the **XKeyboardControl** structure. The value_mask argument specifies which values are to be changed.

XChangeKeyboardControl can generate **BadMatch** and **BadValue** errors.

To obtain the current control values for the keyboard, use **XGetKeyboardControl**.

```
XGetKeyboardControl(display, values_return)
    Display *display;
    XKeyboardState *values_return;
```

display	Specifies the connection to the X server.
values_return	Returns the current keyboard controls in the specified **XKeyboardState** structure.

The **XGetKeyboardControl** function returns the current control values for the keyboard to the **XKeyboardState** structure.

```
typedef struct {
        int key_click_percent;
        int bell_percent;
        unsigned int bell_pitch, bell_duration;
        unsigned long led_mask;
        int global_auto_repeat;
        char auto_repeats[32];
} XKeyboardState;
```

For the LEDs, the least-significant bit of led_mask corresponds to LED one, and each bit set to 1 in led_mask indicates an LED that is lit. The global_auto_repeat member can be set to

AutoRepeatModeOn or **AutoRepeatModeOff**. The auto_repeats member is a bit vector. Each bit set to 1 indicates that auto-repeat is enabled for the corresponding key. The vector is represented as 32 bytes. Byte N (from 0) contains the bits for keys 8N to 8N + 7 with the least-significant bit in the byte representing key 8N.

To turn on keyboard auto-repeat, use **XAutoRepeatOn**.

XAutoRepeatOn(*display*)
    Display **display*;

display	Specifies the connection to the X server.

The **XAutoRepeatOn** function turns on auto-repeat for the keyboard on the specified display.

To turn off keyboard auto-repeat, use **XAutoRepeatOff**.

XAutoRepeatOff(*display*)
    Display **display*;

display	Specifies the connection to the X server.

The **XAutoRepeatOff** function turns off auto-repeat for the keyboard on the specified display.

To ring the bell, use **XBell**.

XBell(*display*, *percent*)
    Display **display*;
    int *percent*;

display	Specifies the connection to the X server.
percent	Specifies the volume for the bell, which can range from −100 to 100 inclusive.

The **XBell** function rings the bell on the keyboard on the specified display, if possible. The specified volume is relative to the base volume for the keyboard. If the value for the percent argument is not in the range −100 to 100 inclusive, a **BadValue** error results. The volume at which the bell rings when the percent argument is nonnegative is:

    base − [(base * percent) / 100] + percent

The volume at which the bell rings when the percent argument is negative is:

    base + [(base * percent) / 100]

To change the base volume of the bell, use **XChangeKeyboardControl**.

XBell can generate a **BadValue** error.

To obtain a bit vector that describes the state of the keyboard, use **XQueryKeymap**.

XQueryKeymap(*display*, *keys_return*)
  Display **display*;
  char *keys_return*[32];

display	Specifies the connection to the X server.
keys_return	Returns an array of bytes that identifies which keys are pressed down. Each bit represents one key of the keyboard.

The **XQueryKeymap** function returns a bit vector for the logical state of the keyboard, where each bit set to 1 indicates that the corresponding key is currently pressed down. The vector is represented as 32 bytes. Byte N (from 0) contains the bits for keys 8N to 8N + 7 with the least-significant bit in the byte representing key 8N.

Note that the logical state of a device (as seen by client applications) may lag the physical state if device event processing is frozen.

To set the mapping of the pointer buttons, use **XSetPointerMapping**.

int XSetPointerMapping(*display*, *map*, *nmap*)
  Display **display*;
  unsigned char *map*[];
  int *nmap*;

display	Specifies the connection to the X server.
map	Specifies the mapping list.
nmap	Specifies the number of items in the mapping list.

The **XSetPointerMapping** function sets the mapping of the pointer. If it succeeds, the X server generates a **MappingNotify** event, and **XSetPointerMapping** returns **MappingSuccess**. Element map[i] defines the logical button number for the physical button i+1. The length of the list must be the same as **XGetPointerMapping** would return, or a **BadValue** error results. A zero element disables a button, and elements are not restricted in value by the number of physical buttons. However, no two elements can have the same nonzero value, or a **BadValue** error results. If any of the buttons to be altered are logically in the down state, **XSetPointerMapping** returns **MappingBusy**, and the mapping is not changed.

XSetPointerMapping can generate a **BadValue** error.

To get the pointer mapping, use **XGetPointerMapping**.

```
int XGetPointerMapping(display, map_return, nmap)
      Display *display;
      unsigned char map_return[];
      int nmap;
```

display	Specifies the connection to the X server.
map_return	Returns the mapping list.
nmap	Specifies the number of items in the mapping list.

The **XGetPointerMapping** function returns the current mapping of the pointer. Pointer buttons are numbered starting from one. **XGetPointerMapping** returns the number of physical buttons actually on the pointer. The nominal mapping for a pointer is map[i]=i+1. The nmap argument specifies the length of the array where the pointer mapping is returned, and only the first nmap elements are returned in map_return.

To control the pointer's interactive feel, use **XChangePointerControl**.

```
XChangePointerControl(display, do_accel, do_threshold, accel_numerator,
                      accel_denominator, threshold)
      Display *display;
      Bool do_accel, do_threshold;
      int accel_numerator, accel_denominator;
      int threshold;
```

display	Specifies the connection to the X server.
do_accel	Specifies a Boolean value that controls whether the values for the accel_numerator or accel_denominator are used.
do_threshold	Specifies a Boolean value that controls whether the value for the threshold is used.
accel_numerator	Specifies the numerator for the acceleration multiplier.
accel_denominator	Specifies the denominator for the acceleration multiplier.
threshold	Specifies the acceleration threshold.

The **XChangePointerControl** function defines how the pointing device moves. The acceleration, expressed as a fraction, is a multiplier for movement. For example, specifying 3/1 means the pointer moves three times as fast as normal. The fraction may be rounded arbitrarily by the X server. Acceleration only takes effect if the pointer moves more than threshold pixels at once and only applies to the amount beyond the value in the threshold argument. Setting a value to −1 restores the default. The values of the do_accel and do_threshold arguments must be **True** for the pointer values to be set, or the parameters are unchanged. Negative values (other than −1) generate a **BadValue** error, as does a zero value for the accel_denominator argument.

XChangePointerControl can generate a **BadValue** error.

To get the current pointer parameters, use **XGetPointerControl**.

XGetPointerControl(*display*, *accel_numerator_return*, *accel_denominator_return*,
        threshold_return)
    Display **display*;
    int **accel_numerator_return*, **accel_denominator_return*;
    int **threshold_return*;

display Specifies the connection to the X server.

accel_numerator_return
Returns the numerator for the acceleration multiplier.

accel_denominator_return
Returns the denominator for the acceleration multiplier.

threshold_return
Returns the acceleration threshold.

The **XGetPointerControl** function returns the pointer's current acceleration multiplier and acceleration threshold.

12.7. Keyboard Encoding

A KeyCode represents a physical (or logical) key. KeyCodes lie in the inclusive range [8,255]. A KeyCode value carries no intrinsic information, although server implementors may attempt to encode geometry (for example, matrix) information in some fashion so that it can be interpreted in a server-dependent fashion. The mapping between keys and KeyCodes cannot be changed.

A KeySym is an encoding of a symbol on the cap of a key. The set of defined KeySyms includes the ISO Latin character sets (1−4), Katakana, Arabic, Cyrillic, Greek, Technical, Special, Publishing, APL, Hebrew, Thai, Korean and a miscellany of keys found on keyboards (Return, Help, Tab, and so on). To the extent possible, these sets are derived from international standards. In areas where no standards exist, some of these sets are derived from Digital Equipment Corporation standards. The list of defined symbols can be found in **<X11/keysymdef.h>**. Unfortunately, some C preprocessors have limits on the number of defined symbols. If you must use KeySyms not in the Latin 1−4, Greek, and miscellaneous classes, you may have to define a symbol for those sets. Most applications usually only include **<X11/keysym.h>**, which defines symbols for ISO Latin 1−4, Greek, and miscellaneous.

A list of KeySyms is associated with each KeyCode. The list is intended to convey the set of symbols on the corresponding key. If the list (ignoring trailing **NoSymbol** entries) is a single KeySym "*K*", then the list is treated as if it were the list "*K* NoSymbol *K* NoSymbol". If the list (ignoring trailing **NoSymbol** entries) is a pair of KeySyms "*K1 K2*", then the list is treated as if it were the list "*K1 K2 K1 K2*". If the list (ignoring trailing **NoSymbol** entries) is a triple of KeySyms "*K1 K2 K3*", then the list is treated as if it were the list "*K1 K2 K3* NoSymbol". When an explicit "void" element is desired in the list, the value **VoidSymbol** can be used.

The first four elements of the list are split into two groups of KeySyms. Group 1 contains the first and second KeySyms; Group 2 contains the third and fourth KeySyms. Within each group, if the second element of the group is **NoSymbol**, then the group should be treated as if the second element were the same as the first element, except when the first element is an alphabetic KeySym "*K*" for which both lowercase and uppercase forms are defined. In that case, the group should be treated as if the first element were the lowercase form of "*K*" and the second element were the uppercase form of "*K*."

The standard rules for obtaining a KeySym from a **KeyPress** event make use of only the Group 1 and Group 2 KeySyms; no interpretation of other KeySyms in the list is given. Which group to use is determined by the modifier state. Switching between groups is controlled by the KeySym named MODE SWITCH, by attaching that KeySym to some KeyCode and attaching that KeyCode to any one of the modifiers **Mod1** through **Mod5**. This modifier is called the *group modifier*. For any KeyCode, Group 1 is used when the group modifier is off, and Group 2 is used when the group modifier is on.

The **Lock** modifier is interpreted as CapsLock when the KeySym named XK_Caps_Lock is attached to some KeyCode and that KeyCode is attached to the **Lock** modifier. The **Lock** modifier is interpreted as ShiftLock when the KeySym named XK_Shift_Lock is attached to some KeyCode and that KeyCode is attached to the **Lock** modifier. If the **Lock** modifier could be interpreted as both CapsLock and ShiftLock, the CapsLock interpretation is used.

The operation of keypad keys is controlled by the KeySym named XK_Num_Lock, by attaching that KeySym to some KeyCode and attaching that KeyCode to any one of the modifiers **Mod1** through **Mod5**. This modifier is called the *numlock modifier*. The standard KeySyms with the prefix ‘‘XK_KP_’’ in their name are called keypad KeySyms; these are KeySyms with numeric value in the hexadecimal range 0xFF80 to 0xFFBD inclusive. In addition, vendor-specific KeySyms in the hexadecimal range 0x11000000 to 0x1100FFFF are also keypad KeySyms.

Within a group, the choice of KeySym is determined by applying the first rule that is satisfied from the following list:

- The numlock modifier is on and the second KeySym is a keypad KeySym. In this case, if the **Shift** modifier is on, or if the **Lock** modifier is on and is interpreted as ShiftLock, then the first KeySym is used, otherwise the second KeySym is used.
- The **Shift** and **Lock** modifiers are both off. In this case, the first KeySym is used.
- The **Shift** modifier is off, and the **Lock** modifier is on and is interpreted as CapsLock. In this case, the first KeySym is used, but if that KeySym is lowercase alphabetic, then the corresponding uppercase KeySym is used instead.
- The **Shift** modifier is on, and the **Lock** modifier is on and is interpreted as CapsLock. In this case, the second KeySym is used, but if that KeySym is lowercase alphabetic, then the corresponding uppercase KeySym is used instead.
- The **Shift** modifier is on, or the **Lock** modifier is on and is interpreted as ShiftLock, or both. In this case, the second KeySym is used.

No spatial geometry of the symbols on the key is defined by their order in the KeySym list, although a geometry might be defined on a server-specific basis. The X server does not use the mapping between KeyCodes and KeySyms. Rather, it merely stores it for reading and writing by clients.

To obtain the legal KeyCodes for a display, use **XDisplayKeycodes**.

```
XDisplayKeycodes(display, min_keycodes_return, max_keycodes_return)
      Display *display;
      int *min_keycodes_return, *max_keycodes_return;
```

display	Specifies the connection to the X server.
min_keycodes_return	Returns the minimum number of KeyCodes.
max_keycodes_return	Returns the maximum number of KeyCodes.

The **XDisplayKeycodes** function returns the min-keycodes and max-keycodes supported by the specified display. The minimum number of KeyCodes returned is never less than 8, and the maximum number of KeyCodes returned is never greater than 255. Not all KeyCodes in this range are required to have corresponding keys.

To obtain the symbols for the specified KeyCodes, use **XGetKeyboardMapping**.

```
KeySym *XGetKeyboardMapping(display, first_keycode, keycode_count,
                    keysyms_per_keycode_return)
    Display *display;
    KeyCode first_keycode;
    int keycode_count;
    int *keysyms_per_keycode_return;
```

display	Specifies the connection to the X server.
first_keycode	Specifies the first KeyCode that is to be returned.
keycode_count	Specifies the number of KeyCodes that are to be returned.
keysyms_per_keycode_return	Returns the number of KeySyms per KeyCode.

The **XGetKeyboardMapping** function returns the symbols for the specified number of KeyCodes starting with first_keycode. The value specified in first_keycode must be greater than or equal to min_keycode as returned by **XDisplayKeycodes**, or a **BadValue** error results. In addition, the following expression must be less than or equal to max_keycode as returned by **XDisplayKeycodes**:

first_keycode + keycode_count − 1

If this is not the case, a **BadValue** error results. The number of elements in the KeySyms list is:

keycode_count * keysyms_per_keycode_return

KeySym number N, counting from zero, for KeyCode K has the following index in the list, counting from zero:

(K − first_code) * keysyms_per_code_return + N

The X server arbitrarily chooses the keysyms_per_keycode_return value to be large enough to report all requested symbols. A special KeySym value of **NoSymbol** is used to fill in unused elements for individual KeyCodes. To free the storage returned by **XGetKeyboardMapping**, use

XFree.

XGetKeyboardMapping can generate a **BadValue** error.

To change the keyboard mapping, use **XChangeKeyboardMapping**.

```
XChangeKeyboardMapping(display, first_keycode, keysyms_per_keycode, keysyms, num_codes)
      Display *display;
      int first_keycode;
      int keysyms_per_keycode;
      KeySym *keysyms;
      int num_codes;
```

display	Specifies the connection to the X server.
first_keycode	Specifies the first KeyCode that is to be changed.
keysyms_per_keycode	Specifies the number of KeySyms per KeyCode.
keysyms	Specifies an array of KeySyms.
num_codes	Specifies the number of KeyCodes that are to be changed.

The **XChangeKeyboardMapping** function defines the symbols for the specified number of KeyCodes starting with first_keycode. The symbols for KeyCodes outside this range remain unchanged. The number of elements in keysyms must be:

num_codes * keysyms_per_keycode

The specified first_keycode must be greater than or equal to min_keycode returned by **XDisplayKeycodes**, or a **BadValue** error results. In addition, the following expression must be less than or equal to max_keycode as returned by **XDisplayKeycodes**, or a **BadValue** error results:

first_keycode + num_codes − 1

KeySym number N, counting from zero, for KeyCode K has the following index in keysyms, counting from zero:

(K − first_keycode) * keysyms_per_keycode + N

The specified keysyms_per_keycode can be chosen arbitrarily by the client to be large enough to hold all desired symbols. A special KeySym value of **NoSymbol** should be used to fill in unused elements for individual KeyCodes. It is legal for **NoSymbol** to appear in nontrailing positions of the effective list for a KeyCode. **XChangeKeyboardMapping** generates a **MappingNotify** event.

There is no requirement that the X server interpret this mapping. It is merely stored for reading and writing by clients.

XChangeKeyboardMapping can generate **BadAlloc** and **BadValue** errors.

The next six functions make use of the **XModifierKeymap** data structure, which contains:

```
typedef struct {
        int max_keypermod;              /* This server's max number of keys per modifier */
        KeyCode *modifiermap;           /* An 8 by max_keypermod array of the modifiers */
} XModifierKeymap;
```

To create an **XModifierKeymap** structure, use **XNewModifiermap**.

```
XModifierKeymap *XNewModifiermap(max_keys_per_mod)
      int max_keys_per_mod;
```

max_keys_per_mod
Specifies the number of KeyCode entries preallocated to the modifiers in the map.

The **XNewModifiermap** function returns a pointer to **XModifierKeymap** structure for later use.

To add a new entry to an **XModifierKeymap** structure, use **XInsertModifiermapEntry**.

```
XModifierKeymap *XInsertModifiermapEntry(modmap, keycode_entry, modifier)
    XModifierKeymap *modmap;
    KeyCode keycode_entry;
    int modifier;
```

modmap	Specifies the **XModifierKeymap** structure.
keycode_entry	Specifies the KeyCode.
modifier	Specifies the modifier.

The **XInsertModifiermapEntry** function adds the specified KeyCode to the set that controls the specified modifier and returns the resulting **XModifierKeymap** structure (expanded as needed).

To delete an entry from an **XModifierKeymap** structure, use **XDeleteModifiermapEntry**.

```
XModifierKeymap *XDeleteModifiermapEntry(modmap, keycode_entry, modifier)
    XModifierKeymap *modmap;
    KeyCode keycode_entry;
    int modifier;
```

modmap	Specifies the **XModifierKeymap** structure.
keycode_entry	Specifies the KeyCode.
modifier	Specifies the modifier.

The **XDeleteModifiermapEntry** function deletes the specified KeyCode from the set that controls the specified modifier and returns a pointer to the resulting **XModifierKeymap** structure.

To destroy an **XModifierKeymap** structure, use **XFreeModifiermap**.

XFreeModifiermap(*modmap*)
    XModifierKeymap **modmap*;

modmap Specifies the **XModifierKeymap** structure.

The **XFreeModifiermap** function frees the specified **XModifierKeymap** structure.

To set the KeyCodes to be used as modifiers, use **XSetModifierMapping**.

int XSetModifierMapping(*display*, *modmap*)
    Display **display*;
    XModifierKeymap **modmap*;

display Specifies the connection to the X server.

modmap Specifies the **XModifierKeymap** structure.

The **XSetModifierMapping** function specifies the KeyCodes of the keys (if any) that are to be used as modifiers. If it succeeds, the X server generates a **MappingNotify** event, and **XSetModifierMapping** returns **MappingSuccess**. X permits at most eight modifier keys. If more than eight are specified in the **XModifierKeymap** structure, a **BadLength** error results.

The modifiermap member of the **XModifierKeymap** structure contains eight sets of max_keypermod KeyCodes, one for each modifier in the order **Shift**, **Lock**, **Control**, **Mod1**, **Mod2**, **Mod3**, **Mod4**, and **Mod5**. Only nonzero KeyCodes have meaning in each set, and zero KeyCodes are ignored. In addition, all of the nonzero KeyCodes must be in the range specified by min_keycode and max_keycode in the **Display** structure, or a **BadValue** error results.

An X server can impose restrictions on how modifiers can be changed, for example, if certain keys do not generate up transitions in hardware, if auto-repeat cannot be disabled on certain keys, or if multiple modifier keys are not supported. If some such restriction is violated, the status reply is **MappingFailed**, and none of the modifiers are changed. If the new KeyCodes specified for a modifier differ from those currently defined and any (current or new) keys for that modifier are in the logically down state, **XSetModifierMapping** returns **MappingBusy**, and none of the modifiers is changed.

XSetModifierMapping can generate **BadAlloc** and **BadValue** errors.

To obtain the KeyCodes used as modifiers, use **XGetModifierMapping**.

XModifierKeymap *XGetModifierMapping(*display*)
    Display **display*;

display Specifies the connection to the X server.

The **XGetModifierMapping** function returns a pointer to a newly created **XModifierKeymap** structure that contains the keys being used as modifiers. The structure should be freed after use by calling **XFreeModifiermap**. If only zero values appear in the set for any modifier, that modifier is disabled.

Chapter 13

Locales and Internationalized Text Functions

An internationalized application is one that is adaptable to the requirements of different native languages, local customs, and character string encodings. The process of adapting the operation to a particular native language, local custom, or string encoding is called localization. A goal of internationalization is to permit localization without program source modifications or recompilation.

As one of the localization mechanisms, Xlib provides an X Input Method (**XIM**) functional interface for internationalized text input, and an X Output Method (**XOM**) functional interface internationalized text output.

Internationalization in X is based on the concept of a *locale*. A locale defines the localized behavior of a program at run time. Locales affect Xlib in its:

- Encoding and processing of input method text
- Encoding of resource files and values
- Encoding and imaging of text strings
- Encoding and decoding for inter-client text communication

Characters from various languages are represented in a computer using an encoding. Different languages have different encodings, and there are even different encodings for the same characters in the same language.

This chapter defines support for localized text imaging and text input and describes the locale mechanism that controls all locale-dependent Xlib functions. Sets of functions are provided for multibyte (char *) text as well as wide character (wchar_t) text in the form supported by the host C language environment. The multibyte and wide character functions are equivalent except for the form of the text argument.

The Xlib internationalization functions are not meant to provide support for multilingual applications (mixing multiple languages within a single piece of text), but they make it possible to implement applications that work in limited fashion with more than one language in independent contexts.

13.1. X Locale Management

X supports one or more of the locales defined by the host environment. On implementations that conform to the ANSI C library, the locale announcement method is **setlocale**. This function configures the locale operation of both the host C library and Xlib. The operation of Xlib is governed by the LC_CTYPE category; this is called the *current locale*. An implementation is permitted to provide implementation dependent mechanisms for announcing the locale in addition to **setlocale**.

On implementations that do not conform to the ANSI C library, the locale announcement method is Xlib implementation dependent.

The mechanism by which the semantic operation of Xlib is defined for a specific locale is implementation dependent.

X is not required to support all the locales supported by the host. To determine if the current locale is supported by X, use **XSupportsLocale**.

```
Bool XSupportsLocale( )
```

The **XSupportsLocale** function returns **True** if Xlib functions are capable of operating under the current locale. If it returns **False**, Xlib locale-dependent functions for which the **XLocaleNotSupported** return status is defined will return **XLocaleNotSupported**. Other Xlib locale-dependent routines will operate in the ''C'' locale.

The client is responsible for selecting its locale and X modifiers. Clients should provide a means for the user to override the clients' locale selection at client invocation. Most single-display X clients operate in a single locale for both X and the host processing environment. They will configure the locale by calling three functions: the host locale configuration function, **XSupportsLocale**, and **XSetLocaleModifiers**.

The semantics of certain categories of X internationalization capabilities can be configured by setting modifiers. Modifiers are named by implementation dependent and locale-specific strings. The only standard use for this capability at present is selecting one of several styles of keyboard input method.

To configure Xlib locale modifiers for the current locale, use **XSetLocaleModifiers**.

```
char *XSetLocaleModifiers(modifier_list)
    char *modifier_list;
```

modifier_list Specifies the modifiers.

The **XSetLocaleModifiers** function sets the X modifiers for the current locale setting. The modifier_list argument is a null-terminated string of the form ''{@*category*=*value*}'', that is, having zero or more concatenated ''@*category*=*value*'' entries where *category* is a category name and *value* is the (possibly empty) setting for that category. The values are encoded in the current locale. Category names are restricted to the POSIX Portable Filename Character Set.

The local host X locale modifiers announcer (on POSIX-compliant systems, the XMODIFIERS environment variable) is appended to the modifier_list to provide default values on the local host. If a given category appears more than once in the list, the first setting in the list is used. If a given category is not included in the full modifier list, the category is set to an implementation dependent default for the current locale. An empty value for a category explicitly specifies the implementation dependent default.

If the function is successful, it returns a pointer to a string. The contents of the string are such that a subsequent call with that string (in the same locale) will restore the modifiers to the same settings. If modifier_list is a NULL pointer, **XSetLocaleModifiers** also returns a pointer to such a string, and the current locale modifiers are not changed.

If invalid values are given for one or more modifier categories supported by the locale, a NULL pointer is returned, and none of the current modifiers are changed.

At program startup, the modifiers that are in effect are unspecified until the first successful call to set them. Whenever the locale is changed, the modifiers that are in effect become unspecified until the next successful call to set them. Clients should always call **XSetLocaleModifiers** with a non-NULL modifier_list after setting the locale before they call any locale-dependent Xlib routine.

The only standard modifier category currently defined is ‘‘im’’, which identifies the desired input method. The values for input method are not standardized. A single locale may use multiple input methods, switching input method under user control. The modifier may specify the initial input method in effect or an ordered list of input methods. Multiple input methods may be specified in a single im value string in an implementation dependent manner.

The returned modifiers string is owned by Xlib and should not be modified or freed by the client. It may be freed by Xlib after the current locale or modifiers are changed. Until freed, it will not be modified by Xlib.

The recommended procedure for clients initializing their locale and modifiers is to obtain locale and modifier announcers separately from one of the following prioritized sources:

- A command line option
- A resource
- The empty string ("")

The first of these that is defined should be used. Note that when a locale command line option or locale resource is defined, the effect should be to set all categories to the specified locale, overriding any category-specific settings in the local host environment.

13.2. Locale and Modifier Dependencies

The internationalized Xlib functions operate in the current locale configured by the host environment and X locale modifiers set by **XSetLocaleModifiers**, or in the locale and modifiers configured at the time some object supplied to the function was created. For each locale-dependent function, the following table describes the locale (and modifiers) dependency:

Locale from	**Affects the Function**	**In**
	Locale Query/Configuration:	
setlocale	**XSupportsLocale**	Locale queried
	XSetLocaleModifiers	Locale modified
	Resources:	
setlocale	**XrmGetFileDatabase**	Locale of **XrmDatabase**
	XrmGetStringDatabase	
XrmDatabase	**XrmPutFileDatabase**	Locale of **XrmDatabase**
	XrmLocaleOfDatabase	
	Setting Standard Properties:	
setlocale	**XmbSetWMProperties**	Encoding of supplied/returned text (some WM_ property text in environment locale)
setlocale	**XmbTextPropertyToTextList**	Encoding of supplied/returned text
	XwcTextPropertyToTextList	
	XmbTextListToTextProperty	
	XwcTextListToTextProperty	

Locale from	Affects the Function	In
	Text Input:	
setlocale	**XOpenIM**	XIM input method selection
	XRegisterIMInstantiateCallback	XIM selection
	XUnregisterIMInstantiateCallback	XIM selection
XIM	**XCreateIC**	XIC input method configuration
	XLocaleOfIM, and so on	Queried locale
XIC	**XmbLookupString**	Keyboard layout
	XwcLookupString	Encoding of returned text
	Text Drawing:	
setlocale	**XOpenOM**	XOM output method selection
	XCreateFontSet	Charsets of fonts in **XFontSet**
XOM	**XCreateOC**	XOC output method configuration
	XLocaleOfOM, and so on	Queried locale
XFontSet	**XmbDrawText**,	Locale of supplied text
	XwcDrawText, and so on	Locale of supplied text
	XExtentsOfFontSet, and so on **XmbTextExtents**, **XwcTextExtents**, and so on	Locale-dependent metrics
	Xlib Errors:	
setlocale	**XGetErrorDatabaseText** **XGetErrorText**	Locale of error message

Clients may assume that a locale-encoded text string returned by an X function can be passed to a C library routine, or vice-versa, if the locale is the same at the two calls.

All text strings processed by internationalized Xlib functions are assumed to begin in the initial state of the encoding of the locale, if the encoding is state-dependent.

All Xlib functions behave as if they do not change the current locale or X modifier setting. (This means that if they do change locale or call **XSetLocaleModifiers** with a non-NULL argument, they must save and restore the current state on entry and exit.) Also, Xlib functions on implementations that conform to the ANSI C library do not alter the global state associated with the ANSI C functions **mblen**, **mbtowc**, **wctomb**, and **strtok**.

13.3. Variable Argument Lists

Various functions in this chapter have arguments that conform to the ANSI C variable argument list calling convention. Each function denoted with an argument of the form “...” takes a variable length list of name and value pairs, where each name is a string and each value is of type **XPointer**. A name argument that is NULL identifies the end of the list.

A variable length argument list may contain a nested list. If the name **XVaNestedList** is specified in place of an argument name, then the following value is interpreted as a **XVaNestedList** value which specifies a list of values logically inserted into the original list at the point of declaration. A NULL identifies the end of a nested list.

To allocate a nested variable argument list dynamically, use **XVaCreateNestedList**.

```
typedef void * XVaNestedList;

XVaNestedList XVaCreateNestedList(dummy, ...)
      int dummy;
```

dummy	Specifies an unused argument (required by ANSI C).
...	Specifies the variable length argument list.

The **XVaCreateNestedList** function allocates memory and copies its arguments into a single list pointer, which may be used as a value for arguments requiring a list value. Any entries are copied as specified. Data passed by reference is not copied; the caller must ensure data remains valid for the lifetime of the nested list. The list should be freed using **XFree** when it is no longer needed.

13.4. Output Method Overview

Locale-dependent text may include one or more text components, each of which may require different fonts and character set encodings. In some languages, each component might have a different drawing direction, and some components might contain context-dependent characters that change shape based on relationships with neighboring characters.

When drawing such locale-dependent text, some locale-specific knowledge is required; for example, what fonts are required to draw the text, how the text can be separated into components, and which fonts are selected to draw each component. Further, when bi-directional text must be drawn, the internal representation order of the text must be changed into the visual representation order to be drawn.

An X Output Method provides a functional interface so that clients do not have to deal directly with such locale-dependent details. Output methods provide the following capabilities:

- Creating a set of fonts required to draw locale-dependent text.
- Drawing locale-dependent text with a font set without the caller needing to be aware of locale dependencies.
- Obtaining the escapement and extents in pixels of locale-dependent text.
- Determining if bi-directional or context-dependent drawing is required in a specific locale with a specific font set.

Two different abstractions are used in the representation of the output method for clients.

The abstraction used to communicate with an output method is an opaque data structure represented by the **XOM** data type. The abstraction for representing state of a particular output thread is called an *output context*. The Xlib representation of an output context is an **XOC**, which is compatible with **XFontSet** in terms of its functional interface, but is a broader, more generalized abstraction.

13.5. Output Method Functions

To open an output method, use **XOpenOM**.

```
XOM XOpenOM(display, db, res_name, res_class)
    Display *display;
    XrmDatabase db;
    char *res_name;
    char *res_class;
```

display	Specifies the connection to the X server.
db	Specifies a pointer to the resource database.
res_name	Specifies the full resource name of the application.
res_class	Specifies the full class name of the application.

The **XOpenOM** function opens an output method matching the current locale and modifiers specification. The current locale and modifiers are bound to the output method when **XOpenOM** is called. The locale associated with an output method cannot be changed.

The specific output method to which this call will be routed is identified on the basis of the current locale and modifiers. **XOpenOM** will identify a default output method corresponding to the current locale. That default can be modified using **XSetLocaleModifiers** to set the output method modifier.

The db argument is the resource database to be used by the output method for looking up resources that are private to the output method. It is not intended that this database be used to look up values that can be set as OC values in an output context. If db is NULL, no database is passed to the output method.

The res_name and res_class arguments specify the resource name and class of the application. They are intended to be used as prefixes by the output method when looking up resources that are common to all output contexts that may be created for this output method. The characters used for resource names and classes must be in the X Portable Character Set. The resources looked up are not fully specified if res_name or res_class is NULL.

The res_name and res_class arguments are not assumed to exist beyond the call to **XOpenOM**. The specified resource database is assumed to exist for the lifetime of the output method.

XOpenOM returns NULL if no output method could be opened.

To close an output method, use **XCloseOM**.

```
Status XCloseOM(om)
    XOM om;
```

om	Specifies the output method.

The **XCloseOM** function closes the specified output method.

To set output method attributes, use **XSetOMValues**.

char * XSetOMValues(*om*, ...)
    XOM *om*;

om	Specifies the output method.
...	Specifies the variable length argument list to set XOM values.

The **XSetOMValues** function presents a variable argument list programming interface for setting properties or features of the specified output method. This function returns NULL if it succeeds; otherwise, it returns the name of the first argument that could not be obtained.

No standard arguments are currently defined by Xlib.

To query an output method, use **XGetOMValues**.

char * XGetOMValues(*om*, ...)
    XOM *om*;

om	Specifies the output method.
...	Specifies the variable length argument list to get XOM values.

The **XGetOMValues** function presents a variable argument list programming interface for querying properties or features of the specified output method. This function returns NULL if it succeeds; otherwise, it returns the name of the first argument that could not be obtained.

To obtain the display associated with an output method, use **XDisplayOfOM**.

Display * XDisplayOfOM(*om*)
        XOM *om*;

om	Specifies the output method.

The **XDisplayOfOM** function returns the display associated with the specified output method.

To get the locale associated with an output method, use **XLocaleOfOM**.

char * XLocaleOfOM(*om*)
    XOM *om*;

om	Specifies the output method.

The **XLocaleOfOM** returns the locale associated with the specified output method.

13.6. XOM Value Arguments

The following table describes how XOM values are interpreted by an output method.

The first column lists the XOM values. The second column indicates how each of the XOM values are treated by a particular output style.

The following keys apply to this table.

Keys	**Explanation**
G	This value may be read using **XGetOMValues**.

XOM Value	
XNRequiredCharSet	G
XNQueryOrientation	G
XNDirectionalDependentDrawing	G
XNContextualDrawing	G

13.6.1. Required Char Set

The **XNRequiredCharSet** argument returns the list of charsets that are required for loading the fonts needed for the locale. The value of the argument is a pointer to a structure of type **XOMCharSetList**.

The **XOMCharSetList** structure is defined as follows.

```
typedef struct {
        int charset_count;
        char **charset_list;
} XOMCharSetList;
```

The charset_list member is a list of one or more null-terminated charset names, and the charset_count member is the number of charset names.

The required charset list is owned by Xlib and should not be modified or freed by the client. It will be freed by a call to **XCloseOM** with the associated **XOM**. Until freed, its contents will not be modified by Xlib.

13.6.2. Query Orientation

The **XNQueryOrientation** argument returns the global orientation of text when drawn. Other than **XOMOrientation_LTR_TTB**, the set of orientations supported is locale-dependent. The value of the argument is a pointer to a structure of type **XOMOrientation**. Clients are responsible for freeing the **XOMOrientation** structure by using **XFree**.

```
typedef struct {
        int num_orientation;
        XOrientation *orientation;      /* Input Text description */
} XOMOrientation;

typedef enum {
        XOMOrientation_LTR_TTB,
        XOMOrientation_RTL_TTB,
        XOMOrientation_TTB_LTR,
        XOMOrientation_TTB_RTL,
        XOMOrientation_Context
} XOrientation;
```

The possible value for XOrientation may be:

- **XOMOrientation_LTR_TTB** left-to-right, top-to-bottom global orientation
- **XOMOrientation_RTL_TTB** right-to-left, top-to-bottom global orientation
- **XOMOrientation_TTB_LTR** top-to-bottom, left-to-right global orientation
- **XOMOrientation_TTB_RTL** top-to-bottom, right-to-left global orientation
- **XOMOrientation_Context** contextual global orientation

13.6.3. Directional Dependent Drawing

The **XNDirectionalDependentDrawing** argument indicates whether the text rendering functions implement implicit handling of directional text. If this value is **True**, the output method has knowledge of directional dependencies and reorders text as necessary when rendering text. If this value is **False**, the output method does not implement any directional text handling and all character directions are assumed to be left-to-right.

Regardless of the rendering order of characters, the origins of all characters are on the primary draw direction side of the drawing origin.

This OM value presents functionality identical to the **XDirectionalDependentDrawing** function.

13.6.4. Context Dependent Drawing

The **XNContextualDrawing** argument indicates whether the text rendering functions implement implicit context-dependent drawing. If this value is **True**, the output method has knowledge of context dependencies and performs character shape editing, combining glyphs to present a single character as necessary. The actual shape editing is dependent on the locale implementation and the font set used.

This OM value presents functionality identical to the **XContextualDrawing** function.

13.7. Output Context Functions

An output context is an abstraction that contains both the data required by an output method and the information required to display that data. There can be multiple output contexts for one output method. The programming interfaces for creating, reading, or modifying an output context use a variable argument list. The name elements of the argument lists are referred to as XOC values. It is intended that output methods be controlled by these XOC values. As new XOC values are created, they should be registered with the X Consortium. An **XOC** can be used anywhere an

XFontSet can be used, and vise versa; **XFontSet** is retained for compatibility with previous releases. The concepts of output methods and output contexts include broader, more generalized abstraction than font set, supporting complex and more intelligent text display, and dealing not only with multiple fonts but also with context dependencies. However, **XFontSet** is widely used in several interfaces, so **XOC** is defined as an upward compatible type of **XFontSet**.

To create an output context, use **XCreateOC**.

XOC XCreateOC(*om*, ...)
    XOM *om*;

om	Specifies the output method.
...	Specifies the variable length argument list to set XOC values.

The **XCreateOC** function creates an output context within the specified output method.

The base font names argument is mandatory at creation time, and the output context will not be created unless it is provided. All other output context values can be set later.

XCreateOC returns NULL if no output context could be created. NULL can be returned for any of the following reasons:

- A required argument was not set.
- A read-only argument was set.
- An argument name is not recognized.
- The output method encountered an output method implementation-dependent error.

XCreateOC can generate a **BadAtom** error.

To destroy an output context, use **XDestroyOC**.

void XDestroyOC(*oc*)
    XOC *oc*;

oc	Specifies the output context.

The **XDestroyOC** function destroys the specified output context.

To get the output method associated with an output context, use **XOMOfOC**.

XOM XOMOfOC(*oc*)
    XOC *oc*;

oc	Specifies the output context.

The **XOMOfOC** function returns the output method associated with the specified output context.

Xlib provides two functions for setting and reading output context values, respectively, **XSetOCValues** and **XGetOCValues**. Both functions have a variable length argument list. In that argument list, any XOC value's name must be denoted with a character string using the X Portable

Character Set.

To set XOC values, use **XSetOCValues**.

char * XSetOCValues(*oc*, ...)
XOC *oc*;

oc	Specifies the output context.
...	Specifies the variable length argument list to set XOC values.

The **XSetOCValues** function returns NULL if no error occurred; otherwise, it returns the name of the first argument that could not be set. An argument might not be set for any of the following reasons:

- The argument is read-only.
- The argument name is not recognized.
- An implementation-dependent error occurs.

Each value to be set must be an appropriate datum, matching the data type imposed by the semantics of the argument.

XSetOCValues can generate **BadAtom** error.

To obtain XOC values, use **XGetOCValues**.

char * XGetOCValues(*oc*, ...)
XOC *oc*;

oc	Specifies the output context.
...	Specifies the variable length argument list to get XOC values.

The **XGetOCValues** function returns NULL if no error occurred; otherwise, it returns the name of the first argument that could not be obtained. An argument might not be obtained for any of the following reasons:

- The argument name is not recognized.
- An implementation-dependent error occurs.

Each argument value following a name must point to a location where the value is to be stored.

13.8. XOC Value Arguments

The following table describes how XOC values are interpreted by an output method.

The first column lists the XOC values. The second column indicates the alternative interfaces that function identically and are provided for compatibility with previous releases. The third column indicates how each of the XOC values are treated.

The following keys apply to this table.

Keys	**Explanation**
C	This value must be set with **XCreateOC**.

Keys	**Explanation**
D	This value may be set using **XCreateOC**. If it is not set, a default is provided.
G	This value may be read using **XGetOCValues**.
S	This value must be set using **XSetOCValues**.

XOC Value	**alternative interface**	
BaseFontName	XCreateFontSet	C-G
MissingCharSet	XCreateFontSet	G
DefaultString	XCreateFontSet	G
Orientation	-	D-S-G
ResourceName	-	S-G
ResourceClass	-	S-G
FontInfo	XFontsOfFontSet	G
OMAutomatic	-	G

13.8.1. Base Font Name

The **XNBaseFontName** argument is a list of base font names that Xlib uses to load the fonts needed for the locale. The base font names are a comma-separated list. The string is null-terminated, and is assumed to be in the Host Portable Character Encoding; otherwise, the result is implementation dependent. White space immediately on either side of a separating comma is ignored.

Use of XLFD font names permits Xlib to obtain the fonts needed for a variety of locales from a single locale-independent base font name. The single base font name should name a family of fonts whose members are encoded in the various charsets needed by the locales of interest.

An XLFD base font name can explicitly name a charset needed for the locale. This allows the user to specify an exact font for use with a charset required by a locale, fully controlling the font selection.

If a base font name is not an XLFD name, Xlib will attempt to obtain an XLFD name from the font properties for the font. If Xlib is successful, the **XGetOCValues** function will return this XLFD name instead of the client-supplied name.

This argument must be set at creation time and cannot be changed. If no fonts exist for any of the required charsets, or if the locale definition in Xlib requires that a font exist for a particular charset and a font is not found for that charset, **XCreateOC** returns NULL.

13.8.2. Missing CharSet

The **XNMissingCharSet** argument returns the list of required charsets that are missing from the font set. The value of argument is a pointer to a structure of type **XOMCharSetList**.

If fonts exist for all of the charsets required by the current locale, charset_list is set to NULL and charset_count is set to zero. If no fonts exist for one or more of the required charsets, charset_list is set to a list of one or more null-terminated charset names for which no fonts exist, and charset_count is set to the number of missing charsets. The charsets are from the list of the required charsets for the encoding of the locale, and do not include any charsets to which Xlib may be able to remap a required charset.

The missing charset list is owned by Xlib and should not be modified or freed by the client. It will be freed by a call to **XDestroyOC** with the associated **XOC**. Until freed, its contents will not be modified by Xlib.

13.8.3. Default String

When a drawing or measuring function is called with an **XOC** that has missing charsets, some characters in the locale will not be drawable. The **XNDefaultString** argument returns a pointer to a string that represents the glyphs that are drawn with this **XOC** when the charsets of the available fonts do not include all glyphs required to draw a character. The string does not necessarily consist of valid characters in the current locale and is not necessarily drawn with the fonts loaded for the font set, but the client can draw or measure the default glyphs by including this string in a string being drawn or measured with the **XOC**.

If **XNDefaultString** argument returned the empty string (""), no glyphs are drawn and the escapement is zero. The returned string is null-terminated. It is owned by Xlib and should not be modified or freed by the client. It will be freed by a call to **XDestroyOC** with the associated **XOC**. Until freed, its contents will not be modified by Xlib.

13.8.4. Orientation

The **XNOrientation** argument specifies the current orientation of text when drawn. The value of this argument is one of the values returned by the **XGetOMValues** function with the **XNQueryOrientation** argument specified in the **XOrientation** list. The value of the argument is of type **XOrientation**. When **XNOrientation** is queried, the value specifies the current orientation. When **XNOrientation** is set, a value is used to set the current orientation.

When **XOMOrientation_Context** is set, the text orientation of the the text is determined according to an implementation-defined method (for example, ISO 6429 control sequences) and the initial text orientation for locale dependent Xlib functions is assumed to be **XOMOrientation_LTR_TTB**.

The **XNOrientation** value does not change the prime drawing direction for Xlib drawing functions.

13.8.5. Resource Name and Class

The **XNResourceName** and **XNResourceClass** arguments are strings that specify the full name and class used by the client to obtain resources for the display of the output context. These values should be used as prefixes for name and class when looking up resources that may vary according to the output context. If these values are not set, the resources will not be fully specified.

It is not intended that values that can be set as XOM values be set as resources.

13.8.6. Font Info

The **XNFontInfo** argument specifies a list of one or more **XFontStruct** structures and font names for the fonts used for drawing by the given output context. The value of the argument is a pointer to a structure of type **XOMFontInfo**.

```
typedef struct {
        int num_font;
        XFontStruct **font_struct_list;
        char **font_name_list;
} XOMFontInfo;
```

A list of pointers to the **XFontStruct** structures is returned to font_struct_list. A list of pointers to null-terminated, fully-specified font name strings in the locale of the output context is returned to font_name_list. The font_name_list order corresponds to the font_struct_list order. The number of **XFontStruct** structures and font names is returned to num_font.

Because it is not guaranteed that a given character will be imaged using a single font glyph, there is no provision for mapping a character or default string to the font properties, font ID, or direction hint for the font for the character. The client may access the **XFontStruct** list to obtain these values for all the fonts currently in use.

Xlib does not guarantee that fonts are loaded from the server at the creation of an **XOC**. Xlib may choose to cache font data, loading it only as needed to draw text or compute text dimensions. Therefore, existence of the per_char metrics in the **XFontStruct** structures in the **XFontStructSet** is undefined. Also, note that all properties in the **XFontStruct** structures are in the STRING encoding.

The client must not free the **XOMFontInfo** struct itself; it will be freed when the **XOC** is closed.

13.8.7. OM Automatic

The **XNOMAutomatic** argument returns whether the associated output context was created by **XCreateFontSet** or not. Since the **XFreeFontSet** function not only frees the output context but also frees the implicit output method associated with it, **XFreeFontSet** should be used with any output context created by **XCreateFontSet**. However, it is possible that a client does not know how the output context was created. Before a client destroys the output context it can query whether **XNOMAutomatic** is set to determinte whether **XFreeFontSet** or **XDestroyOC** should be used to destroy the output context.

13.9. Creating and Freeing a Font Set

Xlib international text drawing is done using a set of one or more fonts, as needed for the locale of the text. Fonts are loaded according to a list of base font names supplied by the client and the charsets required by the locale. The **XFontSet** is an opaque type representing the state of a particular output thread and is equivalent to the type **XOC**.

The **XCreateFontSet** function is a convenience function for creating an output context using only default values. The returned **XFontSet** has an implicitly created **XOM**. This **XOM** has an OM value **XNOMAutomatic** automatically set to **True** so that the output context self indicates whether it was created by **XCreateOC** or **XCreateFontSet**.

```
XFontSet XCreateFontSet(display, base_font_name_list, missing_charset_list_return,
          missing_charset_count_return, def_string_return)
     Display *display;
     char *base_font_name_list;
     char ***missing_charset_list_return;
     int *missing_charset_count_return;
     char **def_string_return;
```

display	Specifies the connection to the X server.
base_font_name_list	Specifies the base font names.
missing_charset_list_return	Returns the missing charsets.
missing_charset_count_return	Returns the number of missing charsets.
def_string_return	Returns the string drawn for missing charsets.

The **XCreateFontSet** function creates a font set for the specified display. The font set is bound to the current locale when **XCreateFontSet** is called. The font set may be used in subsequent calls to obtain font and character information and to image text in the locale of the font set.

The base_font_name_list argument is a list of base font names that Xlib uses to load the fonts needed for the locale. The base font names are a comma-separated list. The string is null-terminated and is assumed to be in the Host Portable Character Encoding; otherwise, the result is implementation dependent. White space immediately on either side of a separating comma is ignored.

Use of XLFD font names permits Xlib to obtain the fonts needed for a variety of locales from a single locale-independent base font name. The single base font name should name a family of fonts whose members are encoded in the various charsets needed by the locales of interest.

An XLFD base font name can explicitly name a charset needed for the locale. This allows the user to specify an exact font for use with a charset required by a locale, fully controlling the font selection.

If a base font name is not an XLFD name, Xlib will attempt to obtain an XLFD name from the font properties for the font. If this action is successful in obtaining an XLFD name, the **XBaseFontNameListOfFontSet** function will return this XLFD name instead of the client-supplied name.

Xlib uses the following algorithm to select the fonts that will be used to display text with the **XFontSet**.

For each font charset required by the locale, the base font name list is searched for the first appearance of one of the following cases that names a set of fonts that exist at the server:

1. The first XLFD-conforming base font name that specifies the required charset or a superset of the required charset in its **CharSetRegistry** and **CharSetEncoding** fields. The implementation may use a base font name whose specified charset is a superset of the required charset, for example, an ISO8859-1 font for an ASCII charset.
2. The first set of one or more XLFD-conforming base font names that specify one or more charsets that can be remapped to support the required charset. The Xlib implementation may recognize various mappings from a required charset to one or more other charsets and

use the fonts for those charsets. For example, JIS Roman is ASCII with tilde and backslash replaced by yen and overbar; Xlib may load an ISO8859-1 font to support this character set if a JIS Roman font is not available.

3. The first XLFD-conforming font name or the first non-XLFD font name for which an XLFD font name can be obtained, combined with the required charset (replacing the **CharSetRegistry** and **CharSetEncoding** fields in the XLFD font name). As in case 1, the implementation may use a charset that is a superset of the required charset.
4. The first font name that can be mapped in some implementation dependent manner to one or more fonts that support imaging text in the charset.

For example, assume a locale required the charsets:

ISO8859-1
JISX0208.1983
JISX0201.1976
GB2312-1980.0

The user could supply a base_font_name_list that explicitly specifies the charsets, insuring that specific fonts get used if they exist. For example:

```
"-JIS-Fixed-Medium-R-Normal--26-180-100-100-C-240-JISX0208.1983-0,\
-JIS-Fixed-Medium-R-Normal--26-180-100-100-C-120-JISX0201.1976-0,\
-GB-Fixed-Medium-R-Normal--26-180-100-100-C-240-GB2312-1980.0,\
-Adobe-Courier-Bold-R-Normal--25-180-75-75-M-150-ISO8859-1"
```

Alternatively, the user could supply a base_font_name_list that omits the charsets, letting Xlib select font charsets required for the locale. For example:

```
"-JIS-Fixed-Medium-R-Normal--26-180-100-100-C-240,\
-JIS-Fixed-Medium-R-Normal--26-180-100-100-C-120,\
-GB-Fixed-Medium-R-Normal--26-180-100-100-C-240,\
-Adobe-Courier-Bold-R-Normal--25-180-100-100-M-150"
```

Alternatively, the user could simply supply a single base font name that allows Xlib to select from all available fonts that meet certain minimum XLFD property requirements. For example:

```
"-*-*-*-R-Normal--*-180-100-100-*-*"
```

If **XCreateFontSet** is unable to create the font set, either because there is insufficient memory or because the current locale is not supported, **XCreateFontSet** returns NULL, missing_charset_list_return is set to NULL, and missing_charset_count_return is set to zero. If fonts exist for all of the charsets required by the current locale, **XCreateFontSet** returns a valid **XFontSet**, missing_charset_list_return is set to NULL, and missing_charset_count_return is set to zero.

If no font exists for one or more of the required charsets, **XCreateFontSet** sets missing_charset_list_return to a list of one or more null-terminated charset names for which no font exists and sets missing_charset_count_return to the number of missing fonts. The charsets are from the list of the required charsets for the encoding of the locale and do not include any charsets to which Xlib may be able to remap a required charset.

If no font exists for any of the required charsets or if the locale definition in Xlib requires that a font exist for a particular charset and a font is not found for that charset, **XCreateFontSet** returns

NULL. Otherwise, **XCreateFontSet** returns a valid **XFontSet** to font_set.

When an Xmb/wc drawing or measuring function is called with an **XFontSet** that has missing charsets, some characters in the locale will not be drawable. If def_string_return is non-NULL, **XCreateFontSet** returns a pointer to a string that represents the glyphs that are drawn with this **XFontSet** when the charsets of the available fonts do not include all font glyphs required to draw a codepoint. The string does not necessarily consist of valid characters in the current locale and is not necessarily drawn with the fonts loaded for the font set, but the client can draw and measure the default glyphs by including this string in a string being drawn or measured with the **XFontSet**.

If the string returned to def_string_return is the empty string (""), no glyphs are drawn, and the escapement is zero. The returned string is null-terminated. It is owned by Xlib and should not be modified or freed by the client. It will be freed by a call to **XFreeFontSet** with the associated **XFontSet**. Until freed, its contents will not be modified by Xlib.

The client is responsible for constructing an error message from the missing charset and default string information and may choose to continue operation in the case that some fonts did not exist.

The returned **XFontSet** and missing charset list should be freed with **XFreeFontSet** and **XFreeStringList**, respectively. The client-supplied base_font_name_list may be freed by the client after calling **XCreateFontSet**.

To obtain a list of **XFontStruct** structures and full font names given an **XFontSet**, use **XFontsOfFontSet**.

```
int XFontsOfFontSet(font_set, font_struct_list_return, font_name_list_return)
      XFontSet font_set;
      XFontStruct ***font_struct_list_return;
      char ***font_name_list_return;
```

font_set	Specifies the font set.
font_struct_list_return	Returns the list of font structs.
font_name_list_return	Returns the list of font names.

The **XFontsOfFontSet** function returns a list of one or more **XFontStructs** and font names for the fonts used by the Xmb and Xwc layers, for the given font set. A list of pointers to the **XFontStruct** structures is returned to font_struct_list_return. A list of pointers to null-terminated, fully specified font name strings in the locale of the font set is returned to font_name_list_return. The font_name_list order corresponds to the font_struct_list order. The number of **XFontStruct** structures and font names is returned as the value of the function.

Because it is not guaranteed that a given character will be imaged using a single font glyph, there is no provision for mapping a character or default string to the font properties, font ID, or direction hint for the font for the character. The client may access the **XFontStruct** list to obtain these values for all the fonts currently in use.

Xlib does not guarantee that fonts are loaded from the server at the creation of an **XFontSet**. Xlib may choose to cache font data, loading it only as needed to draw text or compute text dimensions. Therefore, existence of the per_char metrics in the **XFontStruct** structures in the **XFontStructSet** is undefined. Also, note that all properties in the **XFontStruct** structures are in the STRING encoding.

The **XFontStruct** and font name lists are owned by Xlib and should not be modified or freed by the client. They will be freed by a call to **XFreeFontSet** with the associated **XFontSet**. Until freed, their contents will not be modified by Xlib.

To obtain the base font name list and the selected font name list given an **XFontSet**, use **XBaseFontNameListOfFontSet**.

char *XBaseFontNameListOfFontSet(*font_set*)
    XFontSet *font_set*;

font_set Specifies the font set.

The **XBaseFontNameListOfFontSet** function returns the original base font name list supplied by the client when the **XFontSet** was created. A null-terminated string containing a list of comma-separated font names is returned as the value of the function. White space may appear immediately on either side of separating commas.

If **XCreateFontSet** obtained an XLFD name from the font properties for the font specified by a non-XLFD base name, the **XBaseFontNameListOfFontSet** function will return the XLFD name instead of the non-XLFD base name.

The base font name list is owned by Xlib and should not be modified or freed by the client. It will be freed by a call to **XFreeFontSet** with the associated **XFontSet**. Until freed, its contents will not be modified by Xlib.

To obtain the locale name given an **XFontSet**, use **XLocaleOfFontSet**.

char *XLocaleOfFontSet(*font_set*)
    XFontSet *font_set*;

font_set Specifies the font set.

The **XLocaleOfFontSet** function returns the name of the locale bound to the specified **XFontSet**, as a null-terminated string.

The returned locale name string is owned by Xlib and should not be modified or freed by the client. It may be freed by a call to **XFreeFontSet** with the associated **XFontSet**. Until freed, it will not be modified by Xlib.

The **XFreeFontSet** function is a convenience function for freeing an output context. **XFreeFontSet** also frees its associated **XOM** if the output context was creating by **XCreateFontSet**.

void XFreeFontSet(*display*, *font_set*)
    Display **display*;
    XFontSet *font_set*;

display	Specifies the connection to the X server.
font_set	Specifies the font set.

The **XFreeFontSet** function frees the specified font set. The associated base font name list, font name list, **XFontStruct** list, and **XFontSetExtents**, if any, are freed.

13.10. Obtaining Font Set Metrics

Metrics for the internationalized text drawing functions are defined in terms of a primary draw direction, which is the default direction in which the character origin advances for each succeeding character in the string. The Xlib interface is currently defined to support only a left-to-right primary draw direction. The drawing origin is the position passed to the drawing function when the text is drawn. The baseline is a line drawn through the drawing origin parallel to the primary draw direction. Character ink is the pixels painted in the foreground color and does not include interline or intercharacter spacing or image text background pixels.

The drawing functions are allowed to implement implicit text directionality control, reversing the order in which characters are rendered along the primary draw direction in response to locale-specific lexical analysis of the string.

Regardless of the character rendering order, the origins of all characters are on the primary draw direction side of the drawing origin. The screen location of a particular character image may be determined with **XmbTextPerCharExtents** or **XwcTextPerCharExtents**.

The drawing functions are allowed to implement context-dependent rendering, where the glyphs drawn for a string are not simply a concatenation of the glyphs that represent each individual character. A string of two characters drawn with **XmbDrawString** may render differently than if the two characters were drawn with separate calls to **XmbDrawString**. If the client appends or inserts a character in a previously drawn string, the client may need to redraw some adjacent characters to obtain proper rendering.

To find out about direction-dependent rendering, use **XDirectionalDependentDrawing**.

Bool XDirectionalDependentDrawing(*font_set*)
    XFontSet *font_set*;

font_set	Specifies the font set.

The **XDirectionalDependentDrawing** function returns **True** if the drawing functions implement implicit text directionality; otherwise, it returns **False**.

To find out about context-dependent rendering, use **XContextualDrawing**.

```
Bool XContextualDrawing(font_set)
      XFontSet font_set;
```

font_set Specifies the font set.

The **XContextualDrawing** function returns **True** if text drawn with the font set might include context-dependent drawing; otherwise, it returns **False**.

To find out about context-dependent or direction-dependent rendering, use **XContextDependentDrawing**.

```
Bool XContextDependentDrawing(font_set)
      XFontSet font_set;
```

font_set Specifies the font set.

The **XContextDependentDrawing** function returns **True** if the drawing functions implement implicit text directionality or if text drawn with the font_set might include context-dependent drawing; otherwise, it returns **False**.

The drawing functions do not interpret newline, tab, or other control characters. The behavior when nonprinting characters other than space are drawn is implementation dependent. It is the client's responsibility to interpret control characters in a text stream.

The maximum character extents for the fonts that are used by the text drawing layers can be accessed by the **XFontSetExtents** structure:

```
typedef struct {
        XRectangle max_ink_extent;              /* over all drawable characters */
        XRectangle max_logical_extent;          /* over all drawable characters */
} XFontSetExtents;
```

The **XRectangle** structures used to return font set metrics are the usual Xlib screen-oriented rectangles with x, y giving the upper left corner, and width and height always positive.

The max_ink_extent member gives the maximum extent, over all drawable characters, of the rectangles that bound the character glyph image drawn in the foreground color, relative to a constant origin. See **XmbTextExtents** and **XwcTextExtents** for detailed semantics.

The max_logical_extent member gives the maximum extent, over all drawable characters, of the rectangles that specify minimum spacing to other graphical features, relative to a constant origin. Other graphical features drawn by the client, for example, a border surrounding the text, should not intersect this rectangle. The max_logical_extent member should be used to compute minimum interline spacing and the minimum area that must be allowed in a text field to draw a given number of arbitrary characters.

Due to context-dependent rendering, appending a given character to a string may change the string's extent by an amount other than that character's individual extent.

The rectangles for a given character in a string can be obtained from **XmbPerCharExtents** or **XwcPerCharExtents**.

To obtain the maximum extents structure given an **XFontSet**, use **XExtentsOfFontSet**.

```
XFontSetExtents *XExtentsOfFontSet(font_set)
      XFontSet font_set;
```

font_set	Specifies the font set.

The **XExtentsOfFontSet** function returns an **XFontSetExtents** structure for the fonts used by the Xmb and Xwc layers, for the given font set.

The **XFontSetExtents** structure is owned by Xlib and should not be modified or freed by the client. It will be freed by a call to **XFreeFontSet** with the associated **XFontSet**. Until freed, its contents will not be modified by Xlib.

To obtain the escapement in pixels of the specified text as a value, use **XmbTextEscapement** or **XwcTextEscapement**.

```
int XmbTextEscapement(font_set, string, num_bytes)
     XFontSet font_set;
     char *string;
     int num_bytes;

int XwcTextEscapement(font_set, string, num_wchars)
     XFontSet font_set;
     wchar_t *string;
     int num_wchars;
```

font_set	Specifies the font set.
string	Specifies the character string.
num_bytes	Specifies the number of bytes in the string argument.
num_wchars	Specifies the number of characters in the string argument.

The **XmbTextEscapement** and **XwcTextEscapement** functions return the escapement in pixels of the specified string as a value, using the fonts loaded for the specified font set. The escapement is the distance in pixels in the primary draw direction from the drawing origin to the origin of the next character to be drawn, assuming that the rendering of the next character is not dependent on the supplied string.

Regardless of the character rendering order, the escapement is always positive.

To obtain the overall_ink_return and overall_logical_return arguments, the overall bounding box of the string's image, and a logical bounding box, use **XmbTextExtents** or **XwcTextExtents**.

```
int XmbTextExtents(font_set, string, num_bytes, overall_return)
    XFontSet font_set;
    char *string;
    int num_bytes;
    XRectangle *overall_ink_return;
    XRectangle *overall_logical_return;
```

```
int XwcTextExtents(font_set, string, num_wchars, overall_return)
    XFontSet font_set;
    wchar_t *string;
    int num_wchars;
    XRectangle *overall_ink_return;
    XRectangle *overall_logical_return;
```

font_set	Specifies the font set.
string	Specifies the character string.
num_bytes	Specifies the number of bytes in the string argument.
num_wchars	Specifies the number of characters in the string argument.
overall_ink_return	Returns the overall ink dimensions.
overall_logical_return	Returns the overall logical dimensions.

The **XmbTextExtents** and **XwcTextExtents** functions set the components of the specified overall_ink_return and overall_logical_return arguments to the overall bounding box of the string's image and a logical bounding box for spacing purposes, respectively. They return the value returned by **XmbTextEscapement** or **XwcTextEscapement**. These metrics are relative to the drawing origin of the string, using the fonts loaded for the specified font set.

If the overall_ink_return argument is non-NULL, it is set to the bounding box of the string's character ink. The overall_ink_return for a nondescending, horizontally drawn Latin character is conventionally entirely above the baseline; that is, overall_ink_return.height <= −overall_ink_return.y. The overall_ink_return for a nonkerned character is entirely at, and to the right of, the origin; that is, overall_ink_return.x >= 0. A character consisting of a single pixel at the origin would set overall_ink_return fields y = 0, x = 0, width = 1, and height = 1.

If the overall_logical_return argument is non-NULL, it is set to the bounding box that provides minimum spacing to other graphical features for the string. Other graphical features, for example, a border surrounding the text, should not intersect this rectangle.

When the **XFontSet** has missing charsets, metrics for each unavailable character are taken from the default string returned by **XCreateFontSet** so that the metrics represent the text as it will actually be drawn. The behavior for an invalid codepoint is undefined.

To determine the effective drawing origin for a character in a drawn string, the client should call **XmbTextPerCharExtents** on the entire string, then on the character, and subtract the x values of the returned rectangles for the character. This is useful to redraw portions of a line of text or to justify words, but for context-dependent rendering, the client should not assume that it can redraw the character by itself and get the same rendering.

To obtain per-character information for a text string, use **XmbTextPerCharExtents** or **XwcTextPerCharExtents**.

```
Status XmbTextPerCharExtents(font_set, string, num_bytes, ink_array_return,
      logical_array_return, array_size, num_chars_return, overall_return)
   XFontSet font_set;
   char *string;
   int num_bytes;
   XRectangle *ink_array_return;
   XRectangle *logical_array_return;
   int array_size;
   int *num_chars_return;
   XRectangle *overall_ink_return;
   XRectangle *overall_logical_return;
```

```
Status XwcTextPerCharExtents(font_set, string, num_wchars, ink_array_return,
      logical_array_return, array_size, num_chars_return, overall_return)
   XFontSet font_set;
   wchar_t *string;
   int num_wchars;
   XRectangle *ink_array_return;
   XRectangle *logical_array_return;
   int array_size;
   int *num_chars_return;
   XRectangle *overall_ink_return;
   XRectangle *overall_logical_return;
```

font_set	Specifies the font set.
string	Specifies the character string.
num_bytes	Specifies the number of bytes in the string argument.
num_wchars	Specifies the number of characters in the string argument.
ink_array_return	Returns the ink dimensions for each character.
logical_array_return	Returns the logical dimensions for each character.
array_size	Specifies the size of ink_array_return and logical_array_return. The caller must pass in arrays of this size.
num_chars_return	Returns the number of characters in the string argument.
overall_ink_return	Returns the overall ink extents of the entire string.
overall_logical_return	Returns the overall logical extents of the entire string.

The **XmbTextPerCharExtents** and **XwcTextPerCharExtents** functions return the text dimensions of each character of the specified text, using the fonts loaded for the specified font set. Each successive element of ink_array_return and logical_array_return is set to the successive character's drawn metrics, relative to the drawing origin of the string and one rectangle for each character in the supplied text string. The number of elements of ink_array_return and logical_array_return that have been set is returned to num_chars_return.

Each element of ink_array_return is set to the bounding box of the corresponding character's drawn foreground color. Each element of logical_array_return is set to the bounding box that provides minimum spacing to other graphical features for the corresponding character. Other graphical features should not intersect any of the logical_array_return rectangles.

Note that an **XRectangle** represents the effective drawing dimensions of the character, regardless of the number of font glyphs that are used to draw the character or the direction in which the character is drawn. If multiple characters map to a single character glyph, the dimensions of all the **XRectangles** of those characters are the same.

When the **XFontSet** has missing charsets, metrics for each unavailable character are taken from the default string returned by **XCreateFontSet** so that the metrics represent the text as it will actually be drawn. The behavior for an invalid codepoint is undefined.

If the array_size is too small for the number of characters in the supplied text, the functions return zero and num_chars_return is set to the number of rectangles required. Otherwise, the functions return a nonzero value.

If the overall_ink_return or overall_logical_return argument is non-NULL, **XmbTextPerCharExtents** and **XwcTextPerCharExtents** return the maximum extent of the string's metrics to overall_ink_return or overall_logical_return, as returned by **XmbTextExtents** or **XwcTextExtents**.

13.11. Drawing Text Using Font Sets

The functions defined in this section draw text at a specified location in a drawable. They are similar to the functions **XDrawText**, **XDrawString**, and **XDrawImageString** except that they work with font sets instead of single fonts and interpret the text based on the locale of the font set instead of treating the bytes of the string as direct font indexes. See section 8.6 for details of the use of GCs and possible protocol errors. If a **BadFont** error is generated, characters prior to the offending character may have been drawn.

The text is drawn using the fonts loaded for the specified font set; the font in the GC is ignored and may be modified by the functions. No validation that all fonts conform to some width rule is performed.

The text functions **XmbDrawText** and **XwcDrawText** use the following structures:

```
typedef struct {
        char *chars;                /* pointer to string */
        int nchars;                 /* number of bytes */
        int delta;                  /* pixel delta between strings */
        XFontSet font_set;          /* fonts, None means don't change */
} XmbTextItem;

typedef struct {
        wchar_t *chars;             /* pointer to wide char string */
        int nchars;                 /* number of wide characters */
        int delta;                  /* pixel delta between strings */
        XFontSet font_set;          /* fonts, None means don't change */
} XwcTextItem;
```

To draw text using multiple font sets in a given drawable, use **XmbDrawText** or **XwcDrawText**.

```
void XmbDrawText(display, d, gc, x, y, items, nitems)
      Display *display;
      Drawable d;
      GC gc;
      int x, y;
      XmbTextItem *items;
      int nitems;

void XwcDrawText(display, d, gc, x, y, items, nitems)
      Display *display;
      Drawable d;
      GC gc;
      int x, y;
      XwcTextItem *items;
      int nitems;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
x	
y	Specify the x and y coordinates.
items	Specifies an array of text items.
nitems	Specifies the number of text items in the array.

The **XmbDrawText** and **XwcDrawText** functions allow complex spacing and font set shifts between text strings. Each text item is processed in turn, with the origin of a text element advanced in the primary draw direction by the escapement of the previous text item. A text item delta specifies an additional escapement of the text item drawing origin in the primary draw direction. A font_set member other than **None** in an item causes the font set to be used for this and subsequent text items in the text_items list. Leading text items with a font_set member set to **None** will not be drawn.

XmbDrawText and **XwcDrawText** do not perform any context-dependent rendering between text segments. Clients may compute the drawing metrics by passing each text segment to **XmbTextExtents** and **XwcTextExtents** or **XmbTextPerCharExtents** and **XwcTextPerCharExtents**. When the **XFontSet** has missing charsets, each unavailable character is drawn with the default string returned by **XCreateFontSet**. The behavior for an invalid codepoint is undefined.

To draw text using a single font set in a given drawable, use **XmbDrawString** or **XwcDrawString**.

```
void XmbDrawString(display, d, font_set, gc, x, y, string, num_bytes)
      Display *display;
      Drawable d;
      XFontSet font_set;
      GC gc;
      int x, y;
      char *string;
      int num_bytes;

void XwcDrawString(display, d, font_set, gc, x, y, string, num_wchars)
      Display *display;
      Drawable d;
      XFontSet font_set;
      GC gc;
      int x, y;
      wchar_t *string;
      int num_wchars;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
font_set	Specifies the font set.
gc	Specifies the GC.
x	
y	Specify the x and y coordinates.
string	Specifies the character string.
num_bytes	Specifies the number of bytes in the string argument.
num_wchars	Specifies the number of characters in the string argument.

The **XmbDrawString** and **XwcDrawString** functions draw the specified text with the foreground pixel. When the **XFontSet** has missing charsets, each unavailable character is drawn with the default string returned by **XCreateFontSet**. The behavior for an invalid codepoint is undefined.

To draw image text using a single font set in a given drawable, use **XmbDrawImageString** or **XwcDrawImageString**.

```
void XmbDrawImageString(display, d, font_set, gc, x, y, string, num_bytes)
    Display *display;
    Drawable d;
    XFontSet font_set;
    GC gc;
    int x, y;
    char *string;
    int num_bytes;

void XwcDrawImageString(display, d, font_set, gc, x, y, string, num_wchars)
    Display *display;
    Drawable d;
    XFontSet font_set;
    GC gc;
    int x, y;
    wchar_t *string;
    int num_wchars;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
font_set	Specifies the font set.
gc	Specifies the GC.
x	
y	Specify the x and y coordinates.
string	Specifies the character string.
num_bytes	Specifies the number of bytes in the string argument.
num_wchars	Specifies the number of characters in the string argument.

The **XmbDrawImageString** and **XwcDrawImageString** functions fill a destination rectangle with the background pixel defined in the GC and then paint the text with the foreground pixel. The filled rectangle is the rectangle returned to overall_logical_return by **XmbTextExtents** or **XwcTextExtents** for the same text and **XFontSet**.

When the **XFontSet** has missing charsets, each unavailable character is drawn with the default string returned by **XCreateFontSet**. The behavior for an invalid codepoint is undefined.

13.12. Input Method Overview

This section provides definitions for terms and concepts used for internationalized text input and a brief overview of the intended use of the mechanisms provided by Xlib.

A large number of languages in the world use alphabets consisting of a small set of symbols (letters) to form words. To enter text into a computer in an alphabetic language, a user usually has a keyboard on which there exists key symbols corresponding to the alphabet. Sometimes, a few characters of an alphabetic language are missing on the keyboard. Many computer users, who speak a Latin-alphabet-based language only have an English-based keyboard. They need to hit a combination of keystrokes to enter a character that does not exist directly on the keyboard. A number of algorithms have been developed for entering such characters. These are known as European input methods, compose input methods, or dead-key input methods.

Japanese is an example of a language with a phonetic symbol set, where each symbol represents a specific sound. There are two phonetic symbol sets in Japanese: Katakana and Hiragana. In general, Katakana is used for words that are of foreign origin, and Hiragana is used for writing native Japanese words. Collectively, the two systems are called Kana. Each set consists of 48 characters.

Korean also has a phonetic symbol set, called Hangul. Each of the 24 basic phonetic symbols (14 consonants and 10 vowels) represents a specific sound. A syllable is composed of two or three parts: the initial consonants, the vowels, and the optional last consonants. With Hangul, syllables can be treated as the basic units on which text processing is done. For example, a delete operation may work on a phonetic symbol or a syllable. Korean code sets include several thousands of these syllables. A user types the phonetic symbols that make up the syllables of the words to be entered. The display may change as each phonetic symbol is entered. For example, when the second phonetic symbol of a syllable is entered, the first phonetic symbol may change its shape and size. Likewise, when the third phonetic symbol is entered, the first two phonetic symbols may change their shape and size.

Not all languages rely solely on alphabetic or phonetic systems. Some languages, including Japanese and Korean, employ an ideographic writing system. In an ideographic system, rather than taking a small set of symbols and combining them in different ways to create words, each word consists of one unique symbol (or, occasionally, several symbols). The number of symbols can be very large: approximately 50,000 have been identified in Hanzi, the Chinese ideographic system.

There are two major aspects of ideographic systems that impact their use with computers. First, the standard computer character sets in Japan, China, and Korea include roughly 8,000 characters, while sets in Taiwan have between 15,000 and 30,000 characters. This makes it necessary to use more than one byte to represent a character. Second, it obviously is impractical to have a keyboard that includes all of a given language's ideographic symbols. Therefore, a mechanism is required for entering characters so that a keyboard with a reasonable number of keys can be used. Those input methods are usually based on phonetics, but there also exist methods based on the graphical properties of characters.

In Japan, both Kana and the ideographic system Kanji are used. In Korea, Hangul and sometimes the ideographic system Hanja are used. Now consider entering ideographs in Japan, Korea, China, and Taiwan.

In Japan, either Kana or English characters are typed and then a region is selected (sometimes automatically) for conversion to Kanji. Several Kanji characters may have the same phonetic representation. If that is the case with the string entered, a menu of characters is presented and the user must choose the appropriate one. If no choice is necessary or a preference has been established, the input method does the substitution directly. When Latin characters are converted to Kana or Kanji, it is called a romaji conversion.

In Korea, it is usually acceptable to keep Korean text in Hangul form, but some people may choose to write Hanja-originated words in Hanja rather than in Hangul. To change Hangul to Hanja, the user selects a region for conversion and then follows the same basic method as that described for Japanese.

Probably because there are well-accepted phonetic writing systems for Japanese and Korean, computer input methods in these countries for entering ideographs are fairly standard. Keyboard keys have both English characters and phonetic symbols engraved on them, and the user can switch between the two sets.

The situation is different for Chinese. While there is a phonetic system called Pinyin promoted by authorities, there is no consensus for entering Chinese text. Some vendors use a phonetic decomposition (Pinyin or another), others use ideographic decomposition of Chinese words, with various implementations and keyboard layouts. There are about 16 known methods, none of which is a clear standard.

Also, there are actually two ideographic sets used: Traditional Chinese (the original written Chinese) and Simplified Chinese. Several years ago, the People's Republic of China launched a campaign to simplify some ideographic characters and eliminate redundancies altogether. Under the plan, characters would be streamlined every five years. Characters have been revised several times now, resulting in the smaller, simpler set that makes up Simplified Chinese.

13.12.1. Input Method Architecture

As shown in the previous section, there are many different input methods in use today, each varying with language, culture, and history. A common feature of many input methods is that the user may type multiple keystrokes to compose a single character (or set of characters). The process of composing characters from keystrokes is called *preediting*. It may require complex algorithms and large dictionaries involving substantial computer resources.

Input methods may require one or more areas in which to show the feedback of the actual keystrokes, to propose disambiguation to the user, to list dictionaries, and so on. The input method areas of concern are as follows:

- The *status* area is a logical extension of the LEDs that exist on the physical keyboard. It is a window that is intended to present the internal state of the input method that is critical to the user. The status area may consist of text data and bitmaps or some combination.
- The *preedit* area displays the intermediate text for those languages that are composing prior to the client handling the data.
- The *auxiliary* area is used for pop-up menus and customizing dialogs that may be required for an input method. There may be multiple auxiliary areas for an input method. Auxiliary areas are managed by the input method independent of the client. Auxiliary areas are assumed to be separate dialogs, which are maintained by the input method.

There are various user interaction styles used for preediting. The ones supported by Xlib are as follows:

- For *on-the-spot* input methods, preediting data will be displayed directly in the application window. Application data is moved to allow preedit data to appear at the point of insertion.
- *Over-the-spot* preediting means that the data is displayed in a preedit window that is placed over the point of insertion.
- *Off-the-spot* preediting means that the preedit window is inside the application window but not at the point of insertion. Often, this type of window is placed at the bottom of the application window.
- *Root-window* preediting refers to input methods that use a preedit window that is the child of **RootWindow**.

It would require a lot of computing resources if portable applications had to include input methods for all the languages in the world. To avoid this, a goal of the Xlib design is to allow an application to communicate with an input method placed in a separate process. Such a process is called an *input server*. The server to which the application should connect is dependent on the environment when the application is started up, that is, the user language and the actual encoding to be used for it. The input method connection is said to be *locale-dependent*. It is also user-dependent. For a given language, the user can choose, to some extent, the user interface style of input method (if choice is possible among several).

Using an input server implies communication overhead, but applications can be migrated without relinking. Input methods can be implemented either as a stub communicating to an input server or as a local library.

An input method may be based on a *front-end* or a *back-end* architecture. In a front-end architecture, there are two separate connections to the X server: keystrokes go directly from the X server to the input method on one connection and other events to the regular client connection. The input method is then acting as a filter and sends composed strings to the client. A front-end architecture requires synchronization between the two connections to avoid lost key events or locking issues.

In a back-end architecture, a single X server connection is used. A dispatching mechanism must decide on this channel to delegate appropriate keystrokes to the input method. For instance, it may retain a Help keystroke for its own purpose. In the case where the input method is a separate process (that is, a server), there must be a special communication protocol between the back-end client and the input server.

A front-end architecture introduces synchronization issues and a filtering mechanism for noncharacter keystrokes (Function keys, Help, and so on). A back-end architecturs sometimes implies more communication overhead and more process switching. If all three processes (X server, input server, client) are running on a single workstation, there are two process switches for each keystroke in a back-end architecture, but there is only one in a front-end architecture.

The abstraction used by a client to communicate with an input method is an opaque data structure represented by the **XIM** data type. This data structure is returned by the **XOpenIM** function, which opens an input method on a given display. Subsequent operations on this data structure encapsulate all communication between client and input method. There is no need for an X client to use any networking library or natural language package to use an input method.

A single input server may be used for one or more languages, supporting one or more encoding schemes. But the strings returned from an input method will always be encoded in the (single) locale associated with **XIM** object.

13.12.2. Input Contexts

Xlib provides the ability to manage a multithreaded state for text input. A client may be using multiple windows, each window with multiple text entry areas, and the user possibly switching among them at any time. The abstraction for representing the state of a particular input thread is called an *input context*. The Xlib representation of an input context is an **XIC**.

An input context is the abstraction retaining the state, properties, and semantics of communication between a client and an input method. An input context is a combination of an input method, a locale specifying the encoding of the character strings to be returned, a client window, internal state information, and various layout or appearance characteristics. The input context concept somewhat matches for input the graphics context abstraction defined for graphics output.

One input context belongs to exactly one input method. Different input contexts may be associated with the same input method, possibly with the same client window. An **XIC** is created with the **XCreateIC** function, providing an **XIM** argument and affiliating the input context to the input method for its lifetime. When an input method is closed with **XCloseIM**, all of its affiliated input contexts should not be used any more (and should preferably be destroyed before closing the input method).

Considering the example of a client window with multiple text entry areas, the application programmer could, for example, choose to implement as follows:

- As many input contexts are created as text entry areas, and the client will get the input accumulated on each context each time it looks up in that context.
- A single context is created for a top-level window in the application. If such a window contains several text entry areas, each time the user moves to another text entry area, the client has to indicate changes in the context.

A range of choices can be made by application designers to use either a single or multiple input contexts, according to the needs of their application.

13.12.3. Getting Keyboard Input

To obtain characters from an input method, a client must call the function **XmbLookupString** or **XwcLookupString** with an input context created from that input method. Both a locale and display are bound to an input method when it is opened, and an input context inherits this locale and display. Any strings returned by **XmbLookupString** or **XwcLookupString** will be encoded in that locale.

13.12.4. Focus Management

For each text entry area in which the **XmbLookupString** or **XwcLookupString** functionss are used, there will be an associated input context.

When the application focus moves to a text entry area, the application must set the input context focus to the input context associated with that area. The input context focus is set by calling **XSetICFocus** with the appropriate input context.

Also, when the application focus moves out of a text entry area, the application should unset the focus for the associated input context by calling **XUnsetICFocus**. As an optimization, if **XSetICFocus** is called successively on two different input contexts, setting the focus on the second will automatically unset the focus on the first.

To set and unset the input context focus correctly, it will be necessary to track application-level focus changes. Such focus changes do not necessarily correspond to X server focus changes.

If a single input context is being used to do input for multiple text entry areas, it will also be necessary to set the focus window of the input context whenever the focus window changes (see section 13.17.3).

13.12.5. Geometry Management

In most input method architectures (on-the-spot being the notable exception), the input method will perform the display of its own data. To provide better visual locality, it is often desirable to have the input method areas embedded within a client. To do this, the client may need to allocate space for an input method. Xlib provides support that allows the size and position of input method areas to be provided by a client. The input method areas that are supported for geometry management are the status area and the preedit area.

The fundamental concept on which geometry management for input method windows is based is the proper division of responsibilities between the client (or toolkit) and the input method. The division of responsibilities is as follows:

- The client is responsible for the geometry of the input method window.
- The input method is responsible for the contents of the input method window.

An input method is able to suggest a size to the client, but it cannot suggest a placement. Also the input method can only suggest a size. It does not determine the size, and it must accept the size it is given.

Before a client provides geometry management for an input method, it must determine if geometry management is needed. The input method indicates the need for geometry management by setting **XIMPreeditArea** or **XIMStatusArea** in its **XIMStyles** value returned by **XGetIMValues**. When a client has decided that it will provide geometry management for an input method, it indicates that decision by setting the **XNInputStyle** value in the **XIC**.

After a client has established with the input method that it will do geometry management, the client must negotiate the geometry with the input method. The geometry is negotiated by the following steps:

- The client suggests an area to the input method by setting the **XNAreaNeeded** value for that area. If the client has no constraints for the input method, it either will not suggest an area or will set the width and height to zero. Otherwise, it will set one of the values.
- The client will get the XIC value **XNAreaNeeded**. The input method will return its suggested size in this value. The input method should pay attention to any constraints suggested by the client.
- The client sets the XIC value **XNArea** to inform the input method of the geometry of its window. The client should try to honor the geometry requested by the input method. The input method must accept this geometry.

Clients doing geometry management must be aware that setting other XIC values may affect the geometry desired by an input method. For example, **XNFontSet** and **XNLineSpacing** may change the geometry desired by the input method.

The table of XIC values (see section 13.17) indicates the values that can cause the desired geometry to change when they are set. It is the responsibility of the client to renegotiate the geometry of the input method window when it is needed.

In addition, a geometry management callback is provided by which an input method can initiate a geometry change.

13.12.6. Event Filtering

A filtering mechanism is provided to allow input methods to capture X events transparently to clients. It is expected that toolkits (or clients) using **XmbLookupString** or **XwcLookupString** will call this filter at some point in the event processing mechanism to make sure that events needed by an input method can be filtered by that input method.

If there were no filter, a client could receive and discard events that are necessary for the proper functioning of an input method. The following provides a few examples of such events:

- Expose events on preedit window in local mode.
- Events may be used by an input method to communicate with an input server. Such input server protocol related events have to be intercepted if one does not want to disturb client code.
- Key events can be sent to a filter before they are bound to translations such as the X Toolkit Intrinsics library provides.

Clients are expected to get the XIC value **XNFilterEvents** and augment the event mask for the client window with that event mask. This mask may be zero.

13.12.7. Callbacks

When an on-the-spot input method is implemented, only the client can insert or delete preedit data in place and possibly scroll existing text. This means the echo of the keystrokes has to be achieved by the client itself, tightly coupled with the input method logic.

When the user enters a keystroke, the client calls **XmbLookupString** or **XwcLookupString**. At this point, in the on-the-spot case, the echo of the keystroke in the preedit has not yet been done. Before returning to the client logic that handles the input characters, the look-up function must call the echoing logic for inserting the new keystroke. If the keystrokes entered so far make up a character, the keystrokes entered need to be deleted, and the composed character will be returned. Hence, what happens is that, while being called by client code, input method logic has to call back to the client before it returns. The client code, that is, a callback procedure, is called from the input method logic.

There are a number of cases where the input method logic has to call back the client. Each of those cases is associated with a well-defined callback action. It is possible for the client to specify, for each input context, what callback is to be called for each action.

There are also callbacks provided for feedback of status information and a callback to initiate a geometry request for an input method.

13.12.8. Visible Position Feedback Masks

In the on-the-spot input style, there is a problem when attempting to draw preedit strings that are longer than the available space. Once the display area is exceeded, it is not clear how best to display the preedit string. The visible position feedback masks of **XIMText** help resolve this problem by allowing the input method to specify hints that indicate the essential portions of the preedit string. For example, such hints can help developers implement scrolling of a long preedit string within a short preedit display area.

13.12.9. Preedit String Management

As highlighted before, the input method architecture provides preediting, which supports a type of pre-processor input composition. In this case, composition consists of interpreting a sequence of key events and returning a committed string via **XmbLookupString** or **XwcLookupString**. This provides the basics for input methods.

In addition to preediting based on key events, a general framework is provided to give a client that desires it more advanced preediting based on the text within the client. This framework is called *string conversion* and is provided using XIC values. The fundamental concept of string conversion is to allow the input method to manipulate the client's text independent of any user preediting operation.

The need for string conversion is based on language needs and input method capabilities. The following are some examples of string conversion:

- Transliteration conversion provides language-specific conversions within the input method. In the case of Korean input, users wish to convert a Hangul string into a Hanja string while in preediting, after preediting, or in other situations (for example, on a selected string). The conversion is triggered when the user presses a Hangul-to-Hanja key sequence (which may be input method specific). Sometimes the user may want to invoke the conversion after finishing preediting, or on a user-selected string. Thus, the string to be converted is in an application buffer, not in the preedit area of the input method. The string conversion services allow the client to request this transliteration conversion from the input method. There are many other transliteration conversions defined for various languages, for example, Kana-to-Kanji conversion in Japanese.

  The key to remember is that transliteration conversions are triggered at the request of the user and returned to the client immediately without affecting the preedit area of the input method.

- Re-conversion of a previously committed string or a selected string is supported by many input methods as a convenience to the user. For example, a user tends to mistype the commit key while preediting. In that case, some input methods provide a special key sequence to request a ‘‘re-convert’’ operation on the committed string, similiar to the undo facility provided by most text editors. Another example is where the user is proof reading a document that has some mis-conversions from preediting, and wants to correct the misconverted text. Such re-conversion is again triggered by the user invoking some special action, but re-conversions should not affect the state of the preedit area.
- Context-sensitive conversion is required for some languages and input methods that need to retrieve text that surrounds the current spot location (cursor position) of the client’s buffer. Such text is needed when the preediting operation depends on some surrounding characters (usually preceding the spot location). For example, in Thai language input, certain character sequences may be invalid and the input method may want to check whether characters constitute a valid word. Input methods that do such context-dependent checking need to retrieve the characters surrounding the current cursor position to obtain complete words.

  Unlike other conversions, this conversion is not explicitly requested by the user. Input methods that provide such context-sensitive conversion continuously need to request context from the client, and any change in the context of the spot location may affect such conversions. The client’s context would be needed if the user moves the cursor and starts editing again.

  For this reason, an input method supporting this type of conversion should take notice of when the client calls **XmbResetIC** or **XwcResetIC**, which is usually an indication of a context change.

Context-sensitive conversions just need a copy of the client’s text, while other conversions replace the client’s text with new text to achieve the re-conversion or transliteration. Yet in all cases the result of a conversion, either immediately or via preediting, is returned by the **XmbLookupString** and **XwcLookupString** functions.

String conversion support is dependent on the availability of the **XNStringConversion** or **XNStringConversionCallback** XIC values. Since the input method may not support string conversions, clients have to query availability of string conversion operations by checking the supported XIC values list by calling **XGetIMValues** with the **XNQueryICValues** IM value.

The difference between these two values is whether the conversion is invoked by the client or the input method. The **XNStringConversion** XIC value is used by clients to request a string conversion from the input method. The client is responsible for determining which events are used to trigger the string conversion and whether the string to be converted should be copied or deleted. The type of conversion is determined by the input method; the client can only pass the string to be converted. The client is guaranteed that no **XNStringConversionCallback** will be issued when this value is set; thus, the client need only set one of the these values.

The **XNStringConversionCallback** XIC value is used by the client to notify the input method that it will accept requests from the input method for string conversion. If this value is set, it is the input method’s responsibility to determine which events are used to trigger the string conversion. When such events occur, the input method issues a call to the client-supplied procedure to retrieve the string to be converted. The client’s callback procedure is notified whether to copy or delete the string and is provided with hints as to the amount of text needed. It is up to the client to determine the actual string to be converted, but it should be the text surrounding the client’s cursor position.

If the input method is performing a context-sensitive conversion, the callback should request a copy of the surrounding text using **XIMStringConversionRetrieval**. If it is one of the other conversions, the callback should request a substitution using **XIMStringConversionSubstitution**. For example, the client should delete the string if the input method is expected to return a newly composed string.

Finally, the input method may call the client's **XNStringConversionCallback** procedure multiple times if the string returned from the callback is not sufficient to perform a successful conversion. The arguments to the client's procedure allow the input method to define a position (in character units) relative to the client's cursor position and the size of the text needed. By varying the position and size of the desired text in subsequent callbacks, the input method can retrieve additional text.

13.13. Input Method Management

The interface to input methods might appear to be simply creating an input method (**XOpenIM**) and freeing an input method (**XCloseIM**). However, input methods may require complex communication with input method servers (IM servers), for example:

- If the X server, IM server, and X clients are started asynchronously, some clients may attempt to connect to the IM server before it is fully operational, and fail. Therefore, some mechanism is needed to allow clients to detect when an IM server has started.

It is up to clients to decide what should be done when an IM server is not available (for example, wait, or use some other IM server).

- Some input methods may allow the underlying IM server to be switched. Such customization may be desired without restarting the entire client.

To support management of input methods in these cases, the following functions are provided:

XRegisterIMInstantiateCallback	This function allows clients to register a callback procedure to be called when Xlib detects that an IM server is up and available.
XOpenIM	A client calls this function as a result of the callback procedure being called.
XSetIMValue, **XSetICValue**	These functions use the XIM and XIC values, **XNDestroyCallback**, to allow a client to register a callback procedure to be called when Xlib detects that an IM server that was associated with an opened input method is no longer available. In addition, this function can be used to switch IM servers for those input methods such functionality. The IM value for switching IM servers is implementation-depe description below about switching IM servers.
XUnregisterIMInstantiateCallback	This function removes a callback procedure registered by the client.

Input methods that support switching of IM servers may exhibit some side-effects:

- The input method will insure that any new IM server supports any of the input styles being used by input contexts already associated with the input method. However, the list of supported input styles may be different.

- Geometry management requests on previously created input contexts may be initiated by the new IM server.

13.13.1. Hot Keys

Some clients need to guarantee which keys can be used to escape from the input method, regardless of the input method state; for example, the client-specific Help key or the keys to move the input focus. The HotKey mechanism allows clients to specify a set of keys for this purpose. However, the input method might not allow clients to specify hot keys. Therefore, clients have to query support of hot keys by checking the supported XIC values list by calling **XGetIMValues** with the **XNQueryICValues** IM value. When the hot keys specified conflict with the key bindings of the input method, hot keys take precedence over the key bindings of the input method.

13.13.2. Preedit State Operation

An input method may have several internal states, depending on its implementation and the locale. However, one state that is independent of locale and implementation is whether the input method is currently performing a preediting operation. Xlib provides the ability for an application to manage the preedit state programmatically. Two methods are provided for retrieving the preedit state of an input context. One method is to query the state by calling **XGetICValues** with the **XNPreeditState** XIC value. Another method is to receive notification whenever the preedit state is changed. To receive such notification, an application needs to register a callback by calling **XSetICValues** with the **XNPreeditStateCallback** XIC value. In order to change the preedit state programatically, an application needs to call **XSetICValues** with **XNPreeditState.**

Availability of the preedit state is input method dependent. The input method may not provide the ability to set the state or to retrieve the state programatically. Therefore, clients have to query availability of preedit state operations by checking the supported XIC values list by calling **XGetIMValues** with the **XNQueryICValues** IM value.

13.14. Input Method Functions

To open a connection, use **XOpenIM**.

```
XIM XOpenIM(display, db, res_name, res_class)
      Display *display;
      XrmDatabase db;
      char *res_name;
      char *res_class;
```

display	Specifies the connection to the X server.
db	Specifies a pointer to the resource database.
res_name	Specifies the full resource name of the application.
res_class	Specifies the full class name of the application.

The **XOpenIM** function opens an input method, matching the current locale and modifiers specification. Current locale and modifiers are bound to the input method at opening time. The locale associated with an input method cannot be changed dynamically. This implies the strings returned by **XmbLookupString** or **XwcLookupString**, for any input context affiliated with a given input method, will be encoded in the locale current at the time the input method is opened.

The specific input method to which this call will be routed is identified on the basis of the current locale. **XOpenIM** will identify a default input method corresponding to the current locale. That default can be modified using **XSetLocaleModifiers** for the input method modifier.

The db argument is the resource database to be used by the input method for looking up resources that are private to the input method. It is not intended that this database be used to look up values that can be set as IC values in an input context. If db is NULL, no database is passed to the input method.

The res_name and res_class arguments specify the resource name and class of the application. They are intended to be used as prefixes by the input method when looking up resources that are common to all input contexts that may be created for this input method. The characters used for resource names and classes must be in the X Portable Character Set. The resources looked up are not fully specified if res_name or res_class is NULL.

The res_name and res_class arguments are not assumed to exist beyond the call to **XOpenIM**. The specified resource database is assumed to exist for the lifetime of the input method.

XOpenIM returns NULL if no input method could be opened.

To close a connection, use **XCloseIM**.

Status XCloseIM(*im*)
    XIM *im*;

im	Specifies the input method.

The **XCloseIM** function closes the specified input method.

To set input method attributes, use **XSetIMValues**.

char * XSetIMValues(*im*, ...)
    XIM *im*;

im	Specifies the input method.
...	Specifies the variable length argument list to set XIM values.

The **XSetIMValues** function presents a variable argument list programming interface for setting attributes of the specified input method. It returns NULL if it succeeds; otherwise, it returns the name of the first argument that could not be obtained.

To query an input method, use **XGetIMValues**.

char * XGetIMValues(*im*, ...)
    XIM *im*;

im	Specifies the input method.
...	Specifies the variable length argument list to get XIM values.

The **XGetIMValues** function presents a variable argument list programming interface for querying properties or features of the specified input method. This function returns NULL if it succeeds; otherwise, it returns the name of the first argument that could not be obtained.

To obtain the display associated with an input method, use **XDisplayOfIM**.

```
Display * XDisplayOfIM(im)
          XIM im;
```

im	Specifies the input method.

The **XDisplayOfIM** function returns the display associated with the specified input method.

To get the locale associated with an input method, use **XLocaleOfIM**.

```
char * XLocaleOfIM(im)
     XIM im;
```

im	Specifies the input method.

The **XLocaleOfIM** function returns the locale associated with the specified input method.

To register an input method instantiate callback, use **XRegisterIMInstantiateCallback**

```
Bool XRegisterIMInstantiateCallback(display, db, res_name, res_class, callback, client_data)
     Display *display;
     XrmDatabase db;
     char *res_name;
     char *res_class;
     XIMProc  callback;
     XPointer *client_data;
```

display	Specifies the connection to the X server.
db	Specifies a pointer to the resource database.
res_name	Specifies the full resource name of the application.
res_class	Specifies the full class name of the application.
callback	Specifies a pointer to the input method instantiate callback.
client_data	Specifies the additional client data.

The **XRegisterIMInstantiateCallback** function registers a callback to be invoked whenever a new input method becomes available for the specified display that matches the current locale and modifiers.

The generic prototype is as follows:

void IMInstantiateCallback(*display*, *client_data*, *call_data*)
    Display **display*;
    XPointer *client_data*;
    XPointer *call_data*;

display	Specifies the connection to the X server.
client_data	Specifies the additional client data.
call_data	Not used for this callback and always passed as NULL.

To unregister an input method instantiation callback, use **XUnregisterIMInstantiateCallback**

Bool XUnregisterIMInstantiateCallback(*display*, *db*, *res_name*, *res_class*, *callback*, *client_data*)
    Display **display*;
    XrmDatabase *db*;
    char **res_name*;
    char **res_class*;
    XIMProc *callback*;
    XPointer **client_data*;

display	Specifies the connection to the X server.
db	Specifies a pointer to the resource database.
res_name	Specifies the full resource name of the application.
res_class	Specifies the full class name of the application.
callback	Specifies a pointer to the input method instantiate callback.
client_data	Specifies the additional client data.

The **XUnregisterIMInstantiateCallback** function removes an input method instantiation callback previously registered.

13.15. XIM Value Arguments

The following table describes how XIM values are interpreted by an input method.

The first column lists the XIM values. The second column indicates how each of the XIM values are treated by that input style.

The following keys apply to this table.

Keys	**Explanation**
D	This value may be set using **XSetIMValues**. If it is not set, a default is provided.
S	This value may be set using **XSetIMValues**.
G	This value may be read using **XGetIMValues**.

XIM Value	
XNQueryInputStyle	G

XIM Value	
XNResourceName	D-S-G
XNResourceClass	D-S-G
XNDestroyCallback	D-S-G
XNQueryIMValuesList	G
XNQueryICValuesList	G
XNVisiblePosition	G
XNR6PreeditCallback	D-S-G

13.15.1. Query Input Style

A client should always query the input method to determine which input styles are supported. The client should then find an input style it is capable of supporting.

If the client cannot find an input style that it can support, it should negotiate with the user the continuation of the program (exit, choose another input method, and so on).

The argument value must be a pointer to a location where the returned value will be stored. The returned value is a pointer to a structure of type **XIMStyles**. Clients are responsible for freeing the **XIMStyles** structure. To do so, use **XFree**.

The **XIMStyles** structure is defined as follows:

```
typedef unsigned long XIMStyle;

#define     XIMPreeditArea              0x0001L
#define     XIMPreeditCallbacks         0x0002L
#define     XIMPreeditPosition          0x0004L
#define     XIMPreeditNothing           0x0008L
#define     XIMPreeditNone              0x0010L

#define     XIMStatusArea               0x0100L
#define     XIMStatusCallbacks          0x0200L
#define     XIMStatusNothing            0x0400L
#define     XIMStatusNone               0x0800L

typedef struct {
        unsigned short count_styles;
        XIMStyle * supported_styles;
} XIMStyles;
```

An **XIMStyles** structure contains the number of input styles supported in its count_styles field. This is also the size of the supported_styles array.

The supported styles is a list of bitmask combinations, which indicate the combination of styles for each of the areas supported. These areas are described below. Each element in the list should select one of the bitmask values for each area. The list describes the complete set of combinations supported. Only these combinations are supported by the input method.

The preedit category defines what type of support is provided by the input method for preedit information.

XIMPreeditArea	If chosen, the input method would require the client to provide some area values for it to do its preediting. Refer to XIC values **XNArea** and **XNAreaNeeded**.
XIMPreeditPosition	If chosen, the input method would require the client to provide positional values. Refer to XIC values **XNSpotLocation** and **XNFocusWindow**.
XIMPreeditCallbacks	If chosen, the input method would require the client to define the set of preedit callbacks. Refer to XIC values **XNPreeditStartCallback**, **XNPreeditDoneCallback**, **XNPreeditDrawCallback**, and **XNPreeditCaretCallback**.
XIMPreeditNothing	If chosen, the input method can function without any preedit values.
XIMPreeditNone	The input method does not provide any preedit feedback. Any preedit value is ignored. This style is mutually exclusive with the other preedit styles.

The status category defines what type of support is provided by the input method for status information.

XIMStatusArea	The input method requires the client to provide some area values for it to do its status feedback. See **XNArea** and **XNAreaNeeded**.
XIMStatusCallbacks	The input method requires the client to define the set of status callbacks, **XNStatusStartCallback**, **XNStatusDoneCallback**, and **XNStatusDrawCallback**.
XIMStatusNothing	The input method can function without any status values.
XIMStatusNone	The input method does not provide any status feedback. If chosen, any status value is ignored. This style is mutually exclusive with the other status styles.

13.15.2. Resource Name and Class

The **XNResourceName** and **XNResourceClass** arguments are strings that specify the full name and class used by the input method. These values should be used as prefixes for the name and class when looking up resources that may vary according to the input method. If these values are not set, the resources will not be fully specified.

It is not intended that values which can be set as XIM values be set as resources.

13.15.3. Destroy Callback

The **XNDestroyCallback** argument is a structure of type **XIMCallback**. **XNDestroyCallback** is triggered when an input method stops its service for any reason. After the callback is invoked, the input method is closed by Xlib. Therefore, the client need not call **XCloseIM**.

The generic prototype of this callback function is as follows:

```
void DestroyCallback(im, client_data, call_data)
    XIM im;
    XPointer client_data;
    XPointer call_data;
```

im	Specifies the input method.
client_data	Specifies the additional client data.
call_data	Not used for this callback and always passed as NULL.

A DestroyCallback is always called with a NULL call_data argument.

13.15.4. Query IM and IC Values List

XNQueryIMValuesList and **XNQueryICValuesList** are used to query about XIM and XIC values supported by the input method.

The argument value must be a pointer to a location where the returned value will be stored. The returned value is a pointer to a structure of type **XIMValuesList**. Clients are responsible for freeing the **XIMValuesList** structure. To do so, use **XFree**.

The **XIMValuesList** structure is defined as follows:

```
typedef struct {
        unsigned short count_values;
        char **supported_values;
} XIMValuesList;
```

13.15.5. Visible Position

The **XNVisiblePosition** argument indicates whether the visible position masks of **XIMFeedback** in **XIMText** are available.

The argument value must be a pointer to a location where the returned value will be stored. The returned value is of type **Bool**. If the returned value is **True**, the input method uses the visible position masks of **XIMFeedback** in **XIMText**; otherwise, the input method does not use the masks.

Since this XIM value is optional, a client should call **XGetIMValues** with argument **XNQueryIMValues** before using this argument. If the **XNVisiblePosition** does not exist in the IM values list returned from **XNQueryIMValues**, the visible positon masks of **XIMFeedback** in **XIMText** are not used to indicate the visible position.

13.15.6. Preedit Callback Behavior

The **XNR6PreeditCallbackBehavior** argument indicates whether the behavior of preedit callbacks regarding **XIMPreeditDrawCallbackStruct** values follows Release 5 or Release 6 semantics.

The argument value must be a pointer to a location where the returned value will be stored. The returned value is of type **Bool**. If the returned value is **True**, the input method uses the Release 6 behavior; otherwise, it uses the Release 5 behavior. The default value is **False**. In order to use Release 6 semantics, the value of **XNR6PreeditCallbackBehavior** must be set to **True**.

Since this XIM value is optional, a client should call **XGetIMValues** with argument **XNQueryIMValues** before using this argument. If the **XNR6PreeditCallbackBehavior** does not exist in the IM values list returned from **XNQueryIMValues**, the PreeditCallback behavior is Release 5 semantics.

13.16. Input Context Functions

An input context is an abstraction that is used to contain both the data required (if any) by an input method and the information required to display that data. There may be multiple input contexts for one input method. The programming interfaces for creating, reading, or modifying an input context use a variable argument list. The name elements of the argument lists are referred to as XIC values. It is intended that input methods be controlled by these XIC values. As new XIC values are created, they should be registered with the X Consortium.

To create an input context, use **XCreateIC**.

```
XIC XCreateIC(im, ...)
    XIM im;
```

im Specifies the input method.

... Specifies the variable length argument list to set XIC values.

The **XCreateIC** function creates a context within the specified input method.

Some of the arguments are mandatory at creation time, and the input context will not be created if those arguments are not provided. The mandatory arguments are the input style and the set of text callbacks (if the input style selected requires callbacks). All other input context values can be set later.

XCreateIC returns a NULL value if no input context could be created. A NULL value could be returned for any of the following reasons:

- A required argument was not set.
- A read-only argument was set (for example, **XNFilterEvents**).
- The argument name is not recognized.
- The input method encountered an input method implementation dependent error.

XCreateIC can generate **BadAtom**, **BadColor**, **BadPixmap**, and **BadWindow** errors.

To destroy an input context, use **XDestroyIC**.

```
void XDestroyIC(ic)
    XIC ic;
```

ic Specifies the input context.

XDestroyIC destroys the specified input context.

To communicate to and synchronize with input method for any changes in keyboard focus from the client side, use **XSetICFocus** and **XUnsetICFocus**.

void XSetICFocus(*ic*)
    XIC *ic*;

ic Specifies the input context.

The **XSetICFocus** function allows a client to notify an input method that the focus window attached to the specified input context has received keyboard focus. The input method should take action to provide appropriate feedback. Complete feedback specification is a matter of user interface policy.

Calling **XSetICFocus** does not affect the focus window value.

void XUnsetICFocus(*ic*)
    XIC *ic*;

ic Specifies the input context.

The **XUnsetICFocus** function allows a client to notify an input method that the specified input context has lost the keyboard focus and that no more input is expected on the focus window attached to that input context. The input method should take action to provide appropriate feedback. Complete feedback specification is a matter of user interface policy.

Calling **XUnsetICFocus** does not affect the focus window value; The client may still receive events from the input method that are directed to the focus window.

To reset the state of an input context to its initial state, use **XmbResetIC** or **XwcResetIC**.

char * XmbResetIC(*ic*)
    XIC *ic*;

wchar_t * XwcResetIC(*ic*)
    XIC *ic*;

ic Specifies the input context.

The **XmbResetIC** and **XwcResetIC** functions reset an input context to its initial state. Any input pending on that context is deleted. The input method is required to clear the preedit area, if any, and update the status accordingly. Calling **XmbResetIC** or **XwcResetIC** does not change the focus.

The return value of **XmbResetIC** is its current preedit string as a multibyte string. If there is any preedit text drawn or visible to the user, then these procedures must return a non-NULL string. If there is no visible preedit text, then it is input method implementation dependent whether these procedures return a non-NULL string or NULL.

The client should free the returned string by calling **XFree**.

To get the input method associated with an input context, use **XIMOfIC**.

```
XIM XIMOfIC(ic)
      XIC ic;
```

ic	Specifies the input context.

The **XIMOfIC** function returns the input method associated with the specified input context.

Xlib provides two functions for setting and reading XIC values, respectively, **XSetICValues** and **XGetICValues**. Both functions have a variable length argument list. In that argument list, any XIC value's name must be denoted with a character string using the X Portable Character Set.

To set XIC values, use **XSetICValues**.

```
char * XSetICValues(ic, ...)
      XIC ic;
```

ic	Specifies the input context.
...	Specifies the variable length argument list to set XIC values.

The **XSetICValues** function returns NULL if no error occurred; otherwise, it returns the name of the first argument that could not be set. An argument might not be set for any of the following reasons:

- The argument is read-only (for example, **XNFilterEvents**).
- The argument name is not recognized.
- An implementation-dependent error occurs.

Each value to be set must be an appropriate datum, matching the data type imposed by the semantics of the argument.

XSetICValues can generate **BadAtom**, **BadColor**, **BadCursor**, **BadPixmap**, and **BadWindow** errors.

To obtain XIC values, use **XGetICValues**.

```
char * XGetICValues(ic, ...)
      XIC ic;
```

ic	Specifies the input context.
...	Specifies the variable length argument list to get XIC values.

The **XGetICValues** function returns NULL if no error occurred; otherwise, it returns the name of the first argument that could not be obtained. An argument could not be obtained for any of the following reasons:

- The argument name is not recognized.
- The input method encountered an implementation dependent error.

Each IC attribute value argument (following a name) must point to a location where the IC value is to be stored. That is, if the IC value is of type T, the argument must be of type T*. If T itself is a pointer type, then **XGetICValues** allocates memory to store the actual data, and the client is responsible for freeing this data by calling **XFree** with the returned pointer. The exception to this rule is for an IC value of type **XVaNestedList** (for preedit and status attributes). In this case, the argument must also be of type **XVaNestedList**. Then, the rule of changing type T to T* and freeing the allocated data applies to each element of the nested list.

13.17. XIC Value Arguments

The following tables describe how XIC values are interpreted by an input method depending on the input style chosen by the user.

The first column lists the XIC values. The second column indicates which values are involved in affecting, negotiating, and setting the geometry of the input method windows. The subentries under the third column indicate the different input styles that are supported. Each of these columns indicates how each of the XIC values are treated by that input style.

The following keys apply to these tables.

Keys	**Explanation**
C	This value must be set with **XCreateIC**.
D	This value may be set using **XCreateIC**. If it is not set, a default is provided.
G	This value may be read using **XGetICValues**.
GN	This value may cause geometry negotiation when its value is set by means of **XCreateIC** or **XSetICValues**.
GR	This value will be the response of the input method when any GN value is changed.
GS	This value will cause the geometry of the input method window to be set.
O	This value must be set once and only once. It need not be set at create time.
S	This value may be set with **XSetICValues**.
Ignored	This value is ignored by the input method for the given input style.

				Input Style		
XIC Value	**Geometry Management**	**Preedit Callback**	**Preedit Position**	**Preedit Area**	**Preedit Nothing**	**Preedit None**
Input Style		C-G	C-G	C-G	C-G	C-G
Client Window		O-G	O-G	O-G	O-G	Ignored
Focus Window	GN	D-S-G	D-S-G	D-S-G	D-S-G	Ignored
Resource Name		Ignored	D-S-G	D-S-G	D-S-G	Ignored
Resource Class		Ignored	D-S-G	D-S-G	D-S-G	Ignored
Geometry Callback		Ignored	Ignored	D-S-G	Ignored	Ignored
Filter Events		G	G	G	G	Ignored
Destroy Callback		D-S-G	D-S-G	D-S-G	D-S-G	D-S-G
String Conversion Callback		S-G	S-G	S-G	S-G	S-G
String Conversion		D-S-G	D-S-G	D-S-G	D-S-G	D-S-G
Reset State		D-S-G	D-S-G	D-S-G	D-S-G	Ignored
HotKey		S-G	S-G	S-G	S-G	Ignored
HotKeyState		D-S-G	D-S-G	D-S-G	D-S-G	Ignored
Preedit						
Area	GS	Ignored	D-S-G	D-S-G	Ignored	Ignored

XIC Value	Geometry Management	Input Style Preedit Callback	Preedit Position	Preedit Area	Preedit Nothing	Preedit None
Area Needed	GN-GR	Ignored	Ignored	S-G	Ignored	Ignored
Spot Location		Ignored	D-S-G	Ignored	Ignored	Ignored
Colormap		Ignored	D-S-G	D-S-G	D-S-G	Ignored
Foreground		Ignored	D-S-G	D-S-G	D-S-G	Ignored
Background		Ignored	D-S-G	D-S-G	D-S-G	Ignored
Background Pixmap		Ignored	D-S-G	D-S-G	D-S-G	Ignored
Font Set	GN	Ignored	D-S-G	D-S-G	D-S-G	Ignored
Line Spacing	GN	Ignored	D-S-G	D-S-G	D-S-G	Ignored
Cursor		Ignored	D-S-G	D-S-G	D-S-G	Ignored
Preedit State		D-S-G	D-S-G	D-S-G	D-S-G	Ignored
Preedit State Callback		S-G	S-G	S-G	S-G	Ignored
Preedit Callbacks		C-S-G	Ignored	Ignored	Ignored	Ignored

XIC Value	Geometry Management	Input Style Status Callback	Status Area	Status Nothing	Status None
Input Style		C-G	C-G	C-G	C-G
Client Window		O-G	O-G	O-G	Ignored
Focus Window	GN	D-S-G	D-S-G	D-S-G	Ignored
Resource Name		Ignored	D-S-G	D-S-G	Ignored
Resource Class		Ignored	D-S-G	D-S-G	Ignored
Geometry Callback		Ignored	D-S-G	Ignored	Ignored
Filter Events		G	G	G	G
Status					
Area	GS	Ignored	D-S-G	Ignored	Ignored
Area Needed	GN-GR	Ignored	S-G	Ignored	Ignored
Colormap		Ignored	D-S-G	D-S-G	Ignored
Foreground		Ignored	D-S-G	D-S-G	Ignored
Background		Ignored	D-S-G	D-S-G	Ignored
Background Pixmap		Ignored	D-S-G	D-S-G	Ignored
Font Set	GN	Ignored	D-S-G	D-S-G	Ignored
Line Spacing	GN	Ignored	D-S-G	D-S-G	Ignored
Cursor		Ignored	D-S-G	D-S-G	Ignored
Status Callbacks		C-S-G	Ignored	Ignored	Ignored

13.17.1. Input Style

The **XNInputStyle** argument specifies the input style to be used. The value of this argument must be one of the values returned by the **XGetIMValues** function with the **XNQueryInputStyle** argument specified in the supported_styles list.

Note that this argument must be set at creation time and cannot be changed.

13.17.2. Client Window

The **XNClientWindow** argument specifies to the input method the client window in which the input method can display data or create subwindows. Geometry values for input method areas are given with respect to the client window. Dynamic change of client window is not supported. This argument may be set only once and should be set before any input is done using this input context. If it is not set, the input method may not operate correctly.

If an attempt is made to set this value a second time with **XSetICValues**, the string **XNClientWindow** will be returned by **XSetICValues**, and the client window will not be changed.

If the client window is not a valid window ID on the display attached to the input method, a **BadWindow** error can be generated when this value is used by the input method.

13.17.3. Focus Window

The **XNFocusWindow** argument specifies the focus window. The primary purpose of the **XNFocusWindow** is to identify the window that will receive the key event when input is composed. In addition, the input method may possibly affect the focus window as follows:

- Select events on it
- Send events to it
- Modify its properties
- Grab the keyboard within that window

The associated value must be of type **Window**. If the focus window is not a valid window ID on the display attached to the input method, a **BadWindow** error can be generated when this value is used by the input method.

When this XIC value is left unspecified, the input method will use the client window as the default focus window.

13.17.4. Resource Name and Class

The **XNResourceName** and **XNResourceClass** arguments are strings that specify the full name and class used by the client to obtain resources for the client window. These values should be used as prefixes for name and class when looking up resources that may vary according to the input context. If these values are not set, the resources will not be fully specified.

It is not intended that values that can be set as XIC values be set as resources.

13.17.5. Geometry Callback

The **XNGeometryCallback** argument is a structure of type **XIMCallback** (see section 13.17.13.10).

The **XNGeometryCallback** argument specifies the geometry callback that a client can set. This callback is not required for correct operation of either an input method or a client. It can be set for a client whose user interface policy permits an input method to request the dynamic change of that input method's window. An input method that does dynamic change will need to filter any events that it uses to initiate the change.

13.17.6. Filter Events

The **XNFilterEvents** argument returns the event mask that an input method needs to have selected for. The client is expected to augment its own event mask for the client window with this one.

This argument is read-only, is set by the input method at create time, and is never changed.

The type of this argument is **unsigned long**. Setting this value will cause an error.

13.17.7. Destroy Callback

The **XNDestroyCallback** argument is a structure of type **XIMCallback** (see section 13.17.13.10). This callback is triggered when the input method stops its service for any reason; for example, when a connection to an IM server is broken. After the destroy callback is called, the input context is destroyed and the input method is closed. Therefore, the client should not call **XDestroyIC** and **XCloseIM**.

13.17.8. String Conversion Callback

The **XNStringConversionCallback** argument is a structure of type **XIMCallback** (see section 13.17.13.10 and 13.18.4).

The **XNStringConversionCallback** argument specifies a string conversion callback. This callback is not required for correct operation of either the input method or the client. It can be set by a client to support string conversions that may be requested by the input method. An input method that does string conversions will filter any events that it uses to initiate the conversion.

Since this XIC value is optional, a client should call **XGetIMValues** with argument **XNQueryICValues** before using this argument.

13.17.9. String Conversion

The **XNStringConversion** argument is a structure of type **XIMStringConversionText**.

The **XNStringConversion** argument specifies the string to be converted by an input method. This argument is not required for correct operation of either the input method or the client.

String conversion facilitates the manipulation of text independent of preediting. It is essential for some input methods and clients to manipulate text by performing context-sensitive conversion, reconversion, or transliteration conversion on it.

Since this XIC value is optional, a client should call **XGetIMValues** with argument **XNQueryICValues** before using this argument.

The **XIMStringConversionText** structure is defined as follows:

```
typedef struct _XIMStringConversionText {
	unsigned short length;
	XIMStringConversionFeedback *feedback;
	Bool encoding_is_wchar;
	union {
		char	*mbs;
		wchar_t *wcs;
	} string;
} XIMStringConversionText;

typedef unsigned long XIMStringConversionFeedback;
```

The feedback member is reserved for future use. The text to be converted is defined by the string and length members. The length is indicated in characters.

13.17.10. Reset State

The **XNResetState** argument specifies the state the input context will return to after calling **XmbResetIC** or **XwcResetIC**.

The XIC state may be set to its initial state, as specified by the **XNPreeditState** value when **XCreateIC** was called, or it may be set to preserve the current state.

The valid masks for **XIMResetState** are as follows:

```
typedef unsigned long XIMResetState;

#define     XIMInitialState          (1L)
#define     XIMPreserveState         (1L<<1)
```

If **XIMInitialState** is set, then **XmbResetIC** and **XwcResetIC** will return to the initial **XNPreeditState** state of the XIC.

If **XIMPreserveState** is set, then **XmbResetIC** and **XwcResetIC** will preserve the current state of the XIC.

If **XNResetState** is left unspecified, the default is **XIMInitialState**.

XIMResetState values other than those specified above will default to **XIMInitialState**.

13.17.11. Hot Keys

The **XNHotKey** argument specifies the hot key list to the XIC. The hot key list is a pointer to the structure of type **XIMHotKeyTriggers**, which specifies the key events that must be received without any interruption of the input method.

Since this XIC value is optional, a client should call **XGetIMValues** with argument **XNQueryICValues** before using this functionality.

The value of the argument is a pointer to a structure of type **XIMHotKeyTriggers**.

If an event for a key in the hot key list is found, then the process will receive the event and it will be processed inside the client.

```
typedef struct {
        KeySym keysym;
        unsigned int modifier;
        unsigned int modifier_mask;
} XIMHotKeyTrigger;

typedef struct {
        int num_hot_key;
        XIMHotKeyTrigger key;
} XIMHotKeyTriggers;
```

13.17.12. Hot Key State

The **XNHotKeyState** argument specifies the hot key state of the input method. This is usually used to switch the input method between hot key operation and normal input processing.

The value of the argument is a pointer to a structure of type XIMHotKeyState.

```
typedef unsigned long XIMHotKeyState;

#define     XIMHotKeyStateON                          (0x0001L)
#define     XIMHotKeyStateOFF                         (0x0002L)
```

13.17.13. Preedit and Status Attributes

The **XNPreeditAttributes** and **XNStatusAttributes** arguments specify to an input method the attributes to be used for the preedit and status areas, if any. Those attributes are passed to **XSetICValues** or **XGetICValues** as a nested variable length list. The names to be used in these lists are described in the following sections.

13.17.13.1. Area

The value of the **XNArea** argument must be a pointer to a structure of type **XRectangle.** The interpretation of the **XNArea** argument is dependent on the input method style that has been set.

If the input method style is **XIMPreeditPosition**, **XNArea** specifies the clipping region within which preediting will take place. If the focus window has been set, the coordinates are assumed to be relative to the focus window. Otherwise, the coordinates are assumed to be relative to the client window. If neither has been set, the results are undefined.

If **XNArea** is not specified, is set to NULL, or is invalid, the input method will default the clipping region to the geometry of the **XNFocusWindow**. If the area specified is NULL or invalid, the results are undefined.

If the input style is **XIMPreeditArea** or **XIMStatusArea**, **XNArea** specifies the geometry provided by the client to the input method. The input method may use this area to display its data, either preedit or status depending on the area designated. The input method may create a window as a child of the client window with dimensions that fit the **XNArea**. The coordinates are relative to the client window. If the client window has not been set yet, the input method should save these values and apply them when the client window is set. If **XNArea** is not specified, is set to NULL, or is invalid, the results are undefined.

13.17.13.2. Area Needed

When set, the **XNAreaNeeded** argument specifies the geometry suggested by the client for this area (preedit or status). The value associated with the argument must be a pointer to a structure of type **XRectangle**. Note that the x, y values are not used and that nonzero values for width or height are the constraints that the client wishes the input method to respect.

When read, the **XNAreaNeeded** argument specifies the preferred geometry desired by the input method for the area.

This argument is only valid if the input style is **XIMPreeditArea** or **XIMStatusArea**. It is used for geometry negotiation between the client and the input method and has no other effect upon the input method (see section 13.11.5).

13.17.13.3. Spot Location

The **XNSpotLocation** argument specifies to the input method the coordinates of the spot to be used by an input method executing with **XNInputStyle** set to **XIMPreeditPosition**. When specified to any input method other than **XIMPreeditPosition**, this XIC value is ignored.

The x coordinate specifies the position where the next character would be inserted. The y coordinate is the position of the baseline used by the current text line in the focus window. The x and y coordinates are relative to the focus window, if it has been set; otherwise, they are relative to the client window. If neither the focus window nor the client window has been set, the results are undefined.

The value of the argument is a pointer to a structure of type **XPoint**.

13.17.13.4. Colormap

Two different arguments can be used to indicate what colormap the input method should use to allocate colors, a colormap ID, or a standard colormap name.

The **XNColormap** argument is used to specify a colormap ID. The argument value is of type **Colormap**. An invalid argument may generate a **BadColor** error when it is used by the input method.

The **XNStdColormap** argument is used to indicate the name of the standard colormap in which the input method should allocate colors. The argument value is an **Atom** that should be a valid atom for calling **XGetRGBColormaps**. An invalid argument may generate a **BadAtom** error when it is used by the input method.

If the colormap is left unspecified, the client window colormap becomes the default.

13.17.13.5. Foreground and Background

The **XNForeground** and **XNBackground** arguments specify the foreground and background pixel, respectively. The argument value is of type **unsigned long**. It must be a valid pixel in the input method colormap.

If these values are left unspecified, the default is determined by the input method.

13.17.13.6. Background Pixmap

The **XNBackgroundPixmap** argument specifies a background pixmap to be used as the background of the window. The value must be of type **Pixmap**. An invalid argument may generate a **BadPixmap** error when it is used by the input method.

If this value is left unspecified, the default is determined by the input method.

13.17.13.7. Font Set

The **XNFontSet** argument specifies to the input method what font set is to be used. The argument value is of type **XFontSet**.

If this value is left unspecified, the default is determined by the input method.

13.17.13.8. Line Spacing

The **XNLineSpace** argument specifies to the input method what line spacing is to be used in the preedit window if more than one line is to be used. This argument is of type **int**.

If this value is left unspecified, the default is determined by the input method.

13.17.13.9. Cursor

The **XNCursor** argument specifies to the input method what cursor is to be used in the specified window. This argument is of type **Cursor**.

An invalid argument may generate a **BadCursor** error when it is used by the input method. If this value is left unspecified, the default is determined by the input method.

13.17.13.10. Preedit State

The **XNPreeditState** argument specifies the state of input preediting for the input method. Input preediting can be on or off.

The valid masks names for **XNPreeditState** are as follows:

```
typedef unsigned long XIMPreeditState;

#define     XIMPreeditUnknown          0L
#define     XIMPreeditEnable           1L
#define     XIMPreeditDisable          (1L<<1)
```

If a value of **XIMPreeditEnable** is set, then input preediting is turned on by the input method.

If a value of XIMPreeditDisable is set, then input preediting is turned off by the input method.

If **XNPreeditState** is left unspecified, then the state will be implementation dependent.

The **XNPreeditState** value specified at the creation time will be reflected as the initial state for **XmbResetIC** and **XwcResetIC**.

13.17.13.11. Preedit and Status Callbacks

A client that wants to support the input style **XIMPreeditCallbacks** must provide a set of preedit callbacks to the input method. The set of preedit callbacks are as follows:

XNPreeditStartCallback	This is called when the input method starts preedit.
XNPreeditDoneCallback	This is called when the input method stops preedit.
XNPreeditDrawCallback	This is called when a number of preedit keystrokes should be echoed.
XNPreeditCaretCallback	This is called to move the text insertion point within the preedit string.

A client that wants to support the input style **XIMStatusCallbacks** must provide a set of status callbacks to the input method. The set of status callbacks are as follows:

XNStatusStartCallback	This is called when the input method initializes the status area.
XNStatusDoneCallback	This is called when the input method no longer needs the status area.
XNStatusDrawCallback	This is called when updating of the status area is required.

The value of any status or preedit argument is a pointer to a structure of type **XIMCallback**.

```
typedef void (*XIMProc)();

typedef struct {
        XPointer client_data;
        XIMProc callback;
} XIMCallback;
```

Each callback has some particular semantics and will carry the data that expresses the environment necessary to the client into a specific data structure. This paragraph only describes the arguments to be used to set the callback.

Setting any of these values while doing preedit may cause unexpected results.

13.18. XIM Callback Semantics

XIM callbacks are procedures defined by clients or text drawing packages that are to be called from the input method when selected events occur. Most clients will use a text editing package or a toolkit and, hence, will not need to define such callbacks. This section defines the callback semantics, when they are triggered, and what their arguments are. This information is mostly useful for X toolkit implementors.

Callbacks are mostly provided so that clients (or text editing packages) can implement on-the-spot preediting in their own window. In that case, the input method needs to communicate and synchronize with the client. The input method needs to communicate changes in the preedit window when it is under control of the client. Those callbacks allow the client to initialize the preedit area, display a new preedit string, move the text insertion point during preedit, terminate preedit, or update the status area.

All callback procedures follow the generic prototype:

```
void CallbackPrototype(ic, client_data, call_data)
    XIC ic;
    XPointer client_data;
    SomeType call_data;
```

ic	Specifies the input context.
client_data	Specifies the additional client data.
call_data	Specifies data specific to the callback.

The call_data argument is a structure that expresses the arguments needed to achieve the semantics; that is, it is a specific data structure appropriate to the callback. In cases where no data is needed in the callback, this call_data argument is NULL. The client_data argument is a closure that has been initially specified by the client when specifying the callback and passed back. It may serve, for example, to inherit application context in the callback.

The following paragraphs describe the programming semantics and specific data structure associated with the different reasons.

13.18.1. Geometry Callback

The geometry callback is triggered by the input method to indicate that it wants the client to negotiate geometry. The generic prototype is as follows:

```
void GeometryCallback(ic, client_data, call_data)
      XIC ic;
      XPointer client_data;
      XPointer call_data;
```

ic	Specifies the input context.
client_data	Specifies the additional client data.
call_data	Not used for this callback and always passed as NULL.

A GeometryCallback is called with a NULL call_data argument.

13.18.2. Preedit State Notify Callback

The preedit state notify callback is triggered by the input method when the preediting state has changed. The generic prototype is as follows:

```
void PreeditStateNotifyCallback(ic, client_data, call_data)
      XIC ic;
      XPointer client_data;
      XIMPreeditStateCallbackStruct *call_data;
```

ic	Specifies the input context.
client_data	Specifies the additional client data.
call_data	Specifies the current preedit state.

The **XIMPreeditStateNotifyCallbackStruct** structure is defined as follows:

```
typedef struct _XIMPreeditStateNotifyCallbackStruct {
          XIMPreeditState state;
} XIMPreeditStateNotifyCallbackStruct;
```

13.18.3. Destroy Callback

The destroy callback is triggered by the input method when it stops service for any reason. After the callback is invoked, the input context will be freed by Xlib. The generic prototype is as follows:

```
void DestroyCallback(ic, client_data, call_data)
      XIC ic;
      XPointer client_data;
      XPointer call_data;
```

ic	Specifies the input context.
client_data	Specifies the additional client data.
call_data	Not used for this callback and always passed as NULL.

The callback is called with a NULL call_data argument.

13.18.4. String Conversion Callback

The string conversion callback is triggered by the input method to request the client to return the string to be converted. The returned string may be either a multibyte or wide character string, with an encoding matching the locale bound to the input context. The callback prototype is as follows:

```
void StringConversionCallback(ic, client_data, call_data)
    XIC ic;
    XPointer client_data;
    XIMStringConversionCallbackStruct *call_data;
```

ic	Specifies the input method.
client_data	Specifies the additional client data.
call_data	Specifies the amount of the string to be converted.

The callback is passed a **XIMStringConversionCallbackStruct** structure in the call_data argument. The text member is a **XIMStringConversionText** structure (see section 13.17.9) to be filled in by the client and describes the text to be sent to the input method. The data pointed to by the string and feedback elements of the **XIMStringConversionText** structure will be freed using XFree by the input method after the callback returns. So the client should not point to internal buffers that are critical to the client.

The **XNStringConversionCallbackStruct** structure is defined as follows:

```
typedef struct _XIMStringConversionCallbackStruct {
        XIMStringConversionPosition position;
        XIMCaretDirection direction;
        short factor;
        XIMStringConversionOperation operation;
        XIMStringConversionText *text;
} XIMStringConversionCallbackStruct;

typedef short XIMStringConversionPosition;

typedef unsigned short XIMStringConversionOperation;


#define    XIMStringConversionSubstitution          (0x0001)
#define    XIMStringConversionRetrieval             (0x0002)
```

XIMStringConversionPosition specifies the starting position of the string to be returned in the **XIMStringConversionText** structure. The value identifies a position, in units of characters, relative to the client's cursor position in the client's buffer.

The ending position of the text buffer is determined by the direction and factor members. Specifically, it is the character position relative to the starting point as defined by the **XIMCaretDirection**. The factor member of **XIMStringConversionCallbackStruct** specifies the number of **XIMCaretDirection** positions to be applied. For example, if the direction specifies **XIMLineStart** and factor is 1, then all characters from the starting position to the end of the current display line are returned. If the direction specifies **XIMAbsolutePosition**, then the factor specifies a relative position, indicated in characters, from the starting position.

XIMStringConversionOperation specifies whether the string to be converted should be deleted (substitution) or copied (retrieval) from the client's buffer. When the **XIMStringConversionOperation** is **XIMStringConversionSubstitution**, the client must delete the string to be converted from its own buffer. When the **XIMStringConversionOperation** is **XIMStringConversionRetrieval**, the client must not delete the string to be converted from its buffer. The substitute operation is typically used for re-conversion and transliteration conversion, while the retrieval operation is typically used for context-sensitive conversion.

13.18.5. Preedit State Callbacks

When the input method turns preediting on or off, a PreeditStartCallback or PreeditDoneCallback callback is triggered to let the toolkit do the setup or the cleanup for the preedit region.

```
int PreeditStartCallback(ic, client_data, call_data)
    XIC ic;
    XPointer client_data;
    XPointer call_data;
```

ic	Specifies the input context.
client_data	Specifies the additional client data.
call_data	Not used for this callback and always passed as NULL.

When preedit starts on the specified input context, the callback is called with a NULL call_data argument. PreeditStartCallback will return the maximum size of the preedit string. A positive number indicates the maximum number of bytes allowed in the preedit string, and a value of −1 indicates there is no limit.

```
void PreeditDoneCallback(ic, client_data, call_data)
    XIC ic;
    XPointer client_data;
    XPointer call_data;
```

ic	Specifies the input context.
client_data	Specifies the additional client data.
call_data	Not used for this callback and always passed as NULL.

When preedit stops on the specified input context, the callback is called with a NULL call_data argument. The client can release the data allocated by PreeditStartCallback.

PreeditStartCallback should initialize appropriate data needed for displaying preedit information and for handling further PreeditDrawCallback calls. Once PreeditStartCallback is called, it will not be called again before PreeditDoneCallback has been called.

13.18.6. Preedit Draw Callback

This callback is triggered to draw and insert, delete or replace, preedit text in the preedit region. The preedit text may include unconverted input text such as Japanese Kana, converted text such as Japanese Kanji characters, or characters of both kinds. That string is either a multibyte or wide character string, whose encoding matches the locale bound to the input context. The callback prototype is as follows:

```
void PreeditDrawCallback(ic, client_data, call_data)
      XIC ic;
      XPointer client_data;
      XIMPreeditDrawCallbackStruct *call_data;
```

ic	Specifies the input context.
client_data	Specifies the additional client data.
call_data	Specifies the preedit drawing information.

The callback is passed a **XIMPreeditDrawCallbackStruct** structure in the call_data argument. The text member of this structure contains the text to be drawn. After the string has been drawn, the caret should be moved to the specified location.

The **XIMPreeditDrawCallbackStruct** structure is defined as follows:

```
typedef struct _XIMPreeditDrawCallbackStruct {
        int caret;                    /* Cursor offset within preedit string */
        int chg_first;                /* Starting change position */
        int chg_length;               /* Length of the change in character count */
        XIMText *text;
} XIMPreeditDrawCallbackStruct;
```

The client must keep updating a buffer of the preedit text and the callback arguments referring to indexes in that buffer. The call_data fields have specific meanings according to the operation, as follows:

- To indicate text deletion, the call_data specifies a NULL text field. The text to be deleted is then the current text in the buffer from position chg_first (starting at zero) on a character length of chg_length.
- When text is non-NULL, it indicates insertion or replacement of text in the buffer.

  A positive chg_length indicates that the characters starting from chg_first to ch_first+chg_length-1 must be deleted and must be replaced by text, whose length is specified in the **XIMText** structure.

  A chg_length value of zero indicates that text must be inserted right at the position specified by chg_first. A value of zero for chg_first specifies the first character in the buffer.
- The caret member is an index in the preedit text buffer that specifies the character after which the cursor should move after text has been drawn or deleted.

```
typedef struct _XIMText {
        unsigned short length;
        XIMFeedback * feedback;
        Bool encoding_is_wchar;
        union {
                char * multi_byte;
                wchar_t * wide_char;
        } string;
} XIMText;
```

The text string passed is actually a structure specifying as follows:

- The length member is the text length in characters.
- The encoding_is_wchar member is a value that indicates if the text string is encoded in wide character or multibyte format. This value should be set by the client when it sets the callback.
- The string member is the text string.
- The feedback member indicates rendering type.

The feedback member expresses the types of rendering feedback the callback should apply when drawing text. Rendering of the text to be drawn is specified either in generic ways (for example, primary, secondary) or in specific ways (reverse, underline). When generic indications are given, the client is free to choose the rendering style. It is necessary, however, that primary and secondary are mapped to two distinct rendering styles.

If an input method wants to control display of the preedit string, an input method can indicate the visibility hints using feedbacks in specific way. The **XIMVisibleToForward**, **XIMVisibleToBackward**, and **XIMVisibleCenter** masks are exclusively used for these visibility hints. The **XIMVisibleToForward** mask indicates that the preedit text is preferably displayed from the text insertion point in the preedit area forward. The **XIMVisibleToBackward** mask indicates that the preedit text is preferably displayed from the text insertion point in the preedit area backward. The **XIMVisibleCenter** mask indicates that the preedit text is preferably displayed with the text insertion point in the preedit area centered.

The insertion point of the preedit string could exist outside of the visible area when visibility hints are used. Only one of the masks is valid for the entire preedit string, and only one character can hold one of these feedbacks for a given input context at one time. Only the most recently set feedback is valid, and any previous feedback is automatically canceled. This is a hint to the client, and the client is free to choose how to display the preedit string.

The feedback member also specifies how rendering of the text argument should be performed. If the feedback is NULL, then rendering is assumed to be the same as rendering of other characters in the text entry. Otherwise, it specifies an array defining the rendering for each character of the string, and the length of the array is thus length.

If an input method wants to indicate that it is only updating the feedback of the preedit text without changing the content of it, the **XIMText** structure will contain a NULL value for the string field, the number of characters affected will be in the length field, and the feedback field will point to an array of **XIMFeedback**.

Each element in the feedback array is a bitmask represented by a value of type **XIMFeedback**. The valid masks names are as follows:

```
typedef unsigned long XIMFeedback;

#define    XIMReverse               1L
#define    XIMUnderline             (1L<<1)
#define    XIMHighlight             (1L<<2)
#define    XIMPrimary               (1L<<5)
#define    XIMSecondary             (1L<<6)
#define    XIMTertiary              (1L<<7)
#define    XIMVisibleToForward      (1L<<8)
#define    XIMVisibleToBackward     (1L<<9)
#define    XIMVisibleCenter         (1L<<10)
```

13.18.7. Preedit Caret Callback

An input method may have its own navigation keys to allow the user to move the text insertion point in the preedit area (for example, to move backward or forward). Consequently, input method needs to indicate to the client that it should move the text insertion point. It then calls the PreeditCaretCallback.

```
void PreeditCaretCallback(ic, client_data, call_data)
    XIC ic;
    XPointer client_data;
    XIMPreeditCaretCallbackStruct *call_data;
```

ic	Specifies the input context.
client_data	Specifies the additional client data.
call_data	Specifies the preedit caret information.

The input method will trigger PreeditCaretCallback to move the text insertion point during preedit. The call_data argument contains a pointer to an **XIMPreeditCaretCallbackStruct** structure, which indicates where the caret should be moved. The callback must move the insertion point to its new location and return, in field position, the new offset value from the initial position.

The **XIMPreeditCaretCallbackStruct** structure is defined as follows:

```
typedef struct _XIMPreeditCaretCallbackStruct {
        int position;                    /* Caret offset within preedit string */
        XIMCaretDirection direction;     /* Caret moves direction */
        XIMCaretStyle style;             /* Feedback of the caret */
} XIMPreeditCaretCallbackStruct;
```

The **XIMCaretStyle** structure is defined as follows:

```
typedef enum {
        XIMIsInvisible,             /* Disable caret feedback */
        XIMIsPrimary,               /* UI defined caret feedback */
        XIMIsSecondary,             /* UI defined caret feedback */
} XIMCaretStyle;
```

The **XIMCaretDirection** structure is defined as follows:

```
typedef enum {
        XIMForwardChar, XIMBackwardChar,
        XIMForwardWord, XIMBackwardWord,
        XIMCaretUp, XIMCaretDown,
        XIMNextLine, XIMPreviousLine,
        XIMLineStart, XIMLineEnd,
        XIMAbsolutePosition,
        XIMDontChange,
 } XIMCaretDirection;
```

These values are defined as follows:

XIMForwardChar	Move the caret forward one character position.
XIMBackwardChar	Move the caret backward one character position.
XIMForwardWord	Move the caret forward one word position.
XIMBackwardWord	Move the caret backward one word position.
XIMCaretUp	Move the caret up one line keeping the current offset.
XIMCaretDown	Move the caret down one line keeping the current offset.
XIMPreviousLine	Move the caret up one line.
XIMNextLine	Move the caret down one line.
XIMLineStart	Move the caret to the beginning of the current display line that contains the caret.
XIMLineEnd	Move the caret to the end of the current display line that contains the caret.
XIMAbsolutePosition	The callback must move to the location specified by the position field of the callback data, indicated in characters, starting from the beginning of the preedit text. Hence, a value of zero means move back to the beginning of the preedit text.
XIMDontChange	The caret position does not change.

13.18.8. Status Callbacks

An input method may communicate changes in the status of an input context (for example, created, destroyed, or focus changes) with three status callbacks: StatusStartCallback, StatusDoneCallback, and StatusDrawCallback.

When the input context is created or gains focus, the input method calls the StatusStartCallback callback.

void StatusStartCallback(*ic*, *client_data*, *call_data*)
  XIC *ic*;
  XPointer *client_data*;
  XPointer *call_data*;

ic	Specifies the input context.
client_data	Specifies the additional client data.
call_data	Not used for this callback and always passed as NULL.

The callback should initialize appropriate data for displaying status and be prepared to further StatusDrawCallback calls. Once StatusStartCallback is called, it will not be called again before StatusDoneCallback has been called.

When an input context is destroyed or when it loses focus, the input method calls StatusDoneCallback.

void StatusDoneCallback(*ic*, *client_data*, *call_data*)
  XIC *ic*;
  XPointer *client_data*;
  XPointer *call_data*;

ic	Specifies the input context.
client_data	Specifies the additional client data.
call_data	Not used for this callback and always passed as NULL.

The callback may release any data allocated on **StatusStart**.

When an input context status has to be updated, the input method calls StatusDrawCallback.

void StatusDrawCallback(*ic*, *client_data*, *call_data*)
  XIC *ic*;
  XPointer *client_data*;
  XIMStatusDrawCallbackStruct **call_data*;

ic	Specifies the input context.
client_data	Specifies the additional client data.
call_data	Specifies the status drawing information.

The callback should update the status area by either drawing a string or imaging a bitmap in the status area.

The **XIMStatusDataType** and **XIMStatusDrawCallbackStruct** structures are defined as follows:

```
typedef enum {
        XIMTextType,
        XIMBitmapType,
} XIMStatusDataType;

typedef struct _XIMStatusDrawCallbackStruct {
        XIMStatusDataType type;
        union {
                XIMText *text;
                Pixmap  bitmap;
        } data;
} XIMStatusDrawCallbackStruct;
```

13.19. Event Filtering

Xlib provides the ability for an input method to register a filter internal to Xlib. This filter is called by a client (or toolkit) by calling **XFilterEvent** after calling **XNextEvent**. Any client that uses the **XIM** interface should call **XFilterEvent** to allow input methods to process their events without knowledge of the client's dispatching mechanism. A client's user interface policy may determine the priority of event filters with respect to other event handling mechanisms (for example, modal grabs).

Clients may not know how many filters there are, if any, and what they do. They may only know if an event has been filtered on return of **XFilterEvent**. Clients should discard filtered events.

To filter an event, use **XFilterEvent**.

```
Bool XFilterEvent(event, w)
    XEvent *event;
    Window w;
```

event	Specifies the event to filter.
w	Specifies the window for which the filter is to be applied.

If the window argument is **None**, **XFilterEvent** applies the filter to the window specified in the **XEvent** structure. The window argument is provided so that layers above Xlib that do event redirection can indicate to which window an event has been redirected.

If **XFilterEvent** returns **True**, then some input method has filtered the event, and the client should discard the event. If **XFilterEvent** returns **False**, then the client should continue processing the event.

If a grab has occurred in the client and **XFilterEvent** returns **True**, the client should ungrab the keyboard.

13.20. Getting Keyboard Input

To get composed input from an input method, use **XmbLookupString** or **XwcLookupString**.

```
int XmbLookupString(ic, event, buffer_return, bytes_buffer, keysym_return, status_return)
      XIC ic;
      XKeyPressedEvent *event;
      char *buffer_return;
      int bytes_buffer;
      KeySym *keysym_return;
      Status *status_return;

int XwcLookupString(ic, event, buffer_return, bytes_buffer, keysym_return, status_return)
      XIC ic;
      XKeyPressedEvent *event;
      wchar_t *buffer_return;
      int wchars_buffer;
      KeySym *keysym_return;
      Status *status_return;
```

ic	Specifies the input context.
event	Specifies the key event to be used.
buffer_return	Returns a multibyte string or wide character string (if any) from the input method.
bytes_buffer	
wchars_buffer	Specifies space available in the return buffer.
keysym_return	Returns the KeySym computed from the event if this argument is not NULL.
status_return	Returns a value indicating what kind of data is returned.

The **XmbLookupString** and **XwcLookupString** functions return the string from the input method specified in the buffer_return argument. If no string is returned, the buffer_return argument is unchanged.

The KeySym into which the KeyCode from the event was mapped is returned in the keysym_return argument if it is non-NULL and the status_return argument indicates that a KeySym was returned. If both a string and a KeySym are returned, the KeySym value does not necessarily correspond to the string returned.

XmbLookupString returns the length of the string in bytes, and **XwcLookupString** returns the length of the string in characters. Both **XmbLookupString** and **XwcLookupString** return text in the encoding of the locale bound to the input method of the specified input context.

Each string returned by **XmbLookupString** and **XwcLookupString** begins in the initial state of the encoding of the locale (if the encoding of the locale is state-dependent).

Note

> To insure proper input processing, it is essential that the client pass only **KeyPress** events to **XmbLookupString** and **XwcLookupString**. Their behavior when a client passes a **KeyRelease** event is undefined.

Clients should check the status_return argument before using the other returned values. These two functions both return a value to status_return that indicates what has been returned in the other arguments. The possible values returned are:

XBufferOverflow	The input string to be returned is too large for the supplied buffer_return. The required size (**XmbLookupString** in bytes; **XwcLookupString** in characters) is returned as the value of the function, and the contents of buffer_return and keysym_return are not modified. The client should recall the function with the same event and a buffer of adequate size to obtain the string.
XLookupNone	No consistent input has been composed so far. The contents of buffer_return and keysym_return are not modified, and the function returns zero.
XLookupChars	Some input characters have been composed. They are placed in the buffer_return argument, and the string length is returned as the value of the function. The string is encoded in the locale bound to the input context. The content of the keysym_return argument is not modified.
XLookupKeySym	A KeySym has been returned instead of a string and is returned in keysym_return. The content of the buffer_return argument is not modified, and the function returns zero.
XLookupBoth	Both a KeySym and a string are returned; **XLookupChars** and **XLookupKeySym** occur simultaneously.

It does not make any difference if the input context passed as an argument to **XmbLookupString** and **XwcLookupString** is the one currently in possession of the focus or not. Input may have been composed within an input context before it lost the focus, and that input may be returned on subsequent calls to **XmbLookupString** or **XwcLookupString** even though it does not have any more keyboard focus.

13.21. Input Method Conventions

The input method architecture is transparent to the client. However, clients should respect a number of conventions in order to work properly. Clients must also be aware of possible effects of synchronization between input method and library in the case of a remote input server.

13.21.1. Client Conventions

A well-behaved client (or toolkit) should first query the input method style. If the client cannot satisfy the requirements of the supported styles (in terms of geometry management or callbacks), it should negotiate with the user continuation of the program or raise an exception or error of some sort.

13.21.2. Synchronization Conventions

A **KeyPress** event with a KeyCode of zero is used exclusively as a signal that an input method has composed input that can be returned by **XmbLookupString** or **XwcLookupString**. No other use is made of a **KeyPress** event with KeyCode of zero.

Such an event may be generated by either a front-end or a back-end input method in an implementation dependent manner. Some possible ways to generate this event include:

- A synthetic event sent by an input method server
- An artificial event created by a input method filter and pushed onto a client’s event queue
- A **KeyPress** event whose KeyCode value is modified by an input method filter

When callback support is specified by client, input methods will not take action unless they explicitly called back the client and obtained no response (the callback is not specified or returned invalid data).

13.22. String Constants

The following symbols for string constants are defined in **<X11/Xlib.h>**. Although they are shown here with particular macro definitions, they may be implemented as macros, as global symbols, or as a mixture of the two. The string pointer value itself is not significant; clients must not assume that inequality of two values implies inequality of the actual string data.

```
#define    XNVaNestedList                      "XNVaNestedList"
#define    XNQueryInputStyle                   "queryInputStyle"
#define    XNClientWindow                      "clientWindow"
#define    XNInputStyle                        "inputStyle"
#define    XNFocusWindow                       "focusWindow"
#define    XNResourceName                      "resourceName"
#define    XNResourceClass                     "resourceClass"
#define    XNGeometryCallback                  "geometryCallback"
#define    XNDestroyCallback                   "destroyCallback"
#define    XNFilterEvents                      "filterEvents"
#define    XNPreeditStartCallback              "preeditStartCallback"
#define    XNPreeditDoneCallback               "preeditDoneCallback"
#define    XNPreeditDrawCallback               "preeditDrawCallback"
#define    XNPreeditCaretCallback              "preeditCaretCallback"
#define    XNPreeditStateNotifyCallback        "preeditStateNotifyCallback"
#define    XNPreeditAttributes                 "preeditAttributes"
#define    XNStatusStartCallback               "statusStartCallback"
#define    XNStatusDoneCallback                "statusDoneCallback"
#define    XNStatusDrawCallback                "statusDrawCallback"
#define    XNStatusAttributes                  "statusAttributes"
#define    XNArea                              "area"
#define    XNAreaNeeded                        "areaNeeded"
#define    XNSpotLocation                      "spotLocation"
#define    XNColormap                          "colorMap"
#define    XNStdColormap                       "stdColorMap"
#define    XNForeground                        "foreground"
#define    XNBackground                        "background"
#define    XNBackgroundPixmap                  "backgroundPixmap"
#define    XNFontSet                           "fontSet"
#define    XNLineSpace                         "lineSpace"
#define    XNCursor                            "cursor"
```

```
#define    XNStatusStartCallback               "statusStartCallback"
#define    XNStatusDoneCallback                "statusDoneCallback"
#define    XNStatusDrawCallback                "statusDrawCallback"
#define    XNStatusAttributes                  "statusAttributes"
#define    XNArea                              "area"
#define    XNAreaNeeded                        "areaNeeded"
#define    XNSpotLocation                      "spotLocation"
#define    XNColormap                          "colorMap"
#define    XNStdColormap                       "stdColorMap"
#define    XNForeground                        "foreground"
#define    XNBackground                        "background"
```

```
#define   XNBackgroundPixmap                  "backgroundPixmap"
#define   XNFontSet                           "fontSet"
#define   XNLineSpace                         "lineSpace"
#define   XNCursor                            "cursor"
#define   XNQueryIMValuesList                 "queryIMValuesList"
#define   XNQueryICValuesList                 "queryICValuesList"
#define   XNStringConversionCallback          "stringConversionCallback"
#define   XNStringConversion                  "stringConversion"
#define   XNResetState                        "resetState"
#define   XNHotKey                            "hotkey"
#define   XNHotKeyState                       "hotkeyState"
#define   XNPreeditState                      "preeditState"

#define   XNRequiredCharSet                   "requiredCharSet"
#define   XNQueryOrientation                  "queryOrientation"
#define   XNDirectionalDependentDrawing       "directionalDependentDrawing"
#define   XNContextualDrawing                 "contextualDrawing"
#define   XNBaseFontName                      "baseFontName"
#define   XNMissingCharSet                    "missingCharSet"
#define   XNDefaultString                     "defaultString"
#define   XNOrientation                       "orientation"
#define   XNDirectionalDependentDrawing       "directionalDependentDrawing"
#define   XNContextualDrawing                 "contextualDrawing"
#define   XNFontInfo                          "fontInfo"
```

Chapter 14

Inter-Client Communication Functions

The *Inter-Client Communication Conventions Manual*, hereafter referred to as the ICCCM, details the X Consortium approved conventions that govern inter-client communications. These conventions ensure peer-to-peer client cooperation in the use of selections, cut buffers, and shared resources as well as client cooperation with window and session managers. For further information, see the *Inter-Client Communication Conventions Manual*.

Xlib provides a number of standard properties and programming interfaces that are ICCCM compliant. The predefined atoms for some of these properties are defined in the **<X11/Xatom.h>** header file, where to avoid name conflicts with user symbols their **#define** name has an XA_ prefix. For further information about atoms and properties, see section 4.3.

Xlib's selection and cut buffer mechanisms provide the primary programming interfaces by which peer client applications communicate with each other (see sections 4.5 and 16.6). The functions discussed in this chapter provide the primary programming interfaces by which client applications communicate with their window and session managers as well as share standard colormaps.

The standard properties that are of special interest for communicating with window and session managers are:

Name	Type	Format	Description
WM_CLASS	STRING	8	Set by application programs to allow window and session managers to obtain the application's resources from the resource database.
WM_CLIENT_MACHINE	TEXT		The string name of the machine on which the client application is running.
WM_COLORMAP_WINDOWS	WINDOW	32	The list of window IDs that may need a different colormap than that of their top-level window.
WM_COMMAND	TEXT		The command and arguments, null-separated, used to invoke the application.
WM_HINTS	WM_HINTS	32	Additional hints set by the client for use by the window manager. The C type of this property is **XWMHints**.
WM_ICON_NAME	TEXT		The name to be used in an icon.

Name	**Type**	**Format**	**Description**
WM_ICON_SIZE	WM_ICON_SIZE	32	The window manager may set this property on the root window to specify the icon sizes it supports. The C type of this property is **XIconSize**.
WM_NAME	TEXT		The name of the application.
WM_NORMAL_HINTS	WM_SIZE_HINTS	32	Size hints for a window in its normal state. The C type of this property is **XSizeHints**.
WM_PROTOCOLS	ATOM	32	List of atoms that identify the communications protocols between the client and window manager in which the client is willing to participate.
WM_STATE	WM_STATE	32	Intended for communication between window and session managers only.
WM_TRANSIENT_FOR	WINDOW	32	Set by application programs to indicate to the window manager that a transient top-level window, such as a dialog box.

The remainder of this chapter discusses:

- Client-to-window-manager communication
- Client-to-session-manager communication
- Standard colormaps

14.1. Client to Window Manager Communication

This section discusses how to:

- Manipulate top-level windows
- Convert string lists
- Set and read text properties
- Set and read the WM_NAME property
- Set and read the WM_ICON_NAME property
- Set and read the WM_HINTS property
- Set and read the WM_NORMAL_HINTS property
- Set and read the WM_CLASS property
- Set and read the WM_TRANSIENT_FOR property
- Set and read the WM_PROTOCOLS property
- Set and read the WM_COLORMAP_WINDOWS property

- Set and read the WM_ICON_SIZE property
- Use window manager convenience functions

14.1.1. Manipulating Top-Level Windows

Xlib provides functions that you can use to change the visibility or size of top-level windows (that is, those that were created as children of the root window). Note that the subwindows that you create are ignored by window managers. Therefore, you should use the basic window functions described in chapter 3 to manipulate your application's subwindows.

To request that a top-level window be iconified, use **XIconifyWindow**.

```
Status XIconifyWindow(display, w, screen_number)
    Display *display;
    Window w;
    int screen_number;
```

display	Specifies the connection to the X server.
w	Specifies the window.
screen_number	Specifies the appropriate screen number on the host server.

The **XIconifyWindow** function sends a WM_CHANGE_STATE **ClientMessage** event with a format of 32 and a first data element of **IconicState** (as described in section 4.1.4 of the *Inter-Client Communication Conventions Manual*) and a window of w to the root window of the specified screen with an event mask set to **SubstructureNotifyMask| SubstructureRedirectMask**. Window managers may elect to receive this message and if the window is in its normal state, may treat it as a request to change the window's state from normal to iconic. If the WM_CHANGE_STATE property cannot be interned, **XIconifyWindow** does not send a message and returns a zero status. It returns a nonzero status if the client message is sent successfully; otherwise, it returns a zero status.

To request that a top-level window be withdrawn, use **XWithdrawWindow**.

```
Status XWithdrawWindow(display, w, screen_number)
    Display *display;
    Window w;
    int screen_number;
```

display	Specifies the connection to the X server.
w	Specifies the window.
screen_number	Specifies the appropriate screen number on the host server.

The **XWithdrawWindow** function unmaps the specified window and sends a synthetic **UnmapNotify** event to the root window of the specified screen. Window managers may elect to receive this message and may treat it as a request to change the window's state to withdrawn. When a window is in the withdrawn state, neither its normal nor its iconic representations is visible. It returns a nonzero status if the **UnmapNotify** event is successfully sent; otherwise, it returns a zero status.

XWithdrawWindow can generate a **BadWindow** error.

To request that a top-level window be reconfigured, use **XReconfigureWMWindow**.

```
Status XReconfigureWMWindow(display, w, screen_number, value_mask, values)
      Display *display;
      Window w;
      int screen_number;
      unsigned int value_mask;
      XWindowChanges *values;
```

display	Specifies the connection to the X server.
w	Specifies the window.
screen_number	Specifies the appropriate screen number on the host server.
value_mask	Specifies which values are to be set using information in the values structure. This mask is the bitwise inclusive OR of the valid configure window values bits.
values	Specifies the **XWindowChanges** structure.

The **XReconfigureWMWindow** function issues a **ConfigureWindow** request on the specified top-level window. If the stacking mode is changed and the request fails with a **BadMatch** error, the error is trapped by Xlib and a synthetic **ConfigureRequestEvent** containing the same configuration parameters is sent to the root of the specified window. Window managers may elect to receive this event and treat it as a request to reconfigure the indicated window. It returns a nonzero status if the request or event is successfully sent; otherwise, it returns a zero status.

XReconfigureWMWindow can generate **BadValue** and **BadWindow** errors.

14.1.2. Converting String Lists

Many of the text properties allow a variety of types and formats. Because the data stored in these properties are not simple null-terminated strings, a **XTextProperty** structure is used to describe the encoding, type, and length of the text as well as its value. The **XTextProperty** structure contains:

```
typedef struct {
        unsigned char *value;          /* property data */
        Atom encoding;                 /* type of property */
        int format;                    /* 8, 16, or 32 */
        unsigned long nitems;          /* number of items in value */
} XTextProperty;
```

Xlib provides functions to convert localized text to or from encodings that support the inter-client communication conventions for text. In addition, functions are provided for converting between lists of pointers to character strings and text properties in the STRING encoding.

The functions for localized text return a signed integer error status that encodes **Success** as zero, specific error conditions as negative numbers, and partial conversion as a count of unconvertible characters.

```
#define     XNoMemory                   −1
#define     XLocaleNotSupported         −2
#define     XConverterNotFound          −3

typedef enum {
        XStringStyle,               /* STRING */
        XCompoundTextStyle,         /* COMPOUND_TEXT */
        XTextStyle,                 /* text in owner’s encoding (current locale) */
        XStdICCTextStyle            /* STRING, else COMPOUND_TEXT */
} XICCEncodingStyle;
```

To convert a list of text strings to an **XTextProperty** structure, use **XmbTextListToTextProperty** or **XwcTextListToTextProperty**.

```
int XmbTextListToTextProperty(display, list, count, style, text_prop_return)
    Display *display;
    char **list;
    int count;
    XICCEncodingStyle style;
    XTextProperty *text_prop_return;

int XwcTextListToTextProperty(display, list, count, style, text_prop_return)
    Display *display;
    wchar_t **list;
    int count;
    XICCEncodingStyle style;
    XTextProperty *text_prop_return;
```

display	Specifies the connection to the X server.
list	Specifies a list of null-terminated character strings.
count	Specifies the number of strings specified.
style	Specifies the manner in which the property is encoded.
text_prop_return	Returns the **XTextProperty** structure.

The **XmbTextListToTextProperty** and **XwcTextListToTextProperty** functions set the specified **XTextProperty** value to a set of null-separated elements representing the concatenation of the specified list of null-terminated text strings. A final terminating null is stored at the end of the value field of text_prop_return but is not included in the nitems member.

The functions set the encoding field of text_prop_return to an **Atom** for the specified display naming the encoding determined by the specified style and convert the specified text list to this encoding for storage in the text_prop_return value field. If the style **XStringStyle** or **XCompoundTextStyle** is specified, this encoding is ‘‘STRING’’ or ‘‘COMPOUND_TEXT’’, respectively. If the style **XTextStyle** is specified, this encoding is the encoding of the current locale. If the style **XStdICCTextStyle** is specified, this encoding is ‘‘STRING’’ if the text is fully convertible to STRING, else ‘‘COMPOUND_TEXT’’.

If insufficient memory is available for the new value string, the functions return **XNoMemory**. If the current locale is not supported, the functions return **XLocaleNotSupported**. In both of these error cases, the functions do not set text_prop_return.

To determine if the functions are guaranteed not to return **XLocaleNotSupported**, use **XSupportsLocale**.

If the supplied text is not fully convertible to the specified encoding, the functions return the number of unconvertible characters. Each unconvertible character is converted to an implementation-defined and encoding-specific default string. Otherwise, the functions return **Success**. Note that full convertibility to all styles except **XStringStyle** is guaranteed.

To free the storage for the value field, use **XFree**.

To obtain a list of text strings from an **XTextProperty** structure, use **XmbTextPropertyToTextList** or **XwcTextPropertyToTextList**.

int XmbTextPropertyToTextList(*display*, *text_prop*, *list_return*, *count_return*)
  Display **display*;
  XTextProperty **text_prop*;
  char ****list_return*;
  int **count_return*;

int XwcTextPropertyToTextList(*display*, *text_prop*, *list_return*, *count_return*)
  Display **display*;
  XTextProperty **text_prop*;
  wchar_t ****list_return*;
  int **count_return*;

display	Specifies the connection to the X server.
text_prop	Specifies the **XTextProperty** structure to be used.
list_return	Returns a list of null-terminated character strings.
count_return	Returns the number of strings.

The **XmbTextPropertyToTextList** and **XwcTextPropertyToTextList** functions return a list of text strings in the current locale representing the null-separated elements of the specified **XTextProperty** structure. The data in text_prop must be format 8.

Multiple elements of the property (for example, the strings in a disjoint text selection) are separated by a null byte. The contents of the property are not required to be null-terminated; any terminating null should not be included in text_prop.nitems.

If insufficient memory is available for the list and its elements, **XmbTextPropertyToTextList** and **XwcTextPropertyToTextList** return **XNoMemory**. If the current locale is not supported, the functions return **XLocaleNotSupported**. Otherwise, if the encoding field of text_prop is not convertible to the encoding of the current locale, the functions return **XConverterNotFound**. For supported locales, existence of a converter from COMPOUND_TEXT, STRING or the encoding of the current locale is guaranteed if **XSupportsLocale** returns **True** for the current locale (but the actual text may contain unconvertible characters). Conversion of other encodings is implementation dependent. In all of these error cases, the functions do not set any return values.

Otherwise, **XmbTextPropertyToTextList** and **XwcTextPropertyToTextList** return the list of null-terminated text strings to list_return and the number of text strings to count_return.

If the value field of text_prop is not fully convertible to the encoding of the current locale, the functions return the number of unconvertible characters. Each unconvertible character is converted to a string in the current locale that is specific to the current locale. To obtain the value of this string, use **XDefaultString**. Otherwise, **XmbTextPropertyToTextList** and **XwcTextPropertyToTextList** return **Success**.

To free the storage for the list and its contents returned by **XmbTextPropertyToTextList**, use **XFreeStringList**. To free the storage for the list and its contents returned by **XwcTextPropertyToTextList**, use **XwcFreeStringList**.

To free the in-memory data associated with the specified wide character string list, use **XwcFreeStringList**.

```
void XwcFreeStringList(list)
     wchar_t **list;
```

list	Specifies the list of strings to be freed.

The **XwcFreeStringList** function frees memory allocated by **XwcTextPropertyToTextList**.

To obtain the default string for text conversion in the current locale, use **XDefaultString**.

```
char *XDefaultString( )
```

The **XDefaultString** function returns the default string used by Xlib for text conversion (for example, in **XmbTextPropertyToTextList**). The default string is the string in the current locale that is output when an unconvertible character is found during text conversion. If the string returned by **XDefaultString** is the empty string (""), no character is output in the converted text. **XDefaultString** does not return NULL.

The string returned by **XDefaultString** is independent of the default string for text drawing; see **XCreateFontSet** to obtain the default string for an **XFontSet**.

The behavior when an invalid codepoint is supplied to any Xlib function is undefined.

The returned string is null-terminated. It is owned by Xlib and should not be modified or freed by the client. It may be freed after the current locale is changed. Until freed, it will not be modified by Xlib.

To set the specified list of strings in the STRING encoding to a **XTextProperty** structure, use **XStringListToTextProperty**.

```
Status XStringListToTextProperty(list, count, text_prop_return)
      char **list;
      int count;
      XTextProperty *text_prop_return;
```

list	Specifies a list of null-terminated character strings.
count	Specifies the number of strings.
text_prop_return	Returns the **XTextProperty** structure.

The **XStringListToTextProperty** function sets the specified **XTextProperty** to be of type STRING (format 8) with a value representing the concatenation of the specified list of null-separated character strings. An extra null byte (which is not included in the nitems member) is stored at the end of the value field of text_prop_return. The strings are assumed (without verification) to be in the STRING encoding. If insufficient memory is available for the new value string, **XStringListToTextProperty** does not set any fields in the **XTextProperty** structure and returns a zero status. Otherwise, it returns a nonzero status. To free the storage for the value field, use **XFree**.

To obtain a list of strings from a specified **XTextProperty** structure in the STRING encoding, use **XTextPropertyToStringList**.

```
Status XTextPropertyToStringList(text_prop, list_return, count_return)
      XTextProperty *text_prop;
      char ***list_return;
      int *count_return;
```

text_prop	Specifies the **XTextProperty** structure to be used.
list_return	Returns a list of null-terminated character strings.
count_return	Returns the number of strings.

The **XTextPropertyToStringList** function returns a list of strings representing the null-separated elements of the specified **XTextProperty** structure. The data in text_prop must be of type STRING and format 8. Multiple elements of the property (for example, the strings in a disjoint text selection) are separated by NULL (encoding 0). The contents of the property are not null-terminated. If insufficient memory is available for the list and its elements, **XTextPropertyToStringList** sets no return values and returns a zero status. Otherwise, it returns a nonzero status. To free the storage for the list and its contents, use **XFreeStringList**.

To free the in-memory data associated with the specified string list, use **XFreeStringList**.

```
void XFreeStringList(list)
      char **list;
```

list	Specifies the list of strings to be freed.

The **XFreeStringList** function releases memory allocated by **XmbTextPropertyToTextList** and **XTextPropertyToStringList** and the missing charset list allocated by **XCreateFontSet**.

14.1.3. Setting and Reading Text Properties

Xlib provides two functions that you can use to set and read the text properties for a given window. You can use these functions to set and read those properties of type TEXT (WM_NAME, WM_ICON_NAME, WM_COMMAND, and WM_CLIENT_MACHINE). In addition, Xlib provides separate convenience functions that you can use to set each of these properties. For further information about these convenience functions, see sections 14.1.4, 14.1.5, 14.2.1, and 14.2.2, respectively.

To set one of a window's text properties, use **XSetTextProperty**.

void XSetTextProperty(*display*, *w*, *text_prop*, *property*)
    Display **display*;
    Window *w*;
    XTextProperty **text_prop*;
    Atom *property*;

display	Specifies the connection to the X server.
w	Specifies the window.
text_prop	Specifies the **XTextProperty** structure to be used.
property	Specifies the property name.

The **XSetTextProperty** function replaces the existing specified property for the named window with the data, type, format, and number of items determined by the value field, the encoding field, the format field, and the nitems field, respectively, of the specified **XTextProperty** structure. If the property does not already exist, **XSetTextProperty** sets it for the specified window.

XSetTextProperty can generate **BadAlloc**, **BadAtom**, **BadValue**, and **BadWindow** errors.

To read one of a window's text properties, use **XGetTextProperty**.

Status XGetTextProperty(*display*, *w*, *text_prop_return*, *property*)
    Display **display*;
    Window *w*;
    XTextProperty **text_prop_return*;
    Atom *property*;

display	Specifies the connection to the X server.
w	Specifies the window.
text_prop_return	Returns the **XTextProperty** structure.
property	Specifies the property name.

The **XGetTextProperty** function reads the specified property from the window and stores the data in the returned **XTextProperty** structure. It stores the data in the value field, the type of the data in the encoding field, the format of the data in the format field, and the number of items of data in the nitems field. An extra byte containing null (which is not included in the nitems member) is stored at the end of the value field of text_prop_return. The particular interpretation of the property's encoding and data as text is left to the calling application. If the specified property does not exist on the window, **XGetTextProperty** sets the value field to NULL, the encoding field to **None**, the format field to zero, and the nitems field to zero.

If it was able to read and store the data in the **XTextProperty** structure, **XGetTextProperty** returns a nonzero status; otherwise, it returns a zero status.

XGetTextProperty can generate **BadAtom** and **BadWindow** errors.

14.1.4. Setting and Reading the WM_NAME Property

Xlib provides convenience functions that you can use to set and read the WM_NAME property for a given window.

To set a window's WM_NAME property with the supplied convenience function, use **XSetWMName**.

void XSetWMName(*display*, *w*, *text_prop*)
    Display **display*;
    Window *w*;
    XTextProperty **text_prop*;

display	Specifies the connection to the X server.
w	Specifies the window.
text_prop	Specifies the **XTextProperty** structure to be used.

The **XSetWMName** convenience function calls **XSetTextProperty** to set the WM_NAME property.

To read a window's WM_NAME property with the supplied convenience function, use **XGetWMName**.

Status XGetWMName(*display*, *w*, *text_prop_return*)
    Display **display*;
    Window *w*;
    XTextProperty **text_prop_return*;

display	Specifies the connection to the X server.
w	Specifies the window.
text_prop_return	Returns the **XTextProperty** structure.

The **XGetWMName** convenience function calls **XGetTextProperty** to obtain the WM_NAME property. It returns a nonzero status on success; otherwise, it returns a zero status.

The following two functions have been superseded by **XSetWMName** and **XGetWMName**, respectively. You can use these additional convenience functions for window names that are encoded as STRING properties.

To assign a name to a window, use **XStoreName**.

```
XStoreName(display, w, window_name)
    Display *display;
    Window w;
    char *window_name;
```

display	Specifies the connection to the X server.
w	Specifies the window.
window_name	Specifies the window name, which should be a null-terminated string.

The **XStoreName** function assigns the name passed to window_name to the specified window. A window manager can display the window name in some prominent place, such as the title bar, to allow users to identify windows easily. Some window managers may display a window's name in the window's icon, although they are encouraged to use the window's icon name if one is provided by the application. If the string is not in the Host Portable Character Encoding, the result is implementation dependent.

XStoreName can generate **BadAlloc** and **BadWindow** errors.

To get the name of a window, use **XFetchName**.

```
Status XFetchName(display, w, window_name_return)
    Display *display;
    Window w;
    char **window_name_return;
```

display	Specifies the connection to the X server.
w	Specifies the window.
window_name_return	Returns the window name, which is a null-terminated string.

The **XFetchName** function returns the name of the specified window. If it succeeds, it returns a nonzero status; otherwise, no name has been set for the window, and it returns zero. If the WM_NAME property has not been set for this window, **XFetchName** sets window_name_return to NULL. If the data returned by the server is in the Latin Portable Character Encoding, then the returned string is in the Host Portable Character Encoding. Otherwise, the result is implementation dependent. When finished with it, a client must free the window name string using **XFree**.

XFetchName can generate a **BadWindow** error.

14.1.5. Setting and Reading the WM_ICON_NAME Property

Xlib provides convenience functions that you can use to set and read the WM_ICON_NAME property for a given window.

To set a window's WM_ICON_NAME property, use **XSetWMIconName**.

```
void XSetWMIconName(display, w, text_prop)
      Display *display;
      Window w;
      XTextProperty *text_prop;
```

display	Specifies the connection to the X server.
w	Specifies the window.
text_prop	Specifies the **XTextProperty** structure to be used.

The **XSetWMIconName** convenience function calls **XSetTextProperty** to set the WM_ICON_NAME property.

To read a window's WM_ICON_NAME property, use **XGetWMIconName**.

```
Status XGetWMIconName(display, w, text_prop_return)
      Display *display;
      Window w;
      XTextProperty *text_prop_return;
```

display	Specifies the connection to the X server.
w	Specifies the window.
text_prop_return	Returns the **XTextProperty** structure.

The **XGetWMIconName** convenience function calls **XGetTextProperty** to obtain the WM_ICON_NAME property. It returns a nonzero status on success; otherwise, it returns a zero status.

The next two functions have been superseded by **XSetWMIconName** and **XGetWMIconName**, respectively. You can use these additional convenience functions for window names that are encoded as STRING properties.

To set the name to be displayed in a window's icon, use **XSetIconName**.

```
XSetIconName(display, w, icon_name)
      Display *display;
      Window w;
      char *icon_name;
```

display	Specifies the connection to the X server.
w	Specifies the window.
icon_name	Specifies the icon name, which should be a null-terminated string.

If the string is not in the Host Portable Character Encoding, the result is implementation dependent. **XSetIconName** can generate **BadAlloc** and **BadWindow** errors.

To get the name a window wants displayed in its icon, use **XGetIconName**.

```
Status XGetIconName(display, w, icon_name_return)
      Display *display;
      Window w;
      char **icon_name_return;
```

display Specifies the connection to the X server.

w Specifies the window.

icon_name_return
Returns the window’s icon name, which is a null-terminated string.

The **XGetIconName** function returns the name to be displayed in the specified window’s icon. If it succeeds, it returns a nonzero status; otherwise, if no icon name has been set for the window, it returns zero. If you never assigned a name to the window, **XGetIconName** sets icon_name_return to NULL. If the data returned by the server is in the Latin Portable Character Encoding, then the returned string is in the Host Portable Character Encoding. Otherwise, the result is implementation dependent. When finished with it, a client must free the icon name string using **XFree**.

XGetIconName can generate a **BadWindow** error.

14.1.6. Setting and Reading the WM_HINTS Property

Xlib provides functions that you can use to set and read the WM_HINTS property for a given window. These functions use the flags and the **XWMHints** structure, as defined in the **<X11/Xutil.h>** header file.

To allocate an **XWMHints** structure, use **XAllocWMHints**.

```
XWMHints *XAllocWMHints()
```

The **XAllocWMHints** function allocates and returns a pointer to a **XWMHints** structure. Note that all fields in the **XWMHints** structure are initially set to zero. If insufficient memory is available, **XAllocWMHints** returns NULL. To free the memory allocated to this structure, use **XFree**.

The **XWMHints** structure contains:

```
/* Window manager hints mask bits */

#define    InputHint                      (1L << 0)
#define    StateHint                      (1L << 1)
#define    IconPixmapHint                 (1L << 2)
#define    IconWindowHint                 (1L << 3)
#define    IconPositionHint               (1L << 4)
#define    IconMaskHint                   (1L << 5)
#define    WindowGroupHint                (1L << 6)
#define    UrgencyHint                    (1L << 8)
#define    AllHints                       (InputHint|StateHint|IconPixmapHint|
                                          IconWindowHint|IconPositionHint|
                                          IconMaskHint|WindowGroupHint)

/* Values */

typedef struct {
        long flags;                  /* marks which fields in this structure are defined */
        Bool input;                  /* does this application rely on the window manager to
                                     get keyboard input? */
        int initial_state;           /* see below */
        Pixmap icon_pixmap;          /* pixmap to be used as icon */
        Window icon_window;          /* window to be used as icon */
        int icon_x, icon_y;          /* initial position of icon */
        Pixmap icon_mask;            /* pixmap to be used as mask for icon_pixmap */
        XID window_group;            /* id of related window group */
        /* this structure may be extended in the future */
} XWMHints;
```

The input member is used to communicate to the window manager the input focus model used by the application. Applications that expect input but never explicitly set focus to any of their subwindows (that is, use the push model of focus management), such as X Version 10 style applications that use real-estate driven focus, should set this member to **True**. Similarly, applications that set input focus to their subwindows only when it is given to their top-level window by a window manager should also set this member to **True**. Applications that manage their own input focus by explicitly setting focus to one of their subwindows whenever they want keyboard input (that is, use the pull model of focus management) should set this member to **False**. Applications that never expect any keyboard input also should set this member to **False**.

Pull model window managers should make it possible for push model applications to get input by setting input focus to the top-level windows of applications whose input member is **True**. Push model window managers should make sure that pull model applications do not break them by resetting input focus to **PointerRoot** when it is appropriate (for example, whenever an application whose input member is **False** sets input focus to one of its subwindows).

The definitions for the initial_state flag are:

```
#define    WithdrawnState         0
#define    NormalState            1      /* most applications start this way */
#define    IconicState            3      /* application wants to start as an icon */
```

The icon_mask specifies which pixels of the icon_pixmap should be used as the icon. This allows for nonrectangular icons. Both icon_pixmap and icon_mask must be bitmaps. The icon_window lets an application provide a window for use as an icon for window managers that support such use. The window_group lets you specify that this window belongs to a group of other windows. For example, if a single application manipulates multiple top-level windows, this allows you to provide enough information that a window manager can iconify all of the windows rather than just the one window.

The **UrgencyHint** flag, if set in the flags field, indicates that the client deems the window contents to be urgent, requiring the timely response of the user. The window manager will make some effort to draw the user's attention to this window while this flag is set. The client must provide some means by which the user can cause the urgency flag to be cleared (either mitigating the condition that made the window urgent or merely shutting off the alarm) or the window to be withdrawn.

To set a window's WM_HINTS property, use **XSetWMHints**.

```
XSetWMHints(display, w, wmhints)
    Display *display;
    Window w;
    XWMHints *wmhints;
```

display	Specifies the connection to the X server.
w	Specifies the window.
wmhints	Specifies the **XWMHints** structure to be used.

The **XSetWMHints** function sets the window manager hints that include icon information and location, the initial state of the window, and whether the application relies on the window manager to get keyboard input.

XSetWMHints can generate **BadAlloc** and **BadWindow** errors.

To read a window's WM_HINTS property, use **XGetWMHints**.

```
XWMHints *XGetWMHints(display, w)
    Display *display;
    Window w;
```

display	Specifies the connection to the X server.
w	Specifies the window.

The **XGetWMHints** function reads the window manager hints and returns NULL if no WM_HINTS property was set on the window or returns a pointer to a **XWMHints** structure if it succeeds. When finished with the data, free the space used for it by calling **XFree**.

XGetWMHints can generate a **BadWindow** error.

14.1.7. Setting and Reading the WM_NORMAL_HINTS Property

Xlib provides functions that you can use to set or read the WM_NORMAL_HINTS property for a given window. The functions use the flags and the **XSizeHints** structure, as defined in the

<X11/Xutil.h> header file.

The size of the **XSizeHints** structure may grow in future releases, as new components are added to support new ICCCM features. Passing statically allocated instances of this structure into Xlib may result in memory corruption when running against a future release of the library. As such, it is recommended that only dynamically allocated instances of the structure be used.

To allocate an **XSizeHints** structure, use **XAllocSizeHints**.

```
XSizeHints *XAllocSizeHints( )
```

The **XAllocSizeHints** function allocates and returns a pointer to a **XSizeHints** structure. Note that all fields in the **XSizeHints** structure are initially set to zero. If insufficient memory is available, **XAllocSizeHints** returns NULL. To free the memory allocated to this structure, use **XFree**.

The **XSizeHints** structure contains:

```
/* Size hints mask bits */

#define    USPosition     (1L << 0)            /* user specified x, y */
#define    USSize         (1L << 1)            /* user specified width, height */
#define    PPosition      (1L << 2)            /* program specified position */
#define    PSize          (1L << 3)            /* program specified size */
#define    PMinSize       (1L << 4)            /* program specified minimum size */
#define    PMaxSize       (1L << 5)            /* program specified maximum size */
#define    PResizeInc     (1L << 6)            /* program specified resize increments */
#define    PAspect        (1L << 7)            /* program specified min and max aspect ratios */
#define    PBaseSize      (1L << 8)
#define    PWinGravity    (1L << 9)
#define    PAllHints      (PPosi-
                          tion|PSize|PMinSize|
                          PMax-
                          Size|PResizeInc|PAspect)

/* Values */

typedef struct {
        long flags;                  /* marks which fields in this structure are defined */
        int x, y;                    /* Obsolete */
        int width, height;           /* Obsolete */
        int min_width, min_height;
        int max_width, max_height;
        int width_inc, height_inc;
        struct {
            int x;                   /* numerator */
            int y;                   /* denominator */
        } min_aspect, max_aspect;
        int base_width, base_height;
        int win_gravity;
        /* this structure may be extended in the future */
} XSizeHints;
```

The x, y, width, and height members are now obsolete and are left solely for compatibility reasons. The min_width and min_height members specify the minimum window size that still allows the application to be useful. The max_width and max_height members specify the maximum window size. The width_inc and height_inc members define an arithmetic progression of sizes (minimum to maximum) into which the window prefers to be resized. The min_aspect and max_aspect members are expressed as ratios of x and y, and they allow an application to specify the range of aspect ratios it prefers. The base_width and base_height members define the desired size of the window. The window manager will interpret the position of the window and its border width to position the point of the outer rectangle of the overall window specified by the win_gravity member. The outer rectangle of the window includes any borders or decorations supplied by the window manager. In other words, if the window manager decides to place the window where the client asked, the position on the parent window's border named by the win_gravity will be placed where the client window would have been placed in the absence of a window manager.

Note that use of the **PAllHints** macro is highly discouraged.

To set a window’s WM_NORMAL_HINTS property, use **XSetWMNormalHints**.

void XSetWMNormalHints(*display*, *w*, *hints*)
    Display **display*;
    Window *w*;
    XSizeHints **hints*;

display	Specifies the connection to the X server.
w	Specifies the window.
hints	Specifies the size hints for the window in its normal state.

The **XSetWMNormalHints** function replaces the size hints for the WM_NORMAL_HINTS property on the specified window. If the property does not already exist, **XSetWMNormalHints** sets the size hints for the WM_NORMAL_HINTS property on the specified window. The property is stored with a type of WM_SIZE_HINTS and a format of 32.

XSetWMNormalHints can generate **BadAlloc** and **BadWindow** errors.

To read a window’s WM_NORMAL_HINTS property, use **XGetWMNormalHints**.

Status XGetWMNormalHints(*display*, *w*, *hints_return*, *supplied_return*)
    Display **display*;
    Window *w*;
    XSizeHints **hints_return*;
    long **supplied_return*;

display	Specifies the connection to the X server.
w	Specifies the window.
hints_return	Returns the size hints for the window in its normal state.
supplied_return	Returns the hints that were supplied by the user.

The **XGetWMNormalHints** function returns the size hints stored in the WM_NORMAL_HINTS property on the specified window. If the property is of type WM_SIZE_HINTS, is of format 32, and is long enough to contain either an old (pre-ICCCM) or new size hints structure, **XGetWMNormalHints** sets the various fields of the **XSizeHints** structure, sets the supplied_return argument to the list of fields that were supplied by the user (whether or not they contained defined values), and returns a nonzero status. Otherwise, it returns a zero status.

If **XGetWMNormalHints** returns successfully and a pre-ICCCM size hints property is read, the supplied_return argument will contain the following bits:

```
(USPosition|USSize|PPosition|PSize|PMinSize|
 PMaxSize|PResizeInc|PAspect)
```

If the property is large enough to contain the base size and window gravity fields as well, the supplied_return argument will also contain the following bits:

PBaseSize|PWinGravity

XGetWMNormalHints can generate a **BadWindow** error.

To set a window's WM_SIZE_HINTS property, use **XSetWMSizeHints**.

```
void XSetWMSizeHints(display, w, hints, property)
      Display *display;
      Window w;
      XSizeHints *hints;
      Atom property;
```

display	Specifies the connection to the X server.
w	Specifies the window.
hints	Specifies the **XSizeHints** structure to be used.
property	Specifies the property name.

The **XSetWMSizeHints** function replaces the size hints for the specified property on the named window. If the specified property does not already exist, **XSetWMSizeHints** sets the size hints for the specified property on the named window. The property is stored with a type of WM_SIZE_HINTS and a format of 32. To set a window's normal size hints, you can use the **XSetWMNormalHints** function.

XSetWMSizeHints can generate **BadAlloc**, **BadAtom**, and **BadWindow** errors.

To read a window's WM_SIZE_HINTS property, use **XGetWMSizeHints**.

```
Status XGetWMSizeHints(display, w, hints_return, supplied_return, property)
      Display *display;
      Window w;
      XSizeHints *hints_return;
      long *supplied_return;
      Atom property;
```

display	Specifies the connection to the X server.
w	Specifies the window.
hints_return	Returns the **XSizeHints** structure.
supplied_return	Returns the hints that were supplied by the user.
property	Specifies the property name.

The **XGetWMSizeHints** function returns the size hints stored in the specified property on the named window. If the property is of type WM_SIZE_HINTS, is of format 32, and is long enough to contain either an old (pre-ICCCM) or new size hints structure, **XGetWMSizeHints** sets the various fields of the **XSizeHints** structure, sets the supplied_return argument to the list of fields that were supplied by the user (whether or not they contained defined values), and returns a nonzero status. Otherwise, it returns a zero status. To get a window's normal size hints, you can use the **XGetWMNormalHints** function.

If **XGetWMSizeHints** returns successfully and a pre-ICCCM size hints property is read, the supplied_return argument will contain the following bits:

```
(USPosition|USSize|PPosition|PSize|PMinSize|
 PMaxSize|PResizeInc|PAspect)
```

If the property is large enough to contain the base size and window gravity fields as well, the supplied_return argument will also contain the following bits:

```
PBaseSize|PWinGravity
```

XGetWMSizeHints can generate **BadAtom** and **BadWindow** errors.

14.1.8. Setting and Reading the WM_CLASS Property

Xlib provides functions that you can use to set and get the WM_CLASS property for a given window. These functions use the **XClassHint** structure, which is defined in the **<X11/Xutil.h>** header file.

To allocate an **XClassHint** structure, use **XAllocClassHint**.

```
XClassHint *XAllocClassHint( )
```

The **XAllocClassHint** function allocates and returns a pointer to a **XClassHint** structure. Note that the pointer fields in the **XClassHint** structure are initially set to NULL. If insufficient memory is available, **XAllocClassHint** returns NULL. To free the memory allocated to this structure, use **XFree**.

The **XClassHint** contains:

```
typedef struct {
	char *res_name;
	char *res_class;
} XClassHint;
```

The res_name member contains the application name, and the res_class member contains the application class. Note that the name set in this property may differ from the name set as WM_NAME. That is, WM_NAME specifies what should be displayed in the title bar and, therefore, can contain temporal information (for example, the name of a file currently in an editor's buffer). On the other hand, the name specified as part of WM_CLASS is the formal name of the application that should be used when retrieving the application's resources from the resource database.

To set a window's WM_CLASS property, use **XSetClassHint**.

XSetClassHint(*display*, *w*, *class_hints*)
  Display **display*;
  Window *w*;
  XClassHint **class_hints*;

display	Specifies the connection to the X server.
w	Specifies the window.
class_hints	Specifies the **XClassHint** structure that is to be used.

The **XSetClassHint** function sets the class hint for the specified window. If the strings are not in the Host Portable Character Encoding, the result is implementation dependent.

XSetClassHint can generate **BadAlloc** and **BadWindow** errors.

To read a window's WM_CLASS property, use **XGetClassHint**.

Status XGetClassHint(*display*, *w*, *class_hints_return*)
  Display **display*;
  Window *w*;
  XClassHint **class_hints_return*;

display	Specifies the connection to the X server.
w	Specifies the window.
class_hints_return	Returns the **XClassHint** structure.

The **XGetClassHint** function returns the class hint of the specified window to the members of the supplied structure. If the data returned by the server is in the Latin Portable Character Encoding, then the returned strings are in the Host Portable Character Encoding. Otherwise, the result is implementation dependent. It returns a nonzero status on success; otherwise, it returns a zero status. To free res_name and res_class when finished with the strings, use **XFree** on each individually.

XGetClassHint can generate a **BadWindow** error.

14.1.9. Setting and Reading the WM_TRANSIENT_FOR Property

Xlib provides functions that you can use to set and read the WM_TRANSIENT_FOR property for a given window.

To set a window's WM_TRANSIENT_FOR property, use **XSetTransientForHint**.

```
XSetTransientForHint(display, w, prop_window)
      Display *display;
      Window w;
      Window prop_window;
```

display	Specifies the connection to the X server.
w	Specifies the window.
prop_window	Specifies the window that the WM_TRANSIENT_FOR property is to be set to.

The **XSetTransientForHint** function sets the WM_TRANSIENT_FOR property of the specified window to the specified prop_window.

XSetTransientForHint can generate **BadAlloc** and **BadWindow** errors.

To read a window's WM_TRANSIENT_FOR property, use **XGetTransientForHint**.

```
Status XGetTransientForHint(display, w, prop_window_return)
      Display *display;
      Window w;
      Window *prop_window_return;
```

display	Specifies the connection to the X server.
w	Specifies the window.
prop_window_return	Returns the WM_TRANSIENT_FOR property of the specified window.

The **XGetTransientForHint** function returns the WM_TRANSIENT_FOR property for the specified window. It returns a nonzero status on success; otherwise, it returns a zero status.

XGetTransientForHint can generate a **BadWindow** error.

14.1.10. Setting and Reading the WM_PROTOCOLS Property

Xlib provides functions that you can use to set and read the WM_PROTOCOLS property for a given window.

To set a window's WM_PROTOCOLS property, use **XSetWMProtocols**.

```
Status XSetWMProtocols(display, w, protocols, count)
      Display *display;
      Window w;
      Atom *protocols;
      int count;
```

display	Specifies the connection to the X server.
w	Specifies the window.
protocols	Specifies the list of protocols.
count	Specifies the number of protocols in the list.

The **XSetWMProtocols** function replaces the WM_PROTOCOLS property on the specified window with the list of atoms specified by the protocols argument. If the property does not already exist, **XSetWMProtocols** sets the WM_PROTOCOLS property on the specified window to the list of atoms specified by the protocols argument. The property is stored with a type of ATOM and a format of 32. If it cannot intern the WM_PROTOCOLS atom, **XSetWMProtocols** returns a zero status. Otherwise, it returns a nonzero status.

XSetWMProtocols can generate **BadAlloc** and **BadWindow** errors.

To read a window's WM_PROTOCOLS property, use **XGetWMProtocols**.

```
Status XGetWMProtocols(display, w, protocols_return, count_return)
      Display *display;
      Window w;
      Atom **protocols_return;
      int *count_return;
```

display	Specifies the connection to the X server.
w	Specifies the window.
protocols_return	Returns the list of protocols.
count_return	Returns the number of protocols in the list.

The **XGetWMProtocols** function returns the list of atoms stored in the WM_PROTOCOLS property on the specified window. These atoms describe window manager protocols in which the owner of this window is willing to participate. If the property exists, is of type ATOM, is of format 32, and the atom WM_PROTOCOLS can be interned, **XGetWMProtocols** sets the protocols_return argument to a list of atoms, sets the count_return argument to the number of elements in the list, and returns a nonzero status. Otherwise, it sets neither of the return arguments and returns a zero status. To release the list of atoms, use **XFree**.

XGetWMProtocols can generate a **BadWindow** error.

14.1.11. Setting and Reading the WM_COLORMAP_WINDOWS Property

Xlib provides functions that you can use to set and read the WM_COLORMAP_WINDOWS property for a given window.

To set a window's WM_COLORMAP_WINDOWS property, use **XSetWMColormapWindows**.

```
Status XSetWMColormapWindows(display, w, colormap_windows, count)
      Display *display;
      Window w;
      Window *colormap_windows;
      int count;
```

display	Specifies the connection to the X server.
w	Specifies the window.
colormap_windows	Specifies the list of windows.
count	Specifies the number of windows in the list.

The **XSetWMColormapWindows** function replaces the WM_COLORMAP_WINDOWS property on the specified window with the list of windows specified by the colormap_windows argument. It the property does not already exist, **XSetWMColormapWindows** sets the WM_COLORMAP_WINDOWS property on the specified window to the list of windows specified by the colormap_windows argument. The property is stored with a type of WINDOW and a format of 32. If it cannot intern the WM_COLORMAP_WINDOWS atom, **XSetWMColormapWindows** returns a zero status. Otherwise, it returns a nonzero status.

XSetWMColormapWindows can generate **BadAlloc** and **BadWindow** errors.

To read a window's WM_COLORMAP_WINDOWS property, use **XGetWMColormapWindows**.

```
Status XGetWMColormapWindows(display, w, colormap_windows_return, count_return)
      Display *display;
      Window w;
      Window **colormap_windows_return;
      int *count_return;
```

display	Specifies the connection to the X server.
w	Specifies the window.
colormap_windows_return	Returns the list of windows.
count_return	Returns the number of windows in the list.

The **XGetWMColormapWindows** function returns the list of window identifiers stored in the WM_COLORMAP_WINDOWS property on the specified window. These identifiers indicate the colormaps that the window manager may need to install for this window. If the property exists, is of type WINDOW, is of format 32, and the atom WM_COLORMAP_WINDOWS can be interned, **XGetWMColormapWindows** sets the windows_return argument to a list of window identifiers, sets the count_return argument to the number of elements in the list, and returns a nonzero status. Otherwise, it sets neither of the return arguments and returns a zero status. To release the list of window identifiers, use **XFree**.

XGetWMColormapWindows can generate a **BadWindow** error.

14.1.12. Setting and Reading the WM_ICON_SIZE Property

Xlib provides functions that you can use to set and read the WM_ICON_SIZE property for a given window. These functions use the **XIconSize** structure, which is defined in the **<X11/Xutil.h>** header file.

To allocate an **XIconSize** structure, use **XAllocIconSize**.

```
XIconSize *XAllocIconSize( )
```

The **XAllocIconSize** function allocates and returns a pointer to a **XIconSize** structure. Note that all fields in the **XIconSize** structure are initially set to zero. If insufficient memory is available, **XAllocIconSize** returns NULL. To free the memory allocated to this structure, use **XFree**.

The **XIconSize** structure contains:

```
typedef struct {
	int min_width, min_height;
	int max_width, max_height;
	int width_inc, height_inc;
} XIconSize;
```

The width_inc and height_inc members define an arithmetic progression of sizes (minimum to maximum) that represent the supported icon sizes.

To set a window's WM_ICON_SIZE property, use **XSetIconSizes**.

```
XSetIconSizes(display, w, size_list, count)
   Display *display;
   Window w;
   XIconSize *size_list;
   int count;
```

display	Specifies the connection to the X server.
w	Specifies the window.
size_list	Specifies the size list.
count	Specifies the number of items in the size list.

The **XSetIconSizes** function is used only by window managers to set the supported icon sizes.

XSetIconSizes can generate **BadAlloc** and **BadWindow** errors.

To read a window's WM_ICON_SIZE property, use **XGetIconSizes**.

Status XGetIconSizes(*display*, *w*, *size_list_return*, *count_return*)
  Display **display*;
  Window *w*;
  XIconSize ***size_list_return*;
  int **count_return*;

display	Specifies the connection to the X server.
w	Specifies the window.
size_list_return	Returns the size list.
count_return	Returns the number of items in the size list.

The **XGetIconSizes** function returns zero if a window manager has not set icon sizes; otherwise, it return nonzero. **XGetIconSizes** should be called by an application that wants to find out what icon sizes would be most appreciated by the window manager under which the application is running. The application should then use **XSetWMHints** to supply the window manager with an icon pixmap or window in one of the supported sizes. To free the data allocated in size_list_return, use **XFree**.

XGetIconSizes can generate a **BadWindow** error.

14.1.13. Using Window Manager Convenience Functions

The **XmbSetWMProperties** function stores the standard set of window manager properties, with text properties in standard encodings for internationalized text communication. The standard window manager properties for a given window are WM_NAME, WM_ICON_NAME, WM_HINTS, WM_NORMAL_HINTS, WM_CLASS, WM_COMMAND, WM_CLIENT_MACHINE, and WM_LOCALE_NAME.

```
void XmbSetWMProperties(display, w, window_name, icon_name, argv, argc,
                normal_hints, wm_hints, class_hints)
    Display *display;
    Window w;
    char *window_name;
    char *icon_name;
    char *argv[];
    int argc;
    XSizeHints *normal_hints;
    XWMHints *wm_hints;
    XClassHint *class_hints;
```

display	Specifies the connection to the X server.
w	Specifies the window.
window_name	Specifies the window name, which should be a null-terminated string.
icon_name	Specifies the icon name, which should be a null-terminated string.
argv	Specifies the application's argument list.
argc	Specifies the number of arguments.
hints	Specifies the size hints for the window in its normal state.
wm_hints	Specifies the **XWMHints** structure to be used.
class_hints	Specifies the **XClassHint** structure to be used.

The **XmbSetWMProperties** convenience function provides a simple programming interface for setting those essential window properties that are used for communicating with other clients (particularly window and session managers).

If the window_name argument is non-NULL, **XmbSetWMProperties** sets the WM_NAME property. If the icon_name argument is non-NULL, **XmbSetWMProperties** sets the WM_ICON_NAME property. The window_name and icon_name arguments are null-terminated strings in the encoding of the current locale. If the arguments can be fully converted to the STRING encoding, the properties are created with type "STRING"; otherwise, the arguments are converted to Compound Text, and the properties are created with type "COMPOUND_TEXT".

If the normal_hints argument is non-NULL, **XmbSetWMProperties** calls **XSetWMNormalHints**, which sets the WM_NORMAL_HINTS property (see section 14.1.7). If the wm_hints argument is non-NULL, **XmbSetWMProperties** calls **XSetWMHints**, which sets the WM_HINTS property (see section 14.1.6).

If the argv argument is non-NULL, **XmbSetWMProperties** sets the WM_COMMAND property from argv and argc. An argc of zero indicates a zero-length command.

The hostname of the machine is stored using **XSetWMClientMachine** (see section 14.2.2).

If the class_hints argument is non-NULL, **XmbSetWMProperties** sets the WM_CLASS property. If the res_name member in the **XClassHint** structure is set to the NULL pointer and the RESOURCE_NAME environment variable is set, the value of the environment variable is substituted for res_name. If the res_name member is NULL, the environment variable is not set, and argv and argv[0] are set, then the value of argv[0], stripped of any directory prefixes, is substituted for res_name.

It is assumed that the supplied class_hints.res_name and argv, the RESOURCE_NAME environment variable, and the hostname of the machine are in the encoding of the locale announced for the LC_CTYPE category (on POSIX-compliant systems, the LC_CTYPE, else LANG environment variable). The corresponding WM_CLASS, WM_COMMAND, and WM_CLIENT_MACHINE properties are typed according to the local host locale announcer. No encoding conversion is performed prior to storage in the properties.

For clients that need to process the property text in a locale, **XmbSetWMProperties** sets the WM_LOCALE_NAME property to be the name of the current locale. The name is assumed to be in the Host Portable Character Encoding and is converted to STRING for storage in the property.

XmbSetWMProperties can generate **BadAlloc** and **BadWindow** errors.

To set a window's standard window manager properties with strings in client-specified encodings, use **XSetWMProperties**. The standard window manager properties for a given window are WM_NAME, WM_ICON_NAME, WM_HINTS, WM_NORMAL_HINTS, WM_CLASS, WM_COMMAND, and WM_CLIENT_MACHINE.

```
void XSetWMProperties(display, w, window_name, icon_name, argv, argc, normal_hints, wm_hints, class_hints)
    Display *display;
    Window w;
    XTextProperty *window_name;
    XTextProperty *icon_name;
    char **argv;
    int argc;
    XSizeHints *normal_hints;
    XWMHints *wm_hints;
    XClassHint *class_hints;
```

display	Specifies the connection to the X server.
w	Specifies the window.
window_name	Specifies the window name, which should be a null-terminated string.
icon_name	Specifies the icon name, which should be a null-terminated string.
argv	Specifies the application's argument list.
argc	Specifies the number of arguments.
normal_hints	Specifies the size hints for the window in its normal state.
wm_hints	Specifies the **XWMHints** structure to be used.
class_hints	Specifies the **XClassHint** structure to be used.

The **XSetWMProperties** convenience function provides a single programming interface for setting those essential window properties that are used for communicating with other clients (particularly window and session managers).

If the window_name argument is non-NULL, **XSetWMProperties** calls **XSetWMName**, which in turn, sets the WM_NAME property (see section 14.1.4). If the icon_name argument is non-NULL, **XSetWMProperties** calls **XSetWMIconName**, which sets the WM_ICON_NAME property (see section 14.1.5). If the argv argument is non-NULL, **XSetWMProperties** calls **XSetCommand**, which sets the WM_COMMAND property (see section 14.2.1). Note that an argc of zero is allowed to indicate a zero-length command. Note also that the hostname of this machine is stored using **XSetWMClientMachine** (see section 14.2.2).

If the normal_hints argument is non-NULL, **XSetWMProperties** calls **XSetWMNormalHints**, which sets the WM_NORMAL_HINTS property (see section 14.1.7). If the wm_hints argument is non-NULL, **XSetWMProperties** calls **XSetWMHints**, which sets the WM_HINTS property (see section 14.1.6).

If the class_hints argument is non-NULL, **XSetWMProperties** calls **XSetClassHint**, which sets the WM_CLASS property (see section 14.1.8). If the res_name member in the **XClassHint** structure is set to the NULL pointer and the RESOURCE_NAME environment variable is set, then the value of the environment variable is substituted for res_name. If the res_name member is NULL, the environment variable is not set, and argv and argv[0] are set, then the value of argv[0], stripped of any directory prefixes, is substituted for res_name.

XSetWMProperties can generate **BadAlloc** and **BadWindow** errors.

14.2. Client to Session Manager Communication

This section discusses how to:

- Set and read the WM_COMMAND property
- Set and read the WM_CLIENT_MACHINE property

14.2.1. Setting and Reading the WM_COMMAND Property

Xlib provides functions that you can use to set and read the WM_COMMAND property for a given window.

To set a window's WM_COMMAND property, use **XSetCommand**.

```
XSetCommand(display, w, argv, argc)
      Display *display;
      Window w;
      char **argv;
      int argc;
```

display	Specifies the connection to the X server.
w	Specifies the window.
argv	Specifies the application's argument list.
argc	Specifies the number of arguments.

The **XSetCommand** function sets the command and arguments used to invoke the application. (Typically, argv is the argv array of your main program.) If the strings are not in the Host Portable Character Encoding, the result is implementation dependent.

XSetCommand can generate **BadAlloc** and **BadWindow** errors.

To read a window's WM_COMMAND property, use **XGetCommand**.

```
Status XGetCommand(display, w, argv_return, argc_return)
      Display *display;
      Window w;
      char ***argv_return;
      int *argc_return;
```

display	Specifies the connection to the X server.
w	Specifies the window.
argv_return	Returns the application's argument list.
argc_return	Returns the number of arguments returned.

The **XGetCommand** function reads the WM_COMMAND property from the specified window and returns a string list. If the WM_COMMAND property exists, it is of type STRING and format 8. If sufficient memory can be allocated to contain the string list, **XGetCommand** fills in the argv_return and argc_return arguments and returns a nonzero status. Otherwise, it returns a zero status. If the data returned by the server is in the Latin Portable Character Encoding, then the returned strings are in the Host Portable Character Encoding. Otherwise, the result is implementation dependent. To free the memory allocated to the string list, use **XFreeStringList**.

14.2.2. Setting and Reading the WM_CLIENT_MACHINE Property

Xlib provides functions that you can use to set and read the WM_CLIENT_MACHINE property for a given window.

To set a window's WM_CLIENT_MACHINE property, use **XSetWMClientMachine**.

```
void XSetWMClientMachine(display, w, text_prop)
      Display *display;
      Window w;
      XTextProperty *text_prop;
```

display	Specifies the connection to the X server.
w	Specifies the window.
text_prop	Specifies the **XTextProperty** structure to be used.

The **XSetWMClientMachine** convenience function calls **XSetTextProperty** to set the WM_CLIENT_MACHINE property.

To read a window's WM_CLIENT_MACHINE property, use **XGetWMClientMachine**.

Status XGetWMClientMachine(*display*, *w*, *text_prop_return*)
    Display **display*;
    Window *w*;
    XTextProperty **text_prop_return*;

display Specifies the connection to the X server.

w Specifies the window.

text_prop_return
Returns the **XTextProperty** structure.

The **XGetWMClientMachine** convenience function performs an **XGetTextProperty** on the WM_CLIENT_MACHINE property. It returns a nonzero status on success; otherwise, it returns a zero status.

14.3. Standard Colormaps

Applications with color palettes, smooth-shaded drawings, or digitized images demand large numbers of colors. In addition, these applications often require an efficient mapping from color triples to pixel values that display the appropriate colors.

As an example, consider a three-dimensional display program that wants to draw a smoothly shaded sphere. At each pixel in the image of the sphere, the program computes the intensity and color of light reflected back to the viewer. The result of each computation is a triple of RGB coefficients in the range 0.0 to 1.0. To draw the sphere, the program needs a colormap that provides a large range of uniformly distributed colors. The colormap should be arranged so that the program can convert its RGB triples into pixel values very quickly, because drawing the entire sphere requires many such conversions.

On many current workstations, the display is limited to 256 or fewer colors. Applications must allocate colors carefully, not only to make sure they cover the entire range they need but also to make use of as many of the available colors as possible. On a typical X display, many applications are active at once. Most workstations have only one hardware look-up table for colors, so only one application colormap can be installed at a given time. The application using the installed colormap is displayed correctly, and the other applications go technicolor and are displayed with false colors.

As another example, consider a user who is running an image processing program to display earth-resources data. The image processing program needs a colormap set up with 8 reds, 8 greens, and 4 blues, for a total of 256 colors. Because some colors are already in use in the default colormap, the image processing program allocates and installs a new colormap.

The user decides to alter some of the colors in the image by invoking a color palette program to mix and choose colors. The color palette program also needs a colormap with eight reds, eight greens, and four blues, so just like the image processing program, it must allocate and install a new colormap.

Because only one colormap can be installed at a time, the color palette may be displayed incorrectly whenever the image processing program is active. Conversely, whenever the palette program is active, the image may be displayed incorrectly. The user can never match or compare colors in the palette and image. Contention for colormap resources can be reduced if applications with similar color needs share colormaps.

The image processing program and the color palette program could share the same colormap if there existed a convention that described how the colormap was set up. Whenever either program was active, both would be displayed correctly.

The standard colormap properties define a set of commonly used colormaps. Applications that share these colormaps and conventions display true colors more often and provide a better interface to the user.

Standard colormaps allow applications to share commonly used color resources. This allows many applications to be displayed in true colors simultaneously, even when each application needs an entirely filled colormap.

Several standard colormaps are described in this section. Usually, a window manager creates these colormaps. Applications should use the standard colormaps if they already exist.

To allocate an **XStandardColormap** structure, use **XAllocStandardColormap**.

```
XStandardColormap *XAllocStandardColormap( )
```

The **XAllocStandardColormap** function allocates and returns a pointer to a **XStandardColormap** structure. Note that all fields in the **XStandardColormap** structure are initially set to zero. If insufficient memory is available, **XAllocStandardColormap** returns NULL. To free the memory allocated to this structure, use **XFree**.

The **XStandardColormap** structure contains:

```
/* Hints */
#define    ReleaseByFreeingColormap    ( (XID) 1L)
/* Values */
typedef struct {
        Colormap colormap;
        unsigned long red_max;
        unsigned long red_mult;
        unsigned long green_max;
        unsigned long green_mult;
        unsigned long blue_max;
        unsigned long blue_mult;
        unsigned long base_pixel;
        VisualID visualid;
        XID killid;
} XStandardColormap;
```

The colormap member is the colormap created by the **XCreateColormap** function. The red_max, green_max, and blue_max members give the maximum red, green, and blue values, respectively. Each color coefficient ranges from zero to its max, inclusive. For example, a common colormap allocation is 3/3/2 (3 planes for red, 3 planes for green, and 2 planes for blue). This colormap would have red_max = 7, green_max = 7, and blue_max = 3. An alternate allocation that uses only 216 colors is red_max = 5, green_max = 5, and blue_max = 5.

The red_mult, green_mult, and blue_mult members give the scale factors used to compose a full pixel value. (See the discussion of the base_pixel members for further information.) For a 3/3/2 allocation, red_mult might be 32, green_mult might be 4, and blue_mult might be 1. For a

6-colors-each allocation, red_mult might be 36, green_mult might be 6, and blue_mult might be 1.

The base_pixel member gives the base pixel value used to compose a full pixel value. Usually, the base_pixel is obtained from a call to the **XAllocColorPlanes** function. Given integer red, green, and blue coefficients in their appropriate ranges, one then can compute a corresponding pixel value by using the following expression:

> (r * red_mult + g * green_mult + b * blue_mult + base_pixel) & 0xFFFFFFFF

For **GrayScale** colormaps, only the colormap, red_max, red_mult, and base_pixel members are defined. The other members are ignored. To compute a **GrayScale** pixel value, use the following expression:

> (gray * red_mult + base_pixel) & 0xFFFFFFFF

Negative multipliers can be represented by converting the 2's complement representation of the multiplier into an unsigned long and storing the result in the appropriate _mult field. The step of masking by 0xFFFFFFFF effectively converts the resulting positive multiplier into a negative one. The masking step will take place automatically on many machine architectures, depending on the size of the integer type used to do the computation,

The visualid member gives the ID number of the visual from which the colormap was created. The killid member gives a resource ID that indicates whether the cells held by this standard colormap are to be released by freeing the colormap ID or by calling the **XKillClient** function on the indicated resource. (Note that this method is necessary for allocating out of an existing colormap.)

The properties containing the **XStandardColormap** information have the type RGB_COLOR_MAP.

The remainder of this section discusses standard colormap properties and atoms as well as how to manipulate standard colormaps.

14.3.1. Standard Colormap Properties and Atoms

Several standard colormaps are available. Each standard colormap is defined by a property, and each such property is identified by an atom. The following list names the atoms and describes the colormap associated with each one. The **<X11/Xatom.h>** header file contains the definitions for each of the following atoms, which are prefixed with XA_.

RGB_DEFAULT_MAP

> This atom names a property. The value of the property is an array of **XStandardColormap** structures. Each entry in the array describes an RGB subset of the default color map for the Visual specified by visual_id.
>
> Some applications only need a few RGB colors and may be able to allocate them from the system default colormap. This is the ideal situation because the fewer colormaps that are active in the system the more applications are displayed with correct colors at all times.
>
> A typical allocation for the RGB_DEFAULT_MAP on 8-plane displays is 6 reds, 6 greens, and 6 blues. This gives 216 uniformly distributed colors (6 intensities of 36 different hues) and still leaves 40 elements of a 256-element colormap available for special-purpose colors for text, borders, and so on.

RGB_BEST_MAP

> This atom names a property. The value of the property is an **XStandardColormap**.

The property defines the best RGB colormap available on the screen. (Of course, this is a subjective evaluation.) Many image processing and three-dimensional applications need to use all available colormap cells and to distribute as many perceptually distinct colors as possible over those cells. This implies that there may be more green values available than red, as well as more green or red than blue.

For an 8-plane **PseudoColor** visual, RGB_BEST_MAP is likely to be a 3/3/2 allocation. For a 24-plane **DirectColor** visual, RGB_BEST_MAP is normally an 8/8/8 allocation.

RGB_RED_MAP
RGB_GREEN_MAP
RGB_BLUE_MAP

These atoms name properties. The value of each property is an **XStandardColormap**.

The properties define all-red, all-green, and all-blue colormaps, respectively. These maps are used by applications that want to make color-separated images. For example, a user might generate a full-color image on an 8-plane display both by rendering an image three times (once with high color resolution in red, once with green, and once with blue) and by multiply-exposing a single frame in a camera.

RGB_GRAY_MAP

This atom names a property. The value of the property is an **XStandardColormap**.

The property describes the best **GrayScale** colormap available on the screen. As previously mentioned, only the colormap, red_max, red_mult, and base_pixel members of the **XStandardColormap** structure are used for **GrayScale** colormaps.

14.3.2. Setting and Obtaining Standard Colormaps

Xlib provides functions that you can use to set and obtain an **XStandardColormap** structure.

To set an **XStandardColormap** structure, use **XSetRGBColormaps**.

void XSetRGBColormaps(*display*, *w*, *std_colormap*, *count*, *property*)
  Display **display*;
  Window *w*;
  XStandardColormap **std_colormap*;
  int *count*;
  Atom *property*;

display	Specifies the connection to the X server.
w	Specifies the window.
std_colormap	Specifies the **XStandardColormap** structure to be used.
count	Specifies the number of colormaps.
property	Specifies the property name.

The **XSetRGBColormaps** function replaces the RGB colormap definition in the specified property on the named window. If the property does not already exist, **XSetRGBColormaps** sets the RGB colormap definition in the specified property on the named window. The property is stored with a type of RGB_COLOR_MAP and a format of 32. Note that it is the caller's responsibility to honor the ICCCM restriction that only RGB_DEFAULT_MAP contain more than one definition.

The **XSetRGBColormaps** function usually is only used by window or session managers. To create a standard colormap, follow this procedure:

1. Open a new connection to the same server.
2. Grab the server.
3. See if the property is on the property list of the root window for the screen.
4. If the desired property is not present:
    - Create a colormap (unless you are using the default colormap of the screen).
    - Determine the color characteristics of the visual.
    - Allocate cells in the colormap (or create it with **AllocAll**).
    - Call **XStoreColors** to store appropriate color values in the colormap.
    - Fill in the descriptive members in the **XStandardColormap** structure.
    - Attach the property to the root window.
    - Use **XSetCloseDownMode** to make the resource permanent.
5. Ungrab the server.

XSetRGBColormaps can generate **BadAlloc**, **BadAtom**, and **BadWindow** errors.

To obtain the **XStandardColormap** structure associated with the specified property, use **XGetRGBColormaps**.

Status XGetRGBColormaps(*display*, *w*, *std_colormap_return*, *count_return*, *property*)
    Display **display*;
    Window *w*;
    XStandardColormap ***std_colormap_return*;
    int **count_return*;
    Atom *property*;

display	Specifies the connection to the X server.
w	Specifies the window.
std_colormap_return	Returns the **XStandardColormap** structure.
count_return	Returns the number of colormaps.
property	Specifies the property name.

The **XGetRGBColormaps** function returns the RGB colormap definitions stored in the specified property on the named window. If the property exists, is of type RGB_COLOR_MAP, is of format 32, and is long enough to contain a colormap definition, **XGetRGBColormaps** allocates and fills in space for the returned colormaps and returns a nonzero status. If the visualid is not present, **XGetRGBColormaps** assumes the default visual for the screen on which the window is located; if the killid is not present, **None** is assumed, which indicates that the resources cannot be released. Otherwise, none of the fields are set, and **XGetRGBColormaps** returns a zero status. Note that it is the caller's responsibility to honor the ICCCM restriction that only RGB_DEFAULT_MAP contain more than one definition.

XGetRGBColormaps can generate **BadAtom** and **BadWindow** errors.

Chapter 15

Resource Manager Functions

A program often needs a variety of options in the X environment (for example, fonts, colors, icons, and cursors). Specifying all of these options on the command line is awkward because users may want to customize many aspects of the program and need a convenient way to establish these customizations as the default settings. The resource manager is provided for this purpose. Resource specifications are usually stored in human-readable files and in server properties.

The resource manager is a database manager with a twist. In most database systems, you perform a query using an imprecise specification, and you get back a set of records. The resource manager, however, allows you to specify a large set of values with an imprecise specification, to query the database with a precise specification, and to get back only a single value. This should be used by applications that need to know what the user prefers for colors, fonts, and other resources. It is this use as a database for dealing with X resources that inspired the name ‘‘Resource Manager,’’ although the resource manager can be and is used in other ways.

For example, a user of your application may want to specify that all windows should have a blue background but that all mail-reading windows should have a red background. With well-engineered and coordinated applications, a user can define this information using only two lines of specifications.

As an example of how the resource manager works, consider a mail-reading application called xmh. Assume that it is designed so that it uses a complex window hierarchy all the way down to individual command buttons, which may be actual small subwindows in some toolkits. These are often called objects or widgets. In such toolkit systems, each user interface object can be composed of other objects and can be assigned a name and a class. Fully qualified names or classes can have arbitrary numbers of component names, but a fully qualified name always has the same number of component names as a fully qualified class. This generally reflects the structure of the application as composed of these objects, starting with the application itself.

For example, the xmh mail program has a name ‘‘xmh’’ and is one of a class of ‘‘Mail’’ programs. By convention, the first character of class components is capitalized, and the first letter of name components is in lowercase. Each name and class finally has an attribute (for example ‘‘foreground’’ or ‘‘font’’). If each window is properly assigned a name and class, it is easy for the user to specify attributes of any portion of the application.

At the top level, the application might consist of a paned window (that is, a window divided into several sections) named ‘‘toc’’. One pane of the paned window is a button box window named ‘‘buttons’’ and is filled with command buttons. One of these command buttons is used to incorporate new mail and has the name ‘‘incorporate’’. This window has a fully qualified name, ‘‘xmh.toc.buttons.incorporate’’, and a fully qualified class, ‘‘Xmh.Paned.Box.Command’’. Its fully qualified name is the name of its parent, ‘‘xmh.toc.buttons’’, followed by its name, ‘‘incorporate’’. Its class is the class of its parent, ‘‘Xmh.Paned.Box’’, followed by its particular class, ‘‘Command’’. The fully qualified name of a resource is the attribute’s name appended to the object’s fully qualified name, and the fully qualified class is its class appended to the object’s class.

The incorporate button might need the following resources: Title string, Font, Foreground color for its inactive state, Background color for its inactive state, Foreground color for its active state, and Background color for its active state. Each resource is considered to be an attribute of the button and, as such, has a name and a class. For example, the foreground color for the button in its active state might be named “activeForeground”, and its class might be “Foreground”.

When an application looks up a resource (for example, a color), it passes the complete name and complete class of the resource to a look-up routine. The resource manager compares this complete specification against the incomplete specifications of entries in the resource database, finds the best match, and returns the corresponding value for that entry.

The definitions for the resource manager are contained in <**X11/Xresource.h**>.

15.1. Resource File Syntax

The syntax of a resource file is a sequence of resource lines terminated by newline characters or the end of the file. The syntax of an individual resource line is:

ResourceLine = Comment | IncludeFile | ResourceSpec | <empty line>
Comment = "!" {<any character except null or newline>}
IncludeFile = "#" WhiteSpace "include" WhiteSpace FileName WhiteSpace
FileName = <valid filename for operating system>
ResourceSpec = WhiteSpace ResourceName WhiteSpace ":" WhiteSpace Value
ResourceName = [Binding] {Component Binding} ComponentName
Binding = "." | "*"
WhiteSpace = {<space> | <horizontal tab>}
Component = "?" | ComponentName
ComponentName = NameChar {NameChar}
NameChar = "a"−"z" | "A"−"Z" | "0"−"9" | "_" | "-"
Value = {<any character except null or unescaped newline>}

Elements separated by vertical bar (|) are alternatives. Curly braces ({...}) indicate zero or more repetitions of the enclosed elements. Square brackets ([...]) indicate that the enclosed element is optional. Quotes ("...") are used around literal characters.

IncludeFile lines are interpreted by replacing the line with the contents of the specified file. The word “include” must be in lowercase. The file name is interpreted relative to the directory of the file in which the line occurs (for example, if the file name contains no directory or contains a relative directory specification).

If a ResourceName contains a contiguous sequence of two or more Binding characters, the sequence will be replaced with single “.” character if the sequence contains only “.” characters; otherwise, the sequence will be replaced with a single “*” character.

A resource database never contains more than one entry for a given ResourceName. If a resource file contains multiple lines with the same ResourceName, the last line in the file is used.

Any white space characters before or after the name or colon in a ResourceSpec are ignored. To allow a Value to begin with white space, the two-character sequence “*\space*” (backslash followed by space) is recognized and replaced by a space character, and the two-character sequence “*\tab*” (backslash followed by horizontal tab) is recognized and replaced by a horizontal tab character. To allow a Value to contain embedded newline characters, the two-character sequence “\n” is recognized and replaced by a newline character. To allow a Value to be broken across multiple lines in a text file, the two-character sequence “*\newline*” (backslash followed by newline) is recognized and removed from the value. To allow a Value to contain arbitrary character codes, the four-character sequence “*\nnn*”, where each *n* is a digit character in the range of “0”−“7”, is recognized and replaced with a single byte that contains the octal value specified by the sequence. Finally, the two-character sequence “\\” is recognized and replaced with a single backslash.

As an example of these sequences, the following resource line contains a value consisting of four characters: a backslash, a null, a “z”, and a newline:

```
magic.values: \\\000\
z\n
```

15.2. Resource Manager Matching Rules

The algorithm for determining which resource database entry matches a given query is the heart of the resource manager. All queries must fully specify the name and class of the desired resource (use of the characters “*” and “?” are not permitted). The library supports up to 100 components in a full name or class. Resources are stored in the database with only partially specified names and classes, using pattern matching constructs. An asterisk (*) is a loose binding and is used to represent any number of intervening components, including none. A period (.) is a tight binding and is used to separate immediately adjacent components. A question mark (?) is used to match any single component name or class. A database entry cannot end in a loose binding; the final component (which cannot be the character “?”) must be specified. The lookup algorithm searches the database for the entry that most closely matches (is most specific for) the full name and class being queried. When more than one database entry matches the full name and class, precedence rules are used to select just one.

The full name and class are scanned from left to right (from highest level in the hierarchy to lowest), one component at a time. At each level, the corresponding component and/or binding of each matching entry is determined, and these matching components and bindings are compared according to precedence rules. Each of the rules is applied at each level before moving to the next level, until a rule selects a single entry over all others. The rules, in order of precedence, are:

1. An entry that contains a matching component (whether name, class, or the character “?”) takes precedence over entries that elide the level (that is, entries that match the level in a loose binding).
2. An entry with a matching name takes precedence over both entries with a matching class and entries that match using the character “?”. An entry with a matching class takes precedence over entries that match using the character “?”.
3. An entry preceded by a tight binding takes precedence over entries preceded by a loose binding.

To illustrate these rules, consider the following resource database entries:

```
xmh*Paned*activeForeground:          red      (entry A)
*incorporate.Foreground:             blue     (entry B)
xmh.toc*Command*activeForeground:    green    (entry C)
xmh.toc*?.Foreground:                white    (entry D)
xmh.toc*Command.activeForeground:    black    (entry E)
```

Consider a query for the resource:

```
xmh.toc.messagefunctions.incorporate.activeForeground (name)
Xmh.Paned.Box.Command.Foreground                      (class)
```

At the first level (xmh, Xmh), rule 1 eliminates entry B. At the second level (toc, Paned), rule 2 eliminates entry A. At the third level (messagefunctions, Box), no entries are eliminated. At the fourth level (incorporate, Command), rule 2 eliminates entry D. At the fifth level (activeForeground, Foreground), rule 3 eliminates entry C.

15.3. Quarks

Most uses of the resource manager involve defining names, classes, and representation types as string constants. However, always referring to strings in the resource manager can be slow, because it is so heavily used in some toolkits. To solve this problem, a shorthand for a string is used in place of the string in many of the resource manager functions. Simple comparisons can be performed rather than string comparisons. The shorthand name for a string is called a quark and is the type **XrmQuark**. On some occasions, you may want to allocate a quark that has no string equivalent.

A quark is to a string what an atom is to a string in the server, but its use is entirely local to your application.

To allocate a new quark, use **XrmUniqueQuark**.

```
XrmQuark XrmUniqueQuark( )
```

The **XrmUniqueQuark** function allocates a quark that is guaranteed not to represent any string that is known to the resource manager.

Each name, class, and representation type is typedef'd as an **XrmQuark**.

```
typedef int XrmQuark, *XrmQuarkList;
typedef XrmQuark XrmName;
typedef XrmQuark XrmClass;
typedef XrmQuark XrmRepresentation;
#define NULLQUARK ((XrmQuark) 0)
```

Lists are represented as null-terminated arrays of quarks. The size of the array must be large enough for the number of components used.

```
typedef XrmQuarkList XrmNameList;
typedef XrmQuarkList XrmClassList;
```

To convert a string to a quark, use **XrmStringToQuark** or **XrmPermStringToQuark**.

```
#define XrmStringToName(string) XrmStringToQuark(string)
#define XrmStringToClass(string) XrmStringToQuark(string)
#define XrmStringToRepresentation(string) XrmStringToQuark(string)

XrmQuark XrmStringToQuark(string)
   char *string;

XrmQuark XrmPermStringToQuark(string)
   char *string;
```

string Specifies the string for which a quark is to be allocated.

These functions can be used to convert from string to quark representation. If the string is not in the Host Portable Character Encoding, the conversion is implementation dependent. The string argument to **XrmStringToQuark** need not be permanently allocated storage. **XrmPermStringToQuark** is just like **XrmStringToQuark**, except that Xlib is permitted to assume the string argument is permanently allocated, and, hence, that it can be used as the value to be returned by **XrmQuarkToString**.

For any given quark, if **XrmStringToQuark** returns a non-NULL value, all future calls will return the same value (identical address).

To convert a quark to a string, use **XrmQuarkToString**.

```
#define XrmNameToString(name) XrmQuarkToString(name)
#define XrmClassToString(class) XrmQuarkToString(class)
#define XrmRepresentationToString(type) XrmQuarkToString(type)

char *XrmQuarkToString(quark)
   XrmQuark quark;
```

quark Specifies the quark for which the equivalent string is desired.

These functions can be used to convert from quark representation to string. The string pointed to by the return value must not be modified or freed. The returned string is byte-for-byte equal to the original string passed to one of the string-to-quark routines. If no string exists for that quark, **XrmQuarkToString** returns NULL. For any given quark, if **XrmQuarkToString** returns a non-NULL value, all future calls will return the same value (identical address).

To convert a string with one or more components to a quark list, use **XrmStringToQuarkList**.

```
#define XrmStringToNameList(str, name)  XrmStringToQuarkList((str), (name))
#define XrmStringToClassList(str,class) XrmStringToQuarkList((str), (class))
```

```
void XrmStringToQuarkList(string, quarks_return)
    char *string;
    XrmQuarkList quarks_return;
```

string	Specifies the string for which a quark list is to be allocated.
quarks_return	Returns the list of quarks.

The **XrmStringToQuarkList** function converts the null-terminated string (generally a fully qualified name) to a list of quarks. Note that the string must be in the valid ResourceName format (see section 15.1). If the string is not in the Host Portable Character Encoding, the conversion is implementation dependent.

A binding list is a list of type **XrmBindingList** and indicates if components of name or class lists are bound tightly or loosely (that is, if wildcarding of intermediate components is specified).

```
typedef enum {XrmBindTightly, XrmBindLoosely} XrmBinding, *XrmBindingList;
```

XrmBindTightly indicates that a period separates the components, and **XrmBindLoosely** indicates that an asterisk separates the components.

To convert a string with one or more components to a binding list and a quark list, use **XrmStringToBindingQuarkList**.

```
XrmStringToBindingQuarkList(string, bindings_return, quarks_return)
    char *string;
    XrmBindingList bindings_return;
    XrmQuarkList quarks_return;
```

string	Specifies the string for which a quark list is to be allocated.
bindings_return	Returns the binding list. The caller must allocate sufficient space for the binding list before calling **XrmStringToBindingQuarkList**.
quarks_return	Returns the list of quarks. The caller must allocate sufficient space for the quarks list before calling **XrmStringToBindingQuarkList**.

Component names in the list are separated by a period or an asterisk character. The string must be in the format of a valid ResourceName (see section 15.1). If the string does not start with a period or an asterisk, a tight binding is assumed. For example, the string ‘‘*a.b*c’’ becomes:

quarks:	a	b	c
bindings:	loose	tight	loose

15.4. Creating and Storing Databases

A resource database is an opaque type, **XrmDatabase**. Each database value is stored in an **XrmValue** structure. This structure consists of a size, an address, and a representation type. The size is specified in bytes. The representation type is a way for you to store data tagged by some application-defined type (for example, the strings “font” or “color”). It has nothing to do with the C data type or with its class. The **XrmValue** structure is defined as:

```
typedef struct {
        unsigned int size;
        XPointer addr;
} XrmValue, *XrmValuePtr;
```

To initialize the resource manager, use **XrmInitialize**.

```
void XrmInitialize( );
```

To retrieve a database from disk, use **XrmGetFileDatabase**.

```
XrmDatabase XrmGetFileDatabase(filename)
   char *filename;
```

filename	Specifies the resource database file name.

The **XrmGetFileDatabase** function opens the specified file, creates a new resource database, and loads it with the specifications read in from the specified file. The specified file should contain a sequence of entries in valid ResourceLine format (see section 15.1); the database that results from reading a file with incorrect syntax is implementation dependent. The file is parsed in the current locale, and the database is created in the current locale. If it cannot open the specified file, **XrmGetFileDatabase** returns NULL.

To store a copy of a database to disk, use **XrmPutFileDatabase**.

```
void XrmPutFileDatabase(database, stored_db)
   XrmDatabase database;
   char *stored_db;
```

database	Specifies the database that is to be used.
stored_db	Specifies the file name for the stored database.

The **XrmPutFileDatabase** function stores a copy of the specified database in the specified file. Text is written to the file as a sequence of entries in valid ResourceLine format (see section 15.1). The file is written in the locale of the database. Entries containing resource names that are not in the Host Portable Character Encoding or containing values that are not in the encoding of the database locale, are written in an implementation dependent manner. The order in which entries are written is implementation dependent. Entries with representation types other than “String” are ignored.

To obtain a pointer to the screen independent resources of a display, use **XResourceManagerString**.

char *XResourceManagerString(*display*)
    Display **display*;

display Specifies the connection to the X server.

The **XResourceManagerString** function returns the RESOURCE_MANAGER property from the server's root window of screen zero, which was returned when the connection was opened using **XOpenDisplay**. The property is converted from type STRING to the current locale. The conversion is identical to that produced by **XmbTextPropertyToTextList** for a single element STRING property. The returned string is owned by Xlib and should not be freed by the client. The property value must be in a format that is acceptable to **XrmGetStringDatabase**. If no property exists, NULL is returned.

To obtain a pointer to the screen-specific resources of a screen, use **XScreenResourceString**.

char *XScreenResourceString(*screen*)
    Screen **screen*;

screen Specifies the screen.

The **XScreenResourceString** function returns the SCREEN_RESOURCES property from the root window of the specified screen. The property is converted from type STRING to the current locale. The conversion is identical to that produced by **XmbTextPropertyToTextList** for a single element STRING property. The property value must be in a format that is acceptable to **XrmGetStringDatabase**. If no property exists, NULL is returned. The caller is responsible for freeing the returned string by using **XFree**.

To create a database from a string, use **XrmGetStringDatabase**.

XrmDatabase XrmGetStringDatabase(*data*)
    char **data*;

data Specifies the database contents using a string.

The **XrmGetStringDatabase** function creates a new database and stores the resources specified in the specified null-terminated string. **XrmGetStringDatabase** is similar to **XrmGetFileDatabase** except that it reads the information out of a string instead of out of a file. The string should contain a sequence of entries in valid ResourceLine format (see section 15.1) terminated by a null character; the database that results from using a string with incorrect syntax is implementation dependent. The string is parsed in the current locale, and the database is created in the current locale.

To obtain locale name of a database, use **XrmLocaleOfDatabase**.

```
char *XrmLocaleOfDatabase(database)
      XrmDatabase database;
```

database	Specifies the resource database.

The **XrmLocaleOfDatabase** function returns the name of the locale bound to the specified database, as a null-terminated string. The returned locale name string is owned by Xlib and should not be modified or freed by the client. Xlib is not permitted to free the string until the database is destroyed. Until the string is freed, it will not be modified by Xlib.

To destroy a resource database and free its allocated memory, use **XrmDestroyDatabase**.

```
void XrmDestroyDatabase(database)
      XrmDatabase database;
```

database	Specifies the resource database.

If database is NULL, **XrmDestroyDatabase** returns immediately.

To associate a resource database with a display, use **XrmSetDatabase**.

```
void XrmSetDatabase(display, database)
      Display *display;
      XrmDatabase database;
```

display	Specifies the connection to the X server.
database	Specifies the resource database.

The **XrmSetDatabase** function associates the specified resource database (or NULL) with the specified display. The database previously associated with the display (if any) is not destroyed. A client or toolkit may find this function convenient for retaining a database once it is constructed.

To get the resource database associated with a display, use **XrmGetDatabase**.

```
XrmDatabase XrmGetDatabase(display)
      Display *display;
```

display	Specifies the connection to the X server.

The **XrmGetDatabase** function returns the database associated with the specified display. It returns NULL if a database has not yet been set.

15.5. Merging Resource Databases

To merge the contents of a resource file into a database, use **XrmCombineFileDatabase**.

Status XrmCombineFileDatabase(*filename*, *target_db*, *override*)
    char **filename*;
    XrmDatabase **target_db*;
    Bool *override*;

filename	Specifies the resource database file name.
target_db	Specifies the resource database into which the source database is to be merged.

The **XrmCombineFileDatabase** function merges the contents of a resource file into a database. If the same specifier is used for an entry in both the file and the database, the entry in the file will replace the entry in the database if override is **True**; otherwise, the entry in the file is discarded. The file is parsed in the current locale. If the file cannot be read, a zero status is returned; otherwise, a nonzero status is returned. If target_db contains NULL, **XrmCombineFileDatabase** creates and returns a new database to it. Otherwise, the database pointed to by target_db is not destroyed by the merge. The database entries are merged without changing values or types, regardless of the locale of the database. The locale of the target database is not modified.

To merge the contents of one database into another database, use **XrmCombineDatabase**.

void XrmCombineDatabase(*source_db*, *target_db*, *override*)
    XrmDatabase *source_db*, **target_db*;
    Bool *override*;

source_db	Specifies the resource database that is to be merged into the target database.
target_db	Specifies the resource database into which the source database is to be merged.
override	Specifies whether source entries override target ones.

The **XrmCombineDatabase** function merges the contents of one database into another. If the same specifier is used for an entry in both databases, the entry in the source_db will replace the entry in the target_db if override is **True**; otherwise, the entry in source_db is discarded. If target_db contains NULL, **XrmCombineDatabase** simply stores source_db in it. Otherwise, source_db is destroyed by the merge, but the database pointed to by target_db is not destroyed. The database entries are merged without changing values or types, regardless of the locales of the databases. The locale of the target database is not modified.

To merge the contents of one database into another database with override semantics, use **XrmMergeDatabases**.

void XrmMergeDatabases(*source_db*, *target_db*)
    XrmDatabase *source_db*, **target_db*;

source_db	Specifies the resource database that is to be merged into the target database.
target_db	Specifies the resource database into which the source database is to be merged.

Calling the **XrmMergeDatabases** function is equivalent to calling the **XrmCombineDatabase** function with an override argument of **True**.

15.6. Looking Up Resources

To retrieve a resource from a resource database, use **XrmGetResource**, **XrmQGetResource**, or **XrmQGetSearchResource**.

```
Bool XrmGetResource(database, str_name, str_class, str_type_return, value_return)
    XrmDatabase database;
    char *str_name;
    char *str_class;
    char **str_type_return;
    XrmValue *value_return;
```

database	Specifies the database that is to be used.
str_name	Specifies the fully qualified name of the value being retrieved (as a string).
str_class	Specifies the fully qualified class of the value being retrieved (as a string).
str_type_return	Returns the representation type of the destination (as a string).
value_return	Returns the value in the database.

```
Bool XrmQGetResource(database, quark_name, quark_class, quark_type_return, value_return)
    XrmDatabase database;
    XrmNameList quark_name;
    XrmClassList quark_class;
    XrmRepresentation *quark_type_return;
    XrmValue *value_return;
```

database	Specifies the database that is to be used.
quark_name	Specifies the fully qualified name of the value being retrieved (as a quark).
quark_class	Specifies the fully qualified class of the value being retrieved (as a quark).
quark_type_return	Returns the representation type of the destination (as a quark).
value_return	Returns the value in the database.

The **XrmGetResource** and **XrmQGetResource** functions retrieve a resource from the specified database. Both take a fully qualified name/class pair, a destination resource representation, and the address of a value (size/address pair). The value and returned type point into database memory; therefore, you must not modify the data.

The database only frees or overwrites entries on **XrmPutResource**, **XrmQPutResource**, or **XrmMergeDatabases**. A client that is not storing new values into the database or is not merging the database should be safe using the address passed back at any time until it exits. If a resource was found, both **XrmGetResource** and **XrmQGetResource** return **True**; otherwise, they return **False**.

Most applications and toolkits do not make random probes into a resource database to fetch resources. The X toolkit access pattern for a resource database is quite stylized. A series of from 1 to 20 probes are made with only the last name/class differing in each probe. The **XrmGetResource** function is at worst a 2^n algorithm, where n is the length of the name/class list. This can be improved upon by the application programmer by prefetching a list of database levels that might match the first part of a name/class list.

To obtain a list of database levels, use **XrmQGetSearchList**.

```
typedef XrmHashTable *XrmSearchList;

Bool XrmQGetSearchList(database, names, classes, list_return, list_length)
    XrmDatabase database;
    XrmNameList names;
    XrmClassList classes;
    XrmSearchList list_return;
    int list_length;
```

database	Specifies the database that is to be used.
names	Specifies a list of resource names.
classes	Specifies a list of resource classes.
list_return	Returns a search list for further use. The caller must allocate sufficient space for the list before calling **XrmQGetSearchList**.
list_length	Specifies the number of entries (not the byte size) allocated for list_return.

The **XrmQGetSearchList** function takes a list of names and classes and returns a list of database levels where a match might occur. The returned list is in best-to-worst order and uses the same algorithm as **XrmGetResource** for determining precedence. If list_return was large enough for the search list, **XrmQGetSearchList** returns **True**; otherwise, it returns **False**.

The size of the search list that the caller must allocate is dependent upon the number of levels and wildcards in the resource specifiers that are stored in the database. The worst case length is 3^n, where n is the number of name or class components in names or classes.

When using **XrmQGetSearchList** followed by multiple probes for resources with a common name and class prefix, only the common prefix should be specified in the name and class list to **XrmQGetSearchList**.

To search resource database levels for a given resource, use **XrmQGetSearchResource**.

Bool XrmQGetSearchResource(*list*, *name*, *class*, *type_return*, *value_return*)
XrmSearchList *list*;
XrmName *name*;
XrmClass *class*;
XrmRepresentation **type_return*;
XrmValue **value_return*;

list	Specifies the search list returned by **XrmQGetSearchList**.
name	Specifies the resource name.
class	Specifies the resource class.
type_return	Returns data representation type.
value_return	Returns the value in the database.

The **XrmQGetSearchResource** function searches the specified database levels for the resource that is fully identified by the specified name and class. The search stops with the first match. **XrmQGetSearchResource** returns **True** if the resource was found; otherwise, it returns **False**.

A call to **XrmQGetSearchList** with a name and class list containing all but the last component of a resource name followed by a call to **XrmQGetSearchResource** with the last component name and class returns the same database entry as **XrmGetResource** and **XrmQGetResource** with the fully qualified name and class.

15.7. Storing Into a Resource Database

To store resources into the database, use **XrmPutResource** or **XrmQPutResource**. Both functions take a partial resource specification, a representation type, and a value. This value is copied into the specified database.

void XrmPutResource(*database*, *specifier*, *type*, *value*)
XrmDatabase **database*;
char **specifier*;
char **type*;
XrmValue **value*;

database	Specifies the resource database.
specifier	Specifies a complete or partial specification of the resource.
type	Specifies the type of the resource.
value	Specifies the value of the resource, which is specified as a string.

If database contains NULL, **XrmPutResource** creates a new database and returns a pointer to it. **XrmPutResource** is a convenience function that calls **XrmStringToBindingQuarkList** followed by:

```
XrmQPutResource(database, bindings, quarks, XrmStringToQuark(type), value)
```

If the specifier and type are not in the Host Portable Character Encoding, the result is implementation dependent. The value is stored in the database without modification.

```
void XrmQPutResource(database, bindings, quarks, type, value)
    XrmDatabase *database;
    XrmBindingList bindings;
    XrmQuarkList quarks;
    XrmRepresentation type;
    XrmValue *value;
```

database	Specifies the resource database.
bindings	Specifies a list of bindings.
quarks	Specifies the complete or partial name or the class list of the resource.
type	Specifies the type of the resource.
value	Specifies the value of the resource, which is specified as a string.

If database contains NULL, **XrmQPutResource** creates a new database and returns a pointer to it. If a resource entry with the identical bindings and quarks already exists in the database, the previous type and value are replaced by the new specified type and value. The value is stored in the database without modification.

To add a resource that is specified as a string, use **XrmPutStringResource**.

```
void XrmPutStringResource(database, specifier, value)
    XrmDatabase *database;
    char *specifier;
    char *value;
```

database	Specifies the resource database.
specifier	Specifies a complete or partial specification of the resource.
value	Specifies the value of the resource, which is specified as a string.

If database contains NULL, **XrmPutStringResource** creates a new database and returns a pointer to it. **XrmPutStringResource** adds a resource with the specified value to the specified database. **XrmPutStringResource** is a convenience function that first calls **XrmStringToBindingQuarkList** on the specifier and then calls **XrmQPutResource**, using a “String” representation type. If the specifier is not in the Host Portable Character Encoding, the result is implementation dependent. The value is stored in the database without modification.

To add a string resource using quarks as a specification, use **XrmQPutStringResource**.

```
void XrmQPutStringResource(database, bindings, quarks, value)
    XrmDatabase *database;
    XrmBindingList bindings;
    XrmQuarkList quarks;
    char *value;
```

database	Specifies the resource database.
bindings	Specifies a list of bindings.
quarks	Specifies the complete or partial name or the class list of the resource.
value	Specifies the value of the resource, which is specified as a string.

If database contains NULL, **XrmQPutStringResource** creates a new database and returns a pointer to it. **XrmQPutStringResource** is a convenience routine that constructs an **XrmValue** for the value string (by calling **strlen** to compute the size) and then calls **XrmQPutResource**, using a ‘‘String’’ representation type. The value is stored in the database without modification.

To add a single resource entry that is specified as a string that contains both a name and a value, use **XrmPutLineResource**.

```
void XrmPutLineResource(database, line)
    XrmDatabase *database;
    char *line;
```

database	Specifies the resource database.
line	Specifies the resource name and value pair as a single string.

If database contains NULL, **XrmPutLineResource** creates a new database and returns a pointer to it. **XrmPutLineResource** adds a single resource entry to the specified database. The line should be in valid ResourceLine format (see section 15.1) terminated by a newline or null character; the database that results from using a string with incorrect syntax is implementation dependent. The string is parsed in the locale of the database. If the **ResourceName** is not in the Host Portable Character Encoding, the result is implementation dependent. Note that comment lines are not stored.

15.8. Enumerating Database Entries

To enumerate the entries of a database, use **XrmEnumerateDatabase**.

```
#define   XrmEnumAllLevels       0
#define   XrmEnumOneLevel        1
```

```
Bool XrmEnumerateDatabase(database, name_prefix, class_prefix, mode, proc, arg)
    XrmDatabase database;
    XrmNameList name_prefix;
    XrmClassList class_prefix;
    int mode;
    Bool (*proc)();
    XPointer arg;
```

database	Specifies the resource database.
name_prefix	Specifies the resource name prefix.
class_prefix	Specifies the resource class prefix.
mode	Specifies the number of levels to enumerate.
proc	Specifies the procedure that is to be called for each matching entry.
arg	Specifies the user-supplied argument that will be passed to the procedure.

The **XrmEnumerateDatabase** function calls the specified procedure for each resource in the database that would match some completion of the given name/class resource prefix. The order in which resources are found is implementation dependent. If mode is **XrmEnumOneLevel**, a resource must match the given name/class prefix with just a single name and class appended. If mode is **XrmEnumAllLevels**, the resource must match the given name/class prefix with one or more names and classes appended. If the procedure returns **True**, the enumeration terminates and the function returns **True**. If the procedure always returns **False**, all matching resources are enumerated and the function returns **False**.

The procedure is called with the following arguments:

```
(*proc)(database, bindings, quarks, type, value, arg)
        XrmDatabase *database;
        XrmBindingList bindings;
        XrmQuarkList quarks;
        XrmRepresentation *type;
        XrmValue *value;
        XPointer closure;
```

The bindings and quarks lists are terminated by **NULLQUARK**. Note that pointers to the database and type are passed, but these values should not be modified.

The procedure must not modifiy the database. If Xlib has been initialized for threads, the procedure is called with the database locked and the result of a call by the procedure to any Xlib function using the same database is not defined.

15.9. Parsing Command Line Options

The **XrmParseCommand** function can be used to parse the command line arguments to a program and modify a resource database with selected entries from the command line.

```
typedef enum {
        XrmoptionNoArg,          /* Value is specified in XrmOptionDescRec.value */
        XrmoptionIsArg,          /* Value is the option string itself */
        XrmoptionStickyArg,      /* Value is characters immediately following option */
        XrmoptionSepArg,         /* Value is next argument in argv */
        XrmoptionResArg,         /* Resource and value in next argument in argv */
        XrmoptionSkipArg,        /* Ignore this option and the next argument in argv */
        XrmoptionSkipLine,       /* Ignore this option and the rest of argv */
        XrmoptionSkipNArgs       /* Ignore this option and the next
                                    XrmOptionDescRec.value arguments in argv */
} XrmOptionKind;
```

Note that **XrmoptionSkipArg** is equivalent to **XrmoptionSkipNArgs** with the **XrmOptionDescRec.value** field containing the value one. Note also that the value zero for **XrmoptionSkipNArgs** indicates that only the option itself is to be skipped.

```
typedef struct {
        char *option;            /* Option specification string in argv    */
        char *specifier;         /* Binding and resource name (sans application name)    */
        XrmOptionKind argKind;   /* Which style of option it is    */
        XPointer value;          /* Value to provide if XrmoptionNoArg or
                                    XrmoptionSkipNArgs   */
} XrmOptionDescRec, *XrmOptionDescList;
```

To load a resource database from a C command line, use **XrmParseCommand**.

```
void XrmParseCommand(database, table, table_count, name, argc_in_out, argv_in_out)
    XrmDatabase *database;
    XrmOptionDescList table;
    int table_count;
    char *name;
    int *argc_in_out;
    char **argv_in_out;
```

database	Specifies the resource database.
table	Specifies the table of command line arguments to be parsed.
table_count	Specifies the number of entries in the table.
name	Specifies the application name.
argc_in_out	Specifies the number of arguments and returns the number of remaining arguments.
argv_in_out	Specifies the command line arguments and returns the remaining arguments.

The **XrmParseCommand** function parses an (argc, argv) pair according to the specified option table, loads recognized options into the specified database with type ‘‘String,’’ and modifies the (argc, argv) pair to remove all recognized options. If database contains NULL,

XrmParseCommand creates a new database and returns a pointer to it. Otherwise, entries are added to the database specified. If a database is created, it is created in the current locale.

The specified table is used to parse the command line. Recognized options in the table are removed from argv, and entries are added to the specified resource database in the order they occur in argv. The table entries contain information on the option string, the option name, the style of option, and a value to provide if the option kind is **XrmoptionNoArg**. The option names are compared byte-for-byte to arguments in argv, independent of any locale. The resource values given in the table are stored in the resource database without modification. All resource database entries are created using a ‘‘String’’ representation type. The argc argument specifies the number of arguments in argv and is set on return to the remaining number of arguments that were not parsed. The name argument should be the name of your application for use in building the database entry. The name argument is prefixed to the resourceName in the option table before storing a database entry. The name argument is treated as a single component, even if it has embedded periods. No separating (binding) character is inserted, so the table must contain either a period (.) or an asterisk (*) as the first character in each resourceName entry. To specify a more completely qualified resource name, the resourceName entry can contain multiple components. If the name argument and the resourceNames are not in the Host Portable Character Encoding, the result is implementation dependent.

The following provides a sample option table:

```
static XrmOptionDescRec opTable[] = {
{"−background",   "*background",                 XrmoptionSepArg,   (XPointer) NULL},
{"−bd",           "*borderColor",                XrmoptionSepArg,   (XPointer) NULL},
{"−bg",           "*background",                 XrmoptionSepArg,   (XPointer) NULL},
{"−borderwidth",  "*TopLevelShell.borderWidth",  XrmoptionSepArg,   (XPointer) NULL},
{"−bordercolor",  "*borderColor",                XrmoptionSepArg,   (XPointer) NULL},
{"−bw",           "*TopLevelShell.borderWidth",  XrmoptionSepArg,   (XPointer) NULL},
{"−display",      ".display",                    XrmoptionSepArg,   (XPointer) NULL},
{"−fg",           "*foreground",                 XrmoptionSepArg,   (XPointer) NULL},
{"−fn",           "*font",                       XrmoptionSepArg,   (XPointer) NULL},
{"−font",         "*font",                       XrmoptionSepArg,   (XPointer) NULL},
{"−foreground",   "*foreground",                 XrmoptionSepArg,   (XPointer) NULL},
{"−geometry",     ".TopLevelShell.geometry",     XrmoptionSepArg,   (XPointer) NULL},
{"−iconic",       ".TopLevelShell.iconic",       XrmoptionNoArg,    (XPointer) "on"},
{"−name",         ".name",                       XrmoptionSepArg,   (XPointer) NULL},
{"−reverse",      "*reverseVideo",               XrmoptionNoArg,    (XPointer) "on"},
{"−rv",           "*reverseVideo",               XrmoptionNoArg,    (XPointer) "on"},
{"−synchronous",  "*synchronous",                XrmoptionNoArg,    (XPointer) "on"},
{"−title",        ".TopLevelShell.title",        XrmoptionSepArg,   (XPointer) NULL},
{"−xrm",          NULL,                          XrmoptionResArg,   (XPointer) NULL},
};
```

In this table, if the −background (or −bg) option is used to set background colors, the stored resource specifier matches all resources of attribute background. If the −borderwidth option is used, the stored resource specifier applies only to border width attributes of class TopLevelShell (that is, outer-most windows, including pop-up windows). If the −title option is used to set a window name, only the topmost application windows receive the resource.

When parsing the command line, any unique unambiguous abbreviation for an option name in the table is considered a match for the option. Note that uppercase and lowercase matter.

Chapter 16

Application Utility Functions

Once you have initialized the X system, you can use the Xlib utility functions to:

- Obtain and classify KeySyms
- Allocate permanent storage
- Parse window geometry strings
- Manipulate regions
- Use cut buffers
- Determine the appropriate visual
- Manipulate images
- Manipulate bitmaps
- Use the context manager

As a group, the functions discussed in this chapter provide the functionality that is frequently needed and that spans toolkits. Many of these functions do not generate actual protocol requests to the server.

16.1. Keyboard Utility Functions

This section discusses mapping between KeyCodes and KeySyms, classifying KeySyms, and mapping between KeySyms and string names. The first three functions in this section operate on a cached copy of the server keyboard mapping. The first four KeySyms for each KeyCode are modified according to the rules given in section 12.7. To obtain the untransformed KeySyms defined for a key, use the functions described in section 12.7.

To obtain a KeySym for the KeyCode of an event, use **XLookupKeysym**.

```
KeySym XLookupKeysym(key_event, index)
    XKeyEvent *key_event;
    int index;
```

key_event	Specifies the **KeyPress** or **KeyRelease** event.
index	Specifies the index into the KeySyms list for the event's KeyCode.

The **XLookupKeysym** function uses a given keyboard event and the index you specified to return the KeySym from the list that corresponds to the KeyCode member in the **XKeyPressedEvent** or **XKeyReleasedEvent** structure. If no KeySym is defined for the KeyCode of the event, **XLookupKeysym** returns **NoSymbol**.

To obtain a KeySym for a specific KeyCode, use **XKeycodeToKeysym**.

```
KeySym XKeycodeToKeysym(display, keycode, index)
    Display *display;
    KeyCode keycode;
    int index;
```

display	Specifies the connection to the X server.
keycode	Specifies the KeyCode.
index	Specifies the element of KeyCode vector.

The **XKeycodeToKeysym** function uses internal Xlib tables and returns the KeySym defined for the specified KeyCode and the element of the KeyCode vector. If no symbol is defined, **XKeycodeToKeysym** returns **NoSymbol**.

To obtain a KeyCode for a key having a specific KeySym, use **XKeysymToKeycode**.

```
KeyCode XKeysymToKeycode(display, keysym)
    Display *display;
    KeySym keysym;
```

display	Specifies the connection to the X server.
keysym	Specifies the KeySym that is to be searched for.

If the specified KeySym is not defined for any KeyCode, **XKeysymToKeycode** returns zero.

The mapping between KeyCodes and KeySyms is cached internal to Xlib. When this information is changed at the server, an Xlib function must be called to refresh the cache. To refresh the stored modifier and keymap information, use **XRefreshKeyboardMapping**.

```
XRefreshKeyboardMapping(event_map)
    XMappingEvent *event_map;
```

event_map	Specifies the mapping event that is to be used.

The **XRefreshKeyboardMapping** function refreshes the stored modifier and keymap information. You usually call this function when a **MappingNotify** event with a request member of **MappingKeyboard** or **MappingModifier** occurs. The result is to update Xlib's knowledge of the keyboard.

To obtain the uppercase and lowercase forms of a KeySym, us **XConvertCase**.

void XConvertCase(*keysym*, *lower_return*, *upper_return*)
  KeySym *keysym*;
  KeySym **lower_return*;
  KeySym **upper_return*;

keysym	Specifies the KeySym that is to be converted.
lower_return	Returns the lowercase form of keysym, or keysym.
upper_return	Returns the uppercase form of keysym, or keysym.

The **XConvertCase** function returns the uppercase and lowercase forms of the specified Keysym, if the KeySym is subject to case conversion; otherwise, the specified KeySym is returned to both lower_return and upper_return. Support for conversion of other than Latin and Cyrillic KeySyms is implementation dependent.

KeySyms have string names as well as numeric codes. To convert the name of the KeySym to the KeySym code, use **XStringToKeysym**.

KeySym XStringToKeysym(*string*)
  char **string*;

string	Specifies the name of the KeySym that is to be converted.

Standard KeySym names are obtained from **<X11/keysymdef.h>** by removing the XK_ prefix from each name. KeySyms that are not part of the Xlib standard also may be obtained with this function. The set of KeySyms that are available in this manner and the mechanisms by which Xlib obtains them is implementation dependent.

If the KeySym name is not in the Host Portable Character Encoding, the result is implementation dependent. If the specified string does not match a valid KeySym, **XStringToKeysym** returns **NoSymbol**.

To convert a KeySym code to the name of the KeySym, use **XKeysymToString**.

char *XKeysymToString(*keysym*)
  KeySym *keysym*;

keysym	Specifies the KeySym that is to be converted.

The returned string is in a static area and must not be modified. The returned string is in the Host Portable Character Encoding. If the specified KeySym is not defined, **XKeysymToString** returns a NULL.

16.1.1. KeySym Classification Macros

You may want to test if a KeySym is, for example, on the keypad or on one of the function keys. You can use KeySym macros to perform the following tests.

IsCursorKey(*keysym*)

keysym Specifies the KeySym that is to be tested.

Returns **True** if the specified KeySym is a cursor key.

IsFunctionKey(*keysym*)

keysym Specifies the KeySym that is to be tested.

Returns **True** if the specified KeySym is a function key.

IsKeypadKey(*keysym*)

keysym Specifies the KeySym that is to be tested.

Returns **True** if the specified KeySym is a standard keypad key.

IsPrivateKeypadKey(*keysym*)

keysym Specifies the KeySym that is to be tested.

Returns **True** if the specified KeySym is a vendor-private keypad key.

IsMiscFunctionKey(*keysym*)

keysym Specifies the KeySym that is to be tested.

Returns **True** if the specified KeySym is a miscellaneous function key.

IsModifierKey(*keysym*)

keysym Specifies the KeySym that is to be tested.

Returns **True** if the specified KeySym is a modifier key.

IsPFKey(*keysym*)

keysym Specifies the KeySym that is to be tested.

Returns **True** if the specified KeySym is a PF key.

16.2. Latin-1 Keyboard Event Functions

Chapter 13 describes internationalized text input facilities, but sometimes it is expedient to write an application that only deals with Latin-1 characters and ASCII controls, so Xlib provides a simple function for that purpose. **XLookupString** handles the standard modifier semantics described in section 12.7. This function does not use any of the input method facilities described in chapter 13 and does not depend on the current locale.

To map a key event to an ISO Latin-1 string, use **XLookupString**.

```
int XLookupString(event_struct, buffer_return, bytes_buffer, keysym_return, status_in_out)
      XKeyEvent *event_struct;
      char *buffer_return;
      int bytes_buffer;
      KeySym *keysym_return;
      XComposeStatus *status_in_out;
```

event_struct	Specifies the key event structure to be used. You can pass **XKeyPressedEvent** or **XKeyReleasedEvent**.
buffer_return	Returns the translated characters.
bytes_buffer	Specifies the length of the buffer. No more than bytes_buffer of translation are returned.
keysym_return	Returns the KeySym computed from the event if this argument is not NULL.
status_in_out	Specifies or returns the **XComposeStatus** structure or NULL.

The **XLookupString** function translates a key event to a KeySym and a string. The KeySym is obtained by using the standard interpretation of the **Shift**, **Lock**, group, and numlock modifiers as defined in the X Protocol specification. If the KeySym has been rebound (see **XRebindKeysym**), the bound string will be stored in the buffer. Otherwise, the KeySym is mapped, if possible, to an ISO Latin-1 character or (if the Control modifier is on) to an ASCII control character, and that character is stored in the buffer. **XLookupString** returns the number of characters that are stored in the buffer.

If present (non-NULL), the **XComposeStatus** structure records the state, which is private to Xlib, that needs preservation across calls to **XLookupString** to implement compose processing. The creation of **XComposeStatus** structures is implementation dependent; a portable program must pass NULL for this argument.

XLookupString depends on the cached keyboard information mentioned in the previous section, so it is necessary to use **XRefreshKeyboardMapping** to keep this information up-to-date.

To rebind the meaning of a KeySym for **XLookupString**, use **XRebindKeysym**.

```
XRebindKeysym(display, keysym, list, mod_count, string, num_bytes)
      Display *display;
      KeySym keysym;
      KeySym list[];
      int mod_count;
      unsigned char *string;
      int num_bytes;
```

display	Specifies the connection to the X server.
keysym	Specifies the KeySym that is to be rebound.
list	Specifies the KeySyms to be used as modifiers.
mod_count	Specifies the number of modifiers in the modifier list.
string	Specifies the string that is copied and will be returned by **XLookupString**.
num_bytes	Specifies the number of bytes in the string argument.

The **XRebindKeysym** function can be used to rebind the meaning of a KeySym for the client. It does not redefine any key in the X server but merely provides an easy way for long strings to be attached to keys. **XLookupString** returns this string when the appropriate set of modifier keys are pressed and when the KeySym would have been used for the translation. No text conversions are performed; the client is responsible for supplying appropriately encoded strings. Note that you can rebind a KeySym that may not exist.

16.3. Allocating Permanent Storage

To allocate some memory you will never give back, use **Xpermalloc**.

```
char *Xpermalloc(size)
     unsigned int size;
```

The **Xpermalloc** function allocates storage that can never be freed for the life of the program. The memory is allocated with alignment for the C type double. This function may provide some performance and space savings over the standard operating system memory allocator.

16.4. Parsing the Window Geometry

To parse standard window geometry strings, use **XParseGeometry**.

int XParseGeometry(*parsestring*, *x_return*, *y_return*, *width_return*, *height_return*)
    char **parsestring*;
    int **x_return*, **y_return*;
    unsigned int **width_return*, **height_return*;

parsestring	Specifies the string you want to parse.
x_return	
y_return	Return the x and y offsets.
width_return	
height_return	Return the width and height determined.

By convention, X applications use a standard string to indicate window size and placement. **XParseGeometry** makes it easier to conform to this standard because it allows you to parse the standard window geometry. Specifically, this function lets you parse strings of the form:

[=][<*width*>{xX}<*height*>][{+-}<*xoffset*>{+-}<*yoffset*>]

The fields map into the arguments associated with this function. (Items enclosed in < > are integers, items in [ ] are optional, and items enclosed in { } indicate "choose one of." Note that the brackets should not appear in the actual string.) If the string is not in the Host Portable Character Encoding, the result is implementation dependent.

The **XParseGeometry** function returns a bitmask that indicates which of the four values (width, height, xoffset, and yoffset) were actually found in the string and whether the x and y values are negative. By convention, −0 is not equal to +0, because the user needs to be able to say "position the window relative to the right or bottom edge." For each value found, the corresponding argument is updated. For each value not found, the argument is left unchanged. The bits are represented by **XValue**, **YValue**, **WidthValue**, **HeightValue**, **XNegative**, or **YNegative** and are defined in <**X11/Xutil.h**>. They will be set whenever one of the values is defined or one of the signs is set.

If the function returns either the **XValue** or **YValue** flag, you should place the window at the requested position.

To construct a window's geometry information, use **XWMGeometry**.

```
int XWMGeometry(display, screen, user_geom, def_geom, bwidth, hints, x_return, y_return,
          width_return, height_return, gravity_return)
     Display *display;
     int screen;
     char *user_geom;
     char *def_geom;
     unsigned int bwidth;
     XSizeHints *hints;
     int *x_return, *y_return;
     int *width_return;
     int *height_return;
     int *gravity_return;
```

display	Specifies the connection to the X server.
screen	Specifies the screen.
user_geom	Specifies the user-specified geometry or NULL.
def_geom	Specifies the application's default geometry or NULL.
bwidth	Specifies the border width.
hints	Specifies the size hints for the window in its normal state.
x_return	
y_return	Return the x and y offsets.
width_return	
height_return	Return the width and height determined.
gravity_return	Returns the window gravity.

The **XWMGeometry** function combines any geometry information (given in the format used by **XParseGeometry**) specified by the user and by the calling program with size hints (usually the ones to be stored in WM_NORMAL_HINTS) and returns the position, size, and gravity (**NorthWestGravity**, **NorthEastGravity**, **SouthEastGravity**, or **SouthWestGravity**) that describe the window. If the base size is not set in the **XSizeHints** structure, the minimum size is used if set. Otherwise, a base size of zero is assumed. If no minimum size is set in the hints structure, the base size is used. A mask (in the form returned by **XParseGeometry**) that describes which values came from the user specification and whether or not the position coordinates are relative to the right and bottom edges is returned. Note that these coordinates will have already been accounted for in the x_return and y_return values.

Note that invalid geometry specifications can cause a width or height of zero to be returned. The caller may pass the address of the hints win_gravity field as gravity_return to update the hints directly.

16.5. Manipulating Regions

Regions are arbitrary sets of pixel locations. Xlib provides functions for manipulating regions. The opaque type **Region** is defined in **<X11/Xutil.h>**. Xlib provides functions that you can use to manipulate regions. This section discusses how to:

- Create, copy, or destroy regions
- Move or shrink regions

- Compute with regions
- Determine if regions are empty or equal
- Locate a point or rectangle in a region

16.5.1. Creating, Copying, or Destroying Regions

To create a new empty region, use **XCreateRegion**.

```
Region XCreateRegion()
```

To generate a region from a polygon, use **XPolygonRegion**.

```
Region XPolygonRegion(points, n, fill_rule)
      XPoint points[];
      int n;
      int fill_rule;
```

points	Specifies an array of points.
n	Specifies the number of points in the polygon.
fill_rule	Specifies the fill-rule you want to set for the specified GC. You can pass **EvenOddRule** or **WindingRule**.

The **XPolygonRegion** function returns a region for the polygon defined by the points array. For an explanation of fill_rule, see **XCreateGC**.

To set the clip-mask of a GC to a region, use **XSetRegion**.

```
XSetRegion(display, gc, r)
      Display *display;
      GC gc;
      Region r;
```

display	Specifies the connection to the X server.
gc	Specifies the GC.
r	Specifies the region.

The **XSetRegion** function sets the clip-mask in the GC to the specified region. The region is specified relative to the drawable's origin. The resulting GC clip origin is implementation dependent. Once it is set in the GC, the region can be destroyed.

To deallocate the storage associated with a specified region, use **XDestroyRegion**.

```
XDestroyRegion(r)
    Region r;
```

r	Specifies the region.

16.5.2. Moving or Shrinking Regions

To move a region by a specified amount, use **XOffsetRegion**.

```
XOffsetRegion(r, dx, dy)
    Region r;
    int dx, dy;
```

r	Specifies the region.
dx	
dy	Specify the x and y coordinates, which define the amount you want to move the specified region.

To reduce a region by a specified amount, use **XShrinkRegion**.

```
XShrinkRegion(r, dx, dy)
    Region r;
    int dx, dy;
```

r	Specifies the region.
dx	
dy	Specify the x and y coordinates, which define the amount you want to shrink the specified region.

Positive values shrink the size of the region, and negative values expand the region.

16.5.3. Computing with Regions

To generate the smallest rectangle enclosing a region, use **XClipBox**.

```
XClipBox(r, rect_return)
    Region r;
    XRectangle *rect_return;
```

r	Specifies the region.
rect_return	Returns the smallest enclosing rectangle.

The **XClipBox** function returns the smallest rectangle enclosing the specified region.

To compute the intersection of two regions, use **XIntersectRegion**.

```
XIntersectRegion(sra, srb, dr_return)
      Region sra, srb, dr_return;
```

sra	
srb	Specify the two regions with which you want to perform the computation.
dr_return	Returns the result of the computation.

To compute the union of two regions, use **XUnionRegion**.

```
XUnionRegion(sra, srb, dr_return)
      Region sra, srb, dr_return;
```

sra	
srb	Specify the two regions with which you want to perform the computation.
dr_return	Returns the result of the computation.

To create a union of a source region and a rectangle, use **XUnionRectWithRegion**.

```
XUnionRectWithRegion(rectangle, src_region, dest_region_return)
     XRectangle *rectangle;
     Region src_region;
     Region dest_region_return;
```

rectangle	Specifies the rectangle.
src_region	Specifies the source region to be used.
dest_region_return	Returns the destination region.

The **XUnionRectWithRegion** function updates the destination region from a union of the specified rectangle and the specified source region.

To subtract two regions, use **XSubtractRegion**.

```
XSubtractRegion(sra, srb, dr_return)
      Region sra, srb, dr_return;
```

sra	
srb	Specify the two regions with which you want to perform the computation.
dr_return	Returns the result of the computation.

The **XSubtractRegion** function subtracts srb from sra and stores the results in dr_return.

To calculate the difference between the union and intersection of two regions, use **XXorRegion**.

XXorRegion(*sra*, *srb*, *dr_return*)
    Region *sra*, *srb*, *dr_return*;

sra	
srb	Specify the two regions with which you want to perform the computation.
dr_return	Returns the result of the computation.

16.5.4. Determining if Regions Are Empty or Equal

To determine if the specified region is empty, use **XEmptyRegion**.

Bool XEmptyRegion(*r*)
    Region *r*;

r	Specifies the region.

The **XEmptyRegion** function returns **True** if the region is empty.

To determine if two regions have the same offset, size, and shape, use **XEqualRegion**.

Bool XEqualRegion(*r1*, *r2*)
    Region *r1*, *r2*;

r1	
r2	Specify the two regions.

The **XEqualRegion** function returns **True** if the two regions have the same offset, size, and shape.

16.5.5. Locating a Point or a Rectangle in a Region

To determine if a specified point resides in a specified region, use **XPointInRegion**.

Bool XPointInRegion(*r*, *x*, *y*)
    Region *r*;
    int *x*, *y*;

r	Specifies the region.
x	
y	Specify the x and y coordinates, which define the point.

The **XPointInRegion** function returns **True** if the point (x, y) is contained in the region r.

To determine if a specified rectangle is inside a region, use **XRectInRegion**.

```
int XRectInRegion(r, x, y, width, height)
      Region r;
      int x, y;
      unsigned int width, height;
```

r	Specifies the region.
x	
y	Specify the x and y coordinates, which define the coordinates of the upper-left corner of the rectangle.
width	
height	Specify the width and height, which define the rectangle .

The **XRectInRegion** function returns **RectangleIn** if the rectangle is entirely in the specified region, **RectangleOut** if the rectangle is entirely out of the specified region, and **RectanglePart** if the rectangle is partially in the specified region.

16.6. Using Cut Buffers

Xlib provides functions to manipulate cut buffers, a very simple form of cut and paste inter-client communication. Selections are a much more powerful and useful mechanism for interchanging data between clients (see section 4.5), and generally should be used instead of cut buffers.

Cut buffers are implemented as properties on the first root window of the display. The buffers can only contain text, in the STRING encoding. The text encoding is not changed by Xlib when fetching or storing. Eight buffers are provided and can be accessed as a ring or as explicit buffers (numbered 0 through 7).

To store data in cut buffer 0, use **XStoreBytes**.

```
XStoreBytes(display, bytes, nbytes)
      Display *display;
      char *bytes;
      int nbytes;
```

display	Specifies the connection to the X server.
bytes	Specifies the bytes, which are not necessarily ASCII or null-terminated.
nbytes	Specifies the number of bytes to be stored.

The data can have embedded null characters and need not be null-terminated. The cut buffer’s contents can be retrieved later by any client calling **XFetchBytes**.

XStoreBytes can generate a **BadAlloc** error.

To store data in a specified cut buffer, use **XStoreBuffer**.

```
XStoreBuffer(display, bytes, nbytes, buffer)
      Display *display;
      char *bytes;
      int nbytes;
      int buffer;
```

display	Specifies the connection to the X server.
bytes	Specifies the bytes, which are not necessarily ASCII or null-terminated.
nbytes	Specifies the number of bytes to be stored.
buffer	Specifies the buffer in which you want to store the bytes.

If an invalid buffer is specified, the call has no effect. The data can have embedded null characters and need not be null-terminated.

XStoreBuffer can generate a **BadAlloc** error.

To return data from cut buffer 0, use **XFetchBytes**.

```
char *XFetchBytes(display, nbytes_return)
      Display *display;
      int *nbytes_return;
```

display	Specifies the connection to the X server.
nbytes_return	Returns the number of bytes in the buffer.

The **XFetchBytes** function returns the number of bytes in the nbytes_return argument, if the buffer contains data. Otherwise, the function returns NULL and sets nbytes to 0. The appropriate amount of storage is allocated and the pointer returned. The client must free this storage when finished with it by calling **XFree**.

To return data from a specified cut buffer, use **XFetchBuffer**.

```
char *XFetchBuffer(display, nbytes_return, buffer)
      Display *display;
      int *nbytes_return;
      int buffer;
```

display	Specifies the connection to the X server.
nbytes_return	Returns the number of bytes in the buffer.
buffer	Specifies the buffer from which you want the stored data returned.

The **XFetchBuffer** function returns zero to the nbytes_return argument if there is no data in the buffer or if an invalid buffer is specified.

To rotate the cut buffers, use **XRotateBuffers**.

```
XRotateBuffers(display, rotate)
      Display *display;
      int rotate;
```

display	Specifies the connection to the X server.
rotate	Specifies how much to rotate the cut buffers.

The **XRotateBuffers** function rotates the cut buffers, such that buffer 0 becomes buffer n, buffer 1 becomes n + 1 mod 8, and so on. This cut buffer numbering is global to the display. Note that **XRotateBuffers** generates **BadMatch** errors if any of the eight buffers have not been created.

16.7. Determining the Appropriate Visual Type

A single display can support multiple screens. Each screen can have several different visual types supported at different depths. You can use the functions described in this section to determine which visual to use for your application.

The functions in this section use the visual information masks and the **XVisualInfo** structure, which is defined in **<X11/Xutil.h>** and contains:

```
/* Visual information mask bits */

#define    VisualNoMask                    0x0
#define    VisualIDMask                    0x1
#define    VisualScreenMask                0x2
#define    VisualDepthMask                 0x4
#define    VisualClassMask                 0x8
#define    VisualRedMaskMask               0x10
#define    VisualGreenMaskMask             0x20
#define    VisualBlueMaskMask              0x40
#define    VisualColormapSizeMask          0x80
#define    VisualBitsPerRGBMask            0x100
#define    VisualAllMask                   0x1FF

/* Values */

typedef struct {
        Visual *visual;
        VisualID visualid;
        int screen;
        unsigned int depth;
        int class;
        unsigned long red_mask;
        unsigned long green_mask;
        unsigned long blue_mask;
        int colormap_size;
        int bits_per_rgb;
} XVisualInfo;
```

To obtain a list of visual information structures that match a specified template, use **XGetVisualInfo**.

```
XVisualInfo *XGetVisualInfo(display, vinfo_mask, vinfo_template, nitems_return)
      Display *display;
      long vinfo_mask;
      XVisualInfo *vinfo_template;
      int *nitems_return;
```

display	Specifies the connection to the X server.
vinfo_mask	Specifies the visual mask value.
vinfo_template	Specifies the visual attributes that are to be used in matching the visual structures.
nitems_return	Returns the number of matching visual structures.

The **XGetVisualInfo** function returns a list of visual structures that have attributes equal to the attributes specified by vinfo_template. If no visual structures match the template using the specified vinfo_mask, **XGetVisualInfo** returns a NULL. To free the data returned by this function, use **XFree**.

To obtain the visual information that matches the specified depth and class of the screen, use **XMatchVisualInfo**.

```
Status XMatchVisualInfo(display, screen, depth, class, vinfo_return)
      Display *display;
      int screen;
      int depth;
      int class;
      XVisualInfo *vinfo_return;
```

display	Specifies the connection to the X server.
screen	Specifies the screen.
depth	Specifies the depth of the screen.
class	Specifies the class of the screen.
vinfo_return	Returns the matched visual information.

The **XMatchVisualInfo** function returns the visual information for a visual that matches the specified depth and class for a screen. Because multiple visuals that match the specified depth and class can exist, the exact visual chosen is undefined. If a visual is found, **XMatchVisualInfo** returns nonzero and the information on the visual to vinfo_return. Otherwise, when a visual is not found, **XMatchVisualInfo** returns zero.

16.8. Manipulating Images

Xlib provides several functions that perform basic operations on images. All operations on images are defined using an **XImage** structure, as defined in **<X11/Xlib.h>**. Because the number of different types of image formats can be very large, this hides details of image storage properly from applications.

This section describes the functions for generic operations on images. Manufacturers can provide very fast implementations of these for the formats frequently encountered on their hardware. These functions are neither sufficient nor desirable to use for general image processing. Rather, they are here to provide minimal functions on screen format images. The basic operations for getting and putting images are **XGetImage** and **XPutImage**.

Note that no functions have been defined, as yet, to read and write images to and from disk files.

The **XImage** structure describes an image as it exists in the client's memory. The user can request that some of the members such as height, width, and xoffset be changed when the image is sent to the server. Note that bytes_per_line in concert with offset can be used to extract a subset of the image. Other members (for example, byte order, bitmap_unit, and so forth) are characteristics of both the image and the server. If these members differ between the image and the server, **XPutImage** makes the appropriate conversions. The first byte of the first line of plane n must be located at the address (data + (n * height * bytes_per_line)). For a description of the **XImage** structure, see section 8.7.

To allocate an **XImage** structure and initialize it with image format values from a display, use **XCreateImage**.

```
XImage *XCreateImage(display, visual, depth, format, offset, data, width, height, bitmap_pad,
                bytes_per_line)
    Display *display;
    Visual *visual;
    unsigned int depth;
    int format;
    int offset;
    char *data;
    unsigned int width;
    unsigned int height;
    int bitmap_pad;
    int bytes_per_line;
```

display	Specifies the connection to the X server.
visual	Specifies the **Visual** structure.
depth	Specifies the depth of the image.
format	Specifies the format for the image. You can pass **XYBitmap**, **XYPixmap**, or **ZPixmap**.
offset	Specifies the number of pixels to ignore at the beginning of the scanline.
data	Specifies the image data.
width	Specifies the width of the image, in pixels.
height	Specifies the height of the image, in pixels.
bitmap_pad	Specifies the quantum of a scanline (8, 16, or 32). In other words, the start of one scanline is separated in client memory from the start of the next scanline by an integer multiple of this many bits.
bytes_per_line	Specifies the number of bytes in the client image between the start of one scanline and the start of the next.

The **XCreateImage** function allocates the memory needed for an **XImage** structure for the specified display but does not allocate space for the image itself. Rather, it initializes the structure byte-order, bit-order, and bitmap-unit values from the display and returns a pointer to the **XImage** structure. The red, green, and blue mask values are defined for Z format images only and are derived from the **Visual** structure passed in. Other values also are passed in. The offset permits the rapid displaying of the image without requiring each scanline to be shifted into position. If you pass a zero value in bytes_per_line, Xlib assumes that the scanlines are contiguous in memory and calculates the value of bytes_per_line itself.

Note that when the image is created using **XCreateImage**, **XGetImage**, or **XSubImage**, the destroy procedure that the **XDestroyImage** function calls frees both the image structure and the data pointed to by the image structure.

The basic functions used to get a pixel, set a pixel, create a subimage, and add a constant value to an image are defined in the image object. The functions in this section are really macro invocations of the functions in the image object and are defined in **<X11/Xutil.h>**.

To obtain a pixel value in an image, use **XGetPixel**.

```
unsigned long XGetPixel(ximage, x, y)
     XImage *ximage;
     int x;
     int y;
```

ximage	Specifies the image.
x	
y	Specify the x and y coordinates.

The **XGetPixel** function returns the specified pixel from the named image. The pixel value is returned in normalized format (that is, the least-significant byte of the long is the least-significant byte of the pixel). The image must contain the x and y coordinates.

To set a pixel value in an image, use **XPutPixel**.

```
XPutPixel(ximage, x, y, pixel)
     XImage *ximage;
     int x;
     int y;
     unsigned long pixel;
```

ximage	Specifies the image.
x	
y	Specify the x and y coordinates.
pixel	Specifies the new pixel value.

The **XPutPixel** function overwrites the pixel in the named image with the specified pixel value. The input pixel value must be in normalized format (that is, the least-significant byte of the long is the least-significant byte of the pixel). The image must contain the x and y coordinates.

To create a subimage, use **XSubImage**.

XImage *XSubImage(*ximage*, *x*, *y*, *subimage_width*, *subimage_height*)
  XImage **ximage*;
  int *x*;
  int *y*;
  unsigned int *subimage_width*;
  unsigned int *subimage_height*;

ximage	Specifies the image.
x *y*	Specify the x and y coordinates.
subimage_width	Specifies the width of the new subimage, in pixels.
subimage_height	Specifies the height of the new subimage, in pixels.

The **XSubImage** function creates a new image that is a subsection of an existing one. It allocates the memory necessary for the new **XImage** structure and returns a pointer to the new image. The data is copied from the source image, and the image must contain the rectangle defined by x, y, subimage_width, and subimage_height.

To increment each pixel in an image by a constant value, use **XAddPixel**.

XAddPixel(*ximage*, *value*)
  XImage **ximage*;
  long *value*;

ximage	Specifies the image.
value	Specifies the constant value that is to be added.

The **XAddPixel** function adds a constant value to every pixel in an image. It is useful when you have a base pixel value from allocating color resources and need to manipulate the image to that form.

To deallocate the memory allocated in a previous call to **XCreateImage**, use **XDestroyImage**.

XDestroyImage(*ximage*)
  XImage **ximage*;

ximage	Specifies the image.

The **XDestroyImage** function deallocates the memory associated with the **XImage** structure.

Note that when the image is created using **XCreateImage**, **XGetImage**, or **XSubImage**, the destroy procedure that this macro calls frees both the image structure and the data pointed to by the image structure.

16.9. Manipulating Bitmaps

Xlib provides functions that you can use to read a bitmap from a file, save a bitmap to a file, or create a bitmap. This section describes those functions that transfer bitmaps to and from the client's file system, thus allowing their reuse in a later connection (for example, from an entirely different client or to a different display or server).

The X version 11 bitmap file format is:

```
#define name_width width
#define name_height height
#define name_x_hot x
#define name_y_hot y
static unsigned char name_bits[] = { 0xNN,... }
```

The lines for the variables ending with _x_hot and _y_hot suffixes are optional because they are present only if a hotspot has been defined for this bitmap. The lines for the other variables are required. The word ‘‘unsigned’’ is optional; that is, the type of the _bits array can be ‘‘char’’ or ‘‘unsigned char’’. The _bits array must be large enough to contain the size bitmap. The bitmap unit is eight.

To read a bitmap from a file and store it in a pixmap, use **XReadBitmapFile**.

```
int XReadBitmapFile(display, d, filename, width_return, height_return, bitmap_return, x_hot_return,
                y_hot_return)
    Display *display;
    Drawable d;
    char *filename;
    unsigned int *width_return, *height_return;
    Pixmap *bitmap_return;
    int *x_hot_return, *y_hot_return;
```

display	Specifies the connection to the X server.
d	Specifies the drawable that indicates the screen.
filename	Specifies the file name to use. The format of the file name is operating-system dependent.
width_return *height_return*	Return the width and height values of the read in bitmap file.
bitmap_return	Returns the bitmap that is created.
x_hot_return *y_hot_return*	Return the hotspot coordinates.

The **XReadBitmapFile** function reads in a file containing a bitmap. The file is parsed in the encoding of the current locale. The ability to read other than the standard format is implementation dependent. If the file cannot be opened, **XReadBitmapFile** returns **BitmapOpenFailed**. If the file can be opened but does not contain valid bitmap data, it returns **BitmapFileInvalid**. If insufficient working storage is allocated, it returns **BitmapNoMemory**. If the file is readable and valid, it returns **BitmapSuccess**.

XReadBitmapFile returns the bitmap's height and width, as read from the file, to width_return and height_return. It then creates a pixmap of the appropriate size, reads the bitmap data from the file into the pixmap, and assigns the pixmap to the caller's variable bitmap. The caller must free the bitmap using **XFreePixmap** when finished. If *name*_x_hot and *name*_y_hot exist, **XReadBitmapFile** returns them to x_hot_return and y_hot_return; otherwise, it returns −1,−1.

XReadBitmapFile can generate **BadAlloc**, **BadDrawable**, and **BadGC** errors.

To read a bitmap from a file and return it as data, use **XReadBitmapFileData**.

```
int XReadBitmapFileData(filename, width_return, height_return, data_return, x_hot_return, y_hot_return)
      char *filename;
      unsigned int *width_return, *height_return;
      unsigned char *data_return;
      int *x_hot_return, *y_hot_return;
```

filename	Specifies the file name to use. The format of the file name is operating-system dependent.
width_return	
height_return	Return the width and height values of the read in bitmap file.
data_return	Returns the bitmap data.
x_hot_return	
y_hot_return	Return the hotspot coordinates.

The **XReadBitmapFileData** function reads in a file containing a bitmap, in the same manner as **XReadBitmapFile**, but returns the data directly rather than creating a pixmap in the server. The bitmap data is returned in data_return; the client must free this storage when finished with it by calling **XFree**. The status and other return values are the same as for **XReadBitmapFile**.

To write out a bitmap from a pixmap to a file, use **XWriteBitmapFile**.

```
int XWriteBitmapFile(display, filename, bitmap, width, height, x_hot, y_hot)
    Display *display;
    char *filename;
    Pixmap bitmap;
    unsigned int width, height;
    int x_hot, y_hot;
```

display	Specifies the connection to the X server.
filename	Specifies the file name to use. The format of the file name is operating-system dependent.
bitmap	Specifies the bitmap.
width	
height	Specify the width and height.
x_hot	
y_hot	Specify where to place the hotspot coordinates (or −1,−1 if none are present) in the file.

The **XWriteBitmapFile** function writes a bitmap out to a file in the X Version 11 format. The name used in the output file is derived from the file name by deleting the directory prefix. The file is written in the encoding of the current locale. If the file cannot be opened for writing, it returns **BitmapOpenFailed**. If insufficient memory is allocated, **XWriteBitmapFile** returns **BitmapNoMemory**; otherwise, on no error, it returns **BitmapSuccess**. If x_hot and y_hot are not −1, −1, **XWriteBitmapFile** writes them out as the hotspot coordinates for the bitmap.

XWriteBitmapFile can generate **BadDrawable** and **BadMatch** errors.

To create a pixmap and then store bitmap-format data into it, use **XCreatePixmapFromBitmapData**.

```
Pixmap XCreatePixmapFromBitmapData(display, d, data, width, height, fg, bg, depth)
    Display *display;
    Drawable d;
    char *data;
    unsigned int width, height;
    unsigned long fg, bg;
    unsigned int depth;
```

display	Specifies the connection to the X server.
d	Specifies the drawable that indicates the screen.
data	Specifies the data in bitmap format.
width	
height	Specify the width and height.
fg	
bg	Specify the foreground and background pixel values to use.
depth	Specifies the depth of the pixmap.

The **XCreatePixmapFromBitmapData** function creates a pixmap of the given depth and then does a bitmap-format **XPutImage** of the data into it. The depth must be supported by the screen of the specified drawable, or a **BadMatch** error results.

XCreatePixmapFromBitmapData can generate **BadAlloc**, **BadDrawable**, **BadGC**, and **BadValue** errors.

To include a bitmap written out by **XWriteBitmapFile** in a program directly, as opposed to reading it in every time at run time, use **XCreateBitmapFromData**.

```
Pixmap XCreateBitmapFromData(display, d, data, width, height)
    Display *display;
    Drawable d;
    char *data;
    unsigned int width, height;
```

display	Specifies the connection to the X server.
d	Specifies the drawable that indicates the screen.
data	Specifies the location of the bitmap data.
width	
height	Specify the width and height.

The **XCreateBitmapFromData** function allows you to include in your C program (using **#include**) a bitmap file that was written out by **XWriteBitmapFile** (X version 11 format only) without reading in the bitmap file. The following example creates a gray bitmap:

```
#include "gray.bitmap"

Pixmap bitmap;
bitmap = XCreateBitmapFromData(display, window, gray_bits, gray_width, gray_height);
```

If insufficient working storage was allocated, **XCreateBitmapFromData** returns **None**. It is your responsibility to free the bitmap using **XFreePixmap** when finished.

XCreateBitmapFromData can generate a **BadAlloc** and **BadGC** errors.

16.10. Using the Context Manager

The context manager provides a way of associating data with an X resource ID (mostly typically a window) in your program. Note that this is local to your program; the data is not stored in the server on a property list. Any amount of data in any number of pieces can be associated with a resource ID, and each piece of data has a type associated with it. The context manager requires knowledge of the resource ID and type to store or retrieve data.

Essentially, the context manager can be viewed as a two-dimensional, sparse array: one dimension is subscripted by the X resource ID and the other by a context type field. Each entry in the array contains a pointer to the data. Xlib provides context management functions with which you can save data values, get data values, delete entries, and create a unique context type. The symbols used are in **<X11/Xutil.h>**.

To save a data value that corresponds to a resource ID and context type, use **XSaveContext**.

```
int XSaveContext(display, rid, context, data)
      Display *display;
      XID rid;
      XContext context;
      XPointer data;
```

display	Specifies the connection to the X server.
rid	Specifies the resource ID with which the data is associated.
context	Specifies the context type to which the data belongs.
data	Specifies the data to be associated with the window and type.

If an entry with the specified resource ID and type already exists, **XSaveContext** overrides it with the specified context. The **XSaveContext** function returns a nonzero error code if an error has occurred and zero otherwise. Possible errors are **XCNOMEM** (out of memory).

To get the data associated with a resource ID and type, use **XFindContext**.

```
int XFindContext(display, rid, context, data_return)
      Display *display;
      XID rid;
      XContext context;
      XPointer *data_return;
```

display	Specifies the connection to the X server.
rid	Specifies the resource ID with which the data is associated.
context	Specifies the context type to which the data belongs.
data_return	Returns the data.

Because it is a return value, the data is a pointer. The **XFindContext** function returns a nonzero error code if an error has occurred and zero otherwise. Possible errors are **XCNOENT** (context-not-found).

To delete an entry for a given resource ID and type, use **XDeleteContext**.

int XDeleteContext(*display*, *rid*, *context*)
    Display **display*;
    XID *rid*;
    XContext *context*;

display	Specifies the connection to the X server.
rid	Specifies the resource ID with which the data is associated.
context	Specifies the context type to which the data belongs.

The **XDeleteContext** function deletes the entry for the given resource ID and type from the data structure. This function returns the same error codes that **XFindContext** returns if called with the same arguments. **XDeleteContext** does not free the data whose address was saved.

To create a unique context type that may be used in subsequent calls to **XSaveContext** and **XFindContext**, use **XUniqueContext**.

XContext XUniqueContext( )

Appendix A

Xlib Functions and Protocol Requests

This appendix provides two tables that relate to Xlib functions and the X protocol. The following table lists each Xlib function (in alphabetical order) and the corresponding protocol request that it generates.

Xlib Function	**Protocol Request**
XActivateScreenSaver	ForceScreenSaver
XAddHost	ChangeHosts
XAddHosts	ChangeHosts
XAddToSaveSet	ChangeSaveSet
XAllocColor	AllocColor
XAllocColorCells	AllocColorCells
XAllocColorPlanes	AllocColorPlanes
XAllocNamedColor	AllocNamedColor
XAllowEvents	AllowEvents
XAutoRepeatOff	ChangeKeyboardControl
XAutoRepeatOn	ChangeKeyboardControl
XBell	Bell
XChangeActivePointerGrab	ChangeActivePointerGrab
XChangeGC	ChangeGC
XChangeKeyboardControl	ChangeKeyboardControl
XChangeKeyboardMapping	ChangeKeyboardMapping
XChangePointerControl	ChangePointerControl
XChangeProperty	ChangeProperty
XChangeSaveSet	ChangeSaveSet
XChangeWindowAttributes	ChangeWindowAttributes
XCirculateSubwindows	CirculateWindow
XCirculateSubwindowsDown	CirculateWindow
XCirculateSubwindowsUp	CirculateWindow
XClearArea	ClearArea
XClearWindow	ClearArea
XConfigureWindow	ConfigureWindow
XConvertSelection	ConvertSelection
XCopyArea	CopyArea
XCopyColormapAndFree	CopyColormapAndFree
XCopyGC	CopyGC
XCopyPlane	CopyPlane
XCreateBitmapFromData	CreateGC CreatePixmap FreeGC PutImage
XCreateColormap	CreateColormap

Xlib Function	**Protocol Request**
XCreateFontCursor	CreateGlyphCursor
XCreateGC	CreateGC
XCreateGlyphCursor	CreateGlyphCursor
XCreatePixmap	CreatePixmap
XCreatePixmapCursor	CreateCursor
XCreatePixmapFromData	CreateGC CreatePixmap FreeGC PutImage
XCreateSimpleWindow	CreateWindow
XCreateWindow	CreateWindow
XDefineCursor	ChangeWindowAttributes
XDeleteProperty	DeleteProperty
XDestroySubwindows	DestroySubwindows
XDestroyWindow	DestroyWindow
XDisableAccessControl	SetAccessControl
XDrawArc	PolyArc
XDrawArcs	PolyArc
XDrawImageString	ImageText8
XDrawImageString16	ImageText16
XDrawLine	PolySegment
XDrawLines	PolyLine
XDrawPoint	PolyPoint
XDrawPoints	PolyPoint
XDrawRectangle	PolyRectangle
XDrawRectangles	PolyRectangle
XDrawSegments	PolySegment
XDrawString	PolyText8
XDrawString16	PolyText16
XDrawText	PolyText8
XDrawText16	PolyText16
XEnableAccessControl	SetAccessControl
XFetchBytes	GetProperty
XFetchName	GetProperty
XFillArc	PolyFillArc
XFillArcs	PolyFillArc
XFillPolygon	FillPoly
XFillRectangle	PolyFillRectangle
XFillRectangles	PolyFillRectangle
XForceScreenSaver	ForceScreenSaver
XFreeColormap	FreeColormap
XFreeColors	FreeColors
XFreeCursor	FreeCursor
XFreeFont	CloseFont
XFreeGC	FreeGC
XFreePixmap	FreePixmap
XGetAtomName	GetAtomName

Xlib Function	**Protocol Request**
XGetClassHint	GetProperty
XGetFontPath	GetFontPath
XGetGeometry	GetGeometry
XGetIconName	GetProperty
XGetIconSizes	GetProperty
XGetImage	GetImage
XGetInputFocus	GetInputFocus
XGetKeyboardControl	GetKeyboardControl
XGetKeyboardMapping	GetKeyboardMapping
XGetModifierMapping	GetModifierMapping
XGetMotionEvents	GetMotionEvents
XGetModifierMapping	GetModifierMapping
XGetNormalHints	GetProperty
XGetPointerControl	GetPointerControl
XGetPointerMapping	GetPointerMapping
XGetRGBColormaps	GetProperty
XGetScreenSaver	GetScreenSaver
XGetSelectionOwner	GetSelectionOwner
XGetSizeHints	GetProperty
XGetTextProperty	GetProperty
XGetTransientForHint	GetProperty
XGetWMClientMachine	GetProperty
XGetWMColormapWindows	GetProperty InternAtom
XGetWMHints	GetProperty
XGetWMIconName	GetProperty
XGetWMName	GetProperty
XGetWMNormalHints	GetProperty
XGetWMProtocols	GetProperty InternAtom
XGetWMSizeHints	GetProperty
XGetWindowAttributes	GetWindowAttributes GetGeometry
XGetWindowProperty	GetProperty
XGetZoomHints	GetProperty
XGrabButton	GrabButton
XGrabKey	GrabKey
XGrabKeyboard	GrabKeyboard
XGrabPointer	GrabPointer
XGrabServer	GrabServer
XIconifyWindow	InternAtom SendEvent
XInitExtension	QueryExtension
XInstallColormap	InstallColormap
XInternAtom	InternAtom
XKillClient	KillClient
XListExtensions	ListExtensions

Xlib Function	**Protocol Request**
XListFonts	ListFonts
XListFontsWithInfo	ListFontsWithInfo
XListHosts	ListHosts
XListInstalledColormaps	ListInstalledColormaps
XListProperties	ListProperties
XLoadFont	OpenFont
XLoadQueryFont	OpenFont QueryFont
XLookupColor	LookupColor
XLowerWindow	ConfigureWindow
XMapRaised	ConfigureWindow MapWindow
XMapSubwindows	MapSubwindows
XMapWindow	MapWindow
XMoveResizeWindow	ConfigureWindow
XMoveWindow	ConfigureWindow
XNoOp	NoOperation
XOpenDisplay	CreateGC
XParseColor	LookupColor
XPutImage	PutImage
XQueryBestCursor	QueryBestSize
XQueryBestSize	QueryBestSize
XQueryBestStipple	QueryBestSize
XQueryBestTile	QueryBestSize
XQueryColor	QueryColors
XQueryColors	QueryColors
XQueryExtension	QueryExtension
XQueryFont	QueryFont
XQueryKeymap	QueryKeymap
XQueryPointer	QueryPointer
XQueryTextExtents	QueryTextExtents
XQueryTextExtents16	QueryTextExtents
XQueryTree	QueryTree
XRaiseWindow	ConfigureWindow
XReadBitmapFile	CreateGC CreatePixmap FreeGC PutImage
XRecolorCursor	RecolorCursor
XReconfigureWMWindow	ConfigureWindow SendEvent
XRemoveFromSaveSet	ChangeSaveSet
XRemoveHost	ChangeHosts
XRemoveHosts	ChangeHosts
XReparentWindow	ReparentWindow
XResetScreenSaver	ForceScreenSaver
XResizeWindow	ConfigureWindow

Xlib Function	**Protocol Request**
XRestackWindows	ConfigureWindow
XRotateBuffers	RotateProperties
XRotateWindowProperties	RotateProperties
XSelectInput	ChangeWindowAttributes
XSendEvent	SendEvent
XSetAccessControl	SetAccessControl
XSetArcMode	ChangeGC
XSetBackground	ChangeGC
XSetClassHint	ChangeProperty
XSetClipMask	ChangeGC
XSetClipOrigin	ChangeGC
XSetClipRectangles	SetClipRectangles
XSetCloseDownMode	SetCloseDownMode
XSetCommand	ChangeProperty
XSetDashes	SetDashes
XSetFillRule	ChangeGC
XSetFillStyle	ChangeGC
XSetFont	ChangeGC
XSetFontPath	SetFontPath
XSetForeground	ChangeGC
XSetFunction	ChangeGC
XSetGraphicsExposures	ChangeGC
XSetIconName	ChangeProperty
XSetIconSizes	ChangeProperty
XSetInputFocus	SetInputFocus
XSetLineAttributes	ChangeGC
XSetModifierMapping	SetModifierMapping
XSetNormalHints	ChangeProperty
XSetPlaneMask	ChangeGC
XSetPointerMapping	SetPointerMapping
XSetRGBColormaps	ChangeProperty
XSetScreenSaver	SetScreenSaver
XSetSelectionOwner	SetSelectionOwner
XSetSizeHints	ChangeProperty
XSetStandardProperties	ChangeProperty
XSetState	ChangeGC
XSetStipple	ChangeGC
XSetSubwindowMode	ChangeGC
XSetTextProperty	ChangeProperty
XSetTile	ChangeGC
XSetTransientForHint	ChangeProperty
XSetTSOrigin	ChangeGC
XSetWMClientMachine	ChangeProperty
XSetWMColormapWindows	ChangeProperty InternAtom
XSetWMHints	ChangeProperty
XSetWMIconName	ChangeProperty

Xlib Function	**Protocol Request**
XSetWMName	ChangeProperty
XSetWMNormalHints	ChangeProperty
XSetWMProperties	ChangeProperty
XSetWMProtocols	ChangeProperty InternAtom
XSetWMSizeHints	ChangeProperty
XSetWindowBackground	ChangeWindowAttributes
XSetWindowBackgroundPixmap	ChangeWindowAttributes
XSetWindowBorder	ChangeWindowAttributes
XSetWindowBorderPixmap	ChangeWindowAttributes
XSetWindowBorderWidth	ConfigureWindow
XSetWindowColormap	ChangeWindowAttributes
XSetZoomHints	ChangeProperty
XStoreBuffer	ChangeProperty
XStoreBytes	ChangeProperty
XStoreColor	StoreColors
XStoreColors	StoreColors
XStoreName	ChangeProperty
XStoreNamedColor	StoreNamedColor
XSync	GetInputFocus
XSynchronize	GetInputFocus
XTranslateCoordinates	TranslateCoordinates
XUndefineCursor	ChangeWindowAttributes
XUngrabButton	UngrabButton
XUngrabKey	UngrabKey
XUngrabKeyboard	UngrabKeyboard
XUngrabPointer	UngrabPointer
XUngrabServer	UngrabServer
XUninstallColormap	UninstallColormap
XUnloadFont	CloseFont
XUnmapSubwindows	UnmapSubwindows
XUnmapWindow	UnmapWindow
XWarpPointer	WarpPointer
XWithdrawWindow	SendEvent UnmapWindow

The following table lists each X protocol request (in alphabetical order) and the Xlib functions that reference it.

Protocol Request	**Xlib Function**
AllocColor	XAllocColor
AllocColorCells	XAllocColorCells
AllocColorPlanes	XAllocColorPlanes
AllocNamedColor	XAllocNamedColor
AllowEvents	XAllowEvents
Bell	XBell
SetAccessControl	XDisableAccessControl
	XEnableAccessControl
	XSetAccessControl
ChangeActivePointerGrab	XChangeActivePointerGrab
SetCloseDownMode	XSetCloseDownMode
ChangeGC	XChangeGC
	XSetArcMode
	XSetBackground
	XSetClipMask
	XSetClipOrigin
	XSetFillRule
	XSetFillStyle
	XSetFont
	XSetForeground
	XSetFunction
	XSetGraphicsExposures
	XSetLineAttributes
	XSetPlaneMask
	XSetState
	XSetStipple
	XSetSubwindowMode
	XSetTile
	XSetTSOrigin
ChangeHosts	XAddHost
	XAddHosts
	XRemoveHost
	XRemoveHosts
ChangeKeyboardControl	XAutoRepeatOff
	XAutoRepeatOn
	XChangeKeyboardControl
ChangeKeyboardMapping	XChangeKeyboardMapping
ChangePointerControl	XChangePointerControl
ChangeProperty	XChangeProperty
	XSetClassHint
	XSetCommand
	XSetIconName
	XSetIconSizes
	XSetNormalHints

Protocol Request	Xlib Function
	XSetRGBColormaps XSetSizeHints XSetStandardProperties XSetTextProperty XSetTransientForHint XSetWMClientMachine XSetWMColormapWindows XSetWMHints XSetWMIconName XSetWMName XSetWMNormalHints XSetWMProperties XSetWMProtocols XSetWMSizeHints XSetZoomHints XStoreBuffer XStoreBytes XStoreName
ChangeSaveSet	XAddToSaveSet XChangeSaveSet XRemoveFromSaveSet
ChangeWindowAttributes	XChangeWindowAttributes XDefineCursor XSelectInput XSetWindowBackground XSetWindowBackgroundPixmap XSetWindowBorder XSetWindowBorderPixmap XSetWindowColormap XUndefineCursor
CirculateWindow	XCirculateSubwindowsDown XCirculateSubwindowsUp XCirculateSubwindows
ClearArea	XClearArea XClearWindow
CloseFont	XFreeFont XUnloadFont
ConfigureWindow	XConfigureWindow XLowerWindow XMapRaised XMoveResizeWindow XMoveWindow XRaiseWindow XReconfigureWMWindow XResizeWindow XRestackWindows XSetWindowBorderWidth

Protocol Request	**Xlib Function**
ConvertSelection	XConvertSelection
CopyArea	XCopyArea
CopyColormapAndFree	XCopyColormapAndFree
CopyGC	XCopyGC
CopyPlane	XCopyPlane
CreateColormap	XCreateColormap
CreateCursor	XCreatePixmapCursor
CreateGC	XCreateGC
	XCreateBitmapFromData
	XCreatePixmapFromData
	XOpenDisplay
	XReadBitmapFile
CreateGlyphCursor	XCreateFontCursor
	XCreateGlyphCursor
CreatePixmap	XCreatePixmap
	XCreateBitmapFromData
	XCreatePixmapFromData
	XReadBitmapFile
CreateWindow	XCreateSimpleWindow
	XCreateWindow
DeleteProperty	XDeleteProperty
DestroySubwindows	XDestroySubwindows
DestroyWindow	XDestroyWindow
FillPoly	XFillPolygon
ForceScreenSaver	XActivateScreenSaver
	XForceScreenSaver
	XResetScreenSaver
FreeColormap	XFreeColormap
FreeColors	XFreeColors
FreeCursor	XFreeCursor
FreeGC	XFreeGC
	XCreateBitmapFromData
	XCreatePixmapFromData
	XReadBitmapFile
FreePixmap	XFreePixmap
GetAtomName	XGetAtomName
GetFontPath	XGetFontPath
GetGeometry	XGetGeometry
	XGetWindowAttributes
GetImage	XGetImage
GetInputFocus	XGetInputFocus
	XSync
	XSynchronize
GetKeyboardControl	XGetKeyboardControl
GetKeyboardMapping	XGetKeyboardMapping
GetModifierMapping	XGetModifierMapping
GetMotionEvents	XGetMotionEvents

Protocol Request	**Xlib Function**
GetPointerControl	XGetPointerControl
GetPointerMapping	XGetPointerMapping
GetProperty	XFetchBytes
	XFetchName
	XGetClassHint
	XGetIconName
	XGetIconSizes
	XGetNormalHints
	XGetRGBColormaps
	XGetSizeHints
	XGetTextProperty
	XGetTransientForHint
	XGetWMClientMachine
	XGetWMColormapWindows
	XGetWMHints
	XGetWMIconName
	XGetWMName
	XGetWMNormalHints
	XGetWMProtocols
	XGetWMSizeHints
	XGetWindowProperty
	XGetZoomHints
GetSelectionOwner	XGetSelectionOwner
GetWindowAttributes	XGetWindowAttributes
GrabButton	XGrabButton
GrabKey	XGrabKey
GrabKeyboard	XGrabKeyboard
GrabPointer	XGrabPointer
GrabServer	XGrabServer
ImageText16	XDrawImageString16
ImageText8	XDrawImageString
InstallColormap	XInstallColormap
InternAtom	XGetWMColormapWindows
	XGetWMProtocols
	XIconifyWindow
	XInternAtom
	XSetWMColormapWindows
	XSetWMProtocols
KillClient	XKillClient
ListExtensions	XListExtensions
ListFonts	XListFonts
ListFontsWithInfo	XListFontsWithInfo
ListHosts	XListHosts
ListInstalledColormaps	XListInstalledColormaps
ListProperties	XListProperties
LookupColor	XLookupColor
	XParseColor

Protocol Request	**Xlib Function**
MapSubwindows	XMapSubwindows
MapWindow	XMapRaised
	XMapWindow
NoOperation	XNoOp
OpenFont	XLoadFont
	XLoadQueryFont
PolyArc	XDrawArc
	XDrawArcs
PolyFillArc	XFillArc
	XFillArcs
PolyFillRectangle	XFillRectangle
	XFillRectangles
PolyLine	XDrawLines
PolyPoint	XDrawPoint
	XDrawPoints
PolyRectangle	XDrawRectangle
	XDrawRectangles
PolySegment	XDrawLine
	XDrawSegments
PolyText16	XDrawString16
	XDrawText16
PolyText8	XDrawString
	XDrawText
PutImage	XPutImage
	XCreateBitmapFromData
	XCreatePixmapFromData
	XReadBitmapFile
QueryBestSize	XQueryBestCursor
	XQueryBestSize
	XQueryBestStipple
	XQueryBestTile
QueryColors	XQueryColor
	XQueryColors
QueryExtension	XInitExtension
	XQueryExtension
QueryFont	XLoadQueryFont
	XQueryFont
QueryKeymap	XQueryKeymap
QueryPointer	XQueryPointer
QueryTextExtents	XQueryTextExtents
	XQueryTextExtents16
QueryTree	XQueryTree
RecolorCursor	XRecolorCursor
ReparentWindow	XReparentWindow
RotateProperties	XRotateBuffers
	XRotateWindowProperties
SendEvent	XIconifyWindow

Protocol Request	**Xlib Function**
	XReconfigureWMWindow
	XSendEvent
	XWithdrawWindow
SetClipRectangles	XSetClipRectangles
SetCloseDownMode	XSetCloseDownMode
SetDashes	XSetDashes
SetFontPath	XSetFontPath
SetInputFocus	XSetInputFocus
SetModifierMapping	XSetModifierMapping
SetPointerMapping	XSetPointerMapping
SetScreenSaver	XGetScreenSaver XSetScreenSaver
SetSelectionOwner	XSetSelectionOwner
StoreColors	XStoreColor XStoreColors
StoreNamedColor	XStoreNamedColor
TranslateCoordinates	XTranslateCoordinates
UngrabButton	XUngrabButton
UngrabKey	XUngrabKey
UngrabKeyboard	XUngrabKeyboard
UngrabPointer	XUngrabPointer
UngrabServer	XUngrabServer
UninstallColormap	XUninstallColormap
UnmapSubwindows	XUnmapSubWindows
UnmapWindow	XUnmapWindow XWithdrawWindow
WarpPointer	XWarpPointer

Appendix B

X Font Cursors

The following are the available cursors that can be used with **XCreateFontCursor**.

```
#define XC_X_cursor 0
#define XC_arrow 2
#define XC_based_arrow_down 4
#define XC_based_arrow_up 6
#define XC_boat 8
#define XC_bogosity 10
#define XC_bottom_left_corner 12
#define XC_bottom_right_corner 14
#define XC_bottom_side 16
#define XC_bottom_tee 18
#define XC_box_spiral 20
#define XC_center_ptr 22
#define XC_circle 24
#define XC_clock 26
#define XC_coffee_mug 28
#define XC_cross 30
#define XC_cross_reverse 32
#define XC_crosshair 34
#define XC_diamond_cross 36
#define XC_dot 38
#define XC_dot_box_mask 40
#define XC_double_arrow 42
#define XC_draft_large 44
#define XC_draft_small 46
#define XC_draped_box 48
#define XC_exchange 50
#define XC_fleur 52
#define XC_gobbler 54
#define XC_gumby 56
#define XC_hand1 58
#define XC_hand2 60
#define XC_heart 62
#define XC_icon 64
#define XC_iron_cross 66
#define XC_left_ptr 68
#define XC_left_side 70
#define XC_left_tee 72
#define XC_leftbutton 74
#define XC_ll_angle 76
#define XC_lr_angle 78
#define XC_man 80
#define XC_middlebutton 82
#define XC_mouse 84
#define XC_pencil 86
#define XC_pirate 88
#define XC_plus 90
#define XC_question_arrow 92
#define XC_right_ptr 94
#define XC_right_side 96
#define XC_right_tee 98
#define XC_rightbutton 100
#define XC_rtl_logo 102
#define XC_sailboat 104
#define XC_sb_down_arrow 106
#define XC_sb_h_double_arrow 108
#define XC_sb_left_arrow 110
#define XC_sb_right_arrow 112
#define XC_sb_up_arrow 114
#define XC_sb_v_double_arrow 116
#define XC_shuttle 118
#define XC_sizing 120
#define XC_spider 122
#define XC_spraycan 124
#define XC_star 126
#define XC_target 128
#define XC_tcross 130
#define XC_top_left_arrow 132
#define XC_top_left_corner 134
#define XC_top_right_corner 136
#define XC_top_side 138
#define XC_top_tee 140
#define XC_trek 142
#define XC_ul_angle 144
#define XC_umbrella 146
#define XC_ur_angle 148
#define XC_watch 150
#define XC_xterm 152
```

Appendix C

Extensions

Because X can evolve by extensions to the core protocol, it is important that extensions not be perceived as second class citizens. At some point, your favorite extensions may be adopted as additional parts of the X Standard.

Therefore, there should be little to distinguish the use of an extension from that of the core protocol. To avoid having to initialize extensions explicitly in application programs, it is also important that extensions perform lazy evaluations, automatically initializing themselves when called for the first time.

This appendix describes techniques for writing extensions to Xlib that will run at essentially the same performance as the core protocol requests.

> Note
>
> It is expected that a given extension to X consists of multiple requests. Defining ten new features as ten separate extensions is a bad practice. Rather, they should be packaged into a single extension and should use minor opcodes to distinguish the requests.

The symbols and macros used for writing stubs to Xlib are listed in **<X11/Xlibint.h>**.

Basic Protocol Support Routines

The basic protocol requests for extensions are **XQueryExtension** and **XListExtensions**.

```
Bool XQueryExtension(display, name, major_opcode_return, first_event_return, first_error_return)
    Display *display;
    char *name;
    int *major_opcode_return;
    int *first_event_return;
    int *first_error_return;
```

display	Specifies the connection to the X server.
name	Specifies the extension name.
major_opcode_return	Returns the major opcode.
first_event_return	Returns the first event code, if any.
	Specifies the extension list.

The **XQueryExtension** function determines if the named extension is present. If the extension is not present, **XQueryExtension** returns **False**; otherwise, it returns **True**. If the extension is present, **XQueryExtension** returns the major opcode for the extension to major_opcode_return; otherwise, it returns zero. Any minor opcode and the request formats are specific to the extension. If the extension involves additional event types, **XQueryExtension** returns the base event type code to first_event_return; otherwise, it returns zero. The format of the events is specific to the extension. If the extension involves additional error codes, **XQueryExtension** returns the base error code to first_error_return; otherwise, it returns zero. The format of additional data in the errors is specific to the extension.

If the extension name is not in the Host Portable Character Encoding the result is implementation dependent. Uppercase and lowercase matter; the strings ‘‘thing’’, ‘‘Thing’’, and ‘‘thinG’’ are all considered different names.

```
char **XListExtensions(display, nextensions_return)
      Display *display;
      int *nextensions_return;
```

display	Specifies the connection to the X server.
nextensions_return	Returns the number of extensions listed.

The **XListExtensions** function returns a list of all extensions supported by the server. If the data returned by the server is in the Latin Portable Character Encoding, then the returned strings are in the Host Portable Character Encoding. Otherwise, the result is implementation dependent.

```
XFreeExtensionList(list)
      char **list;
```

list	Specifies the list of extension names.

The **XFreeExtensionList** function frees the memory allocated by **XListExtensions**.

Hooking into Xlib

These functions allow you to hook into the library. They are not normally used by application programmers but are used by people who need to extend the core X protocol and the X library interface. The functions, which generate protocol requests for X, are typically called stubs.

In extensions, stubs first should check to see if they have initialized themselves on a connection. If they have not, they then should call **XInitExtension** to attempt to initialize themselves on the connection.

If the extension needs to be informed of GC/font allocation or deallocation or if the extension defines new event types, the functions described here allow the extension to be called when these events occur.

The **XExtCodes** structure returns the information from **XInitExtension** and is defined in **<X11/Xlib.h>**:

```
typedef struct _XExtCodes {                  /* public to extension, cannot be changed */
        int extension;                       /* extension number */
        int major_opcode;                    /* major op-code assigned by server */
        int first_event;                     /* first event number for the extension */
        int first_error;                     /* first error number for the extension */
} XExtCodes;
```

XExtCodes *XInitExtension(*display*, *name*)
    Display **display*;
    char **name*;

display	Specifies the connection to the X server.
name	Specifies the extension name.

The **XInitExtension** function determines if the named extension exists. Then, it allocates storage for maintaining the information about the extension on the connection, chains this onto the extension list for the connection, and returns the information the stub implementor will need to access the extension. If the extension does not exist, **XInitExtension** returns NULL.

If the extension name is not in the Host Portable Character Encoding, the result is implementation dependent. Uppercase and lowercase matter; the strings ‘‘thing’’, ‘‘Thing’’, and ‘‘thinG’’ are all considered different names.

The extension number in the **XExtCodes** structure is needed in the other calls that follow. This extension number is unique only to a single connection.

XExtCodes *XAddExtension(*display*)
    Display **display*;

display	Specifies the connection to the X server.

For local Xlib extensions, the **XAddExtension** function allocates the **XExtCodes** structure, bumps the extension number count, and chains the extension onto the extension list. (This permits extensions to Xlib without requiring server extensions.)

Hooks into the Library

These functions allow you to define procedures that are to be called when various circumstances occur. The procedures include the creation of a new GC for a connection, the copying of a GC, the freeing of a GC, the creating and freeing of fonts, the conversion of events defined by extensions to and from wire format, and the handling of errors.

All of these functions return the previous procedure defined for this extension.

int (*XESetCloseDisplay(*display*, *extension*, *proc*))()
Display **display*;
int *extension*;
int (**proc*)();

display	Specifies the connection to the X server.
extension	Specifies the extension number.
proc	Specifies the procedure to call when the display is closed.

The **XESetCloseDisplay** function defines a procedure to be called whenever **XCloseDisplay** is called. It returns any previously defined procedure, usually NULL.

When **XCloseDisplay** is called, your procedure is called with these arguments:

(**proc*)(*display*, *codes*)
Display **display*;
XExtCodes **codes*;

int (*XESetCreateGC(*display*, *extension*, *proc*))()
Display **display*;
int *extension*;
int (**proc*)();

display	Specifies the connection to the X server.
extension	Specifies the extension number.
proc	Specifies the procedure to call when a GC is closed.

The **XESetCreateGC** function defines a procedure to be called whenever a new GC is created. It returns any previously defined procedure, usually NULL.

When a GC is created, your procedure is called with these arguments:

(**proc*)(*display*, *gc*, *codes*)
Display **display*;
GC *gc*;
XExtCodes **codes*;

```
int (*XESetCopyGC(display, extension, proc))()
      Display *display;
      int extension;
      int (*proc)();
```

display	Specifies the connection to the X server.
extension	Specifies the extension number.
proc	Specifies the procedure to call when GC components are copied.

The **XESetCopyGC** function defines a procedure to be called whenever a GC is copied. It returns any previously defined procedure, usually NULL.

When a GC is copied, your procedure is called with these arguments:

```
(*proc)(display, gc, codes)
        Display *display;
        GC gc;
        XExtCodes *codes;
```

```
int (*XESetFreeGC(display, extension, proc))()
      Display *display;
      int extension;
      int (*proc)();
```

display	Specifies the connection to the X server.
extension	Specifies the extension number.
proc	Specifies the procedure to call when a GC is freed.

The **XESetFreeGC** function defines a procedure to be called whenever a GC is freed. It returns any previously defined procedure, usually NULL.

When a GC is freed, your procedure is called with these arguments:

```
(*proc)(display, gc, codes)
        Display *display;
        GC gc;
        XExtCodes *codes;
```

```
int (*XESetCreateFont(display, extension, proc))()
      Display *display;
      int extension;
      int (*proc)();
```

display	Specifies the connection to the X server.
extension	Specifies the extension number.
proc	Specifies the procedure to call when a font is created.

The **XESetCreateFont** function defines a procedure to be called whenever **XLoadQueryFont** and **XQueryFont** are called. It returns any previously defined procedure, usually NULL.

When **XLoadQueryFont** or **XQueryFont** is called, your procedure is called with these arguments:

```
(*proc)(display, fs, codes)
          Display *display;
          XFontStruct *fs;
          XExtCodes *codes;
```

```
int (*XESetFreeFont(display, extension, proc))()
      Display *display;
      int extension;
      int (*proc)();
```

display	Specifies the connection to the X server.
extension	Specifies the extension number.
proc	Specifies the procedure to call when a font is freed.

The **XESetFreeFont** function defines a procedure to be called whenever **XFreeFont** is called. It returns any previously defined procedure, usually NULL.

When **XFreeFont** is called, your procedure is called with these arguments:

```
(*proc)(display, fs, codes)
          Display *display;
          XFontStruct *fs;
          XExtCodes *codes;
```

The **XESetWireToEvent** and **XESetEventToWire** functions allow you to define new events to the library. An **XEvent** structure always has a type code (type **int**) as the first component. This uniquely identifies what kind of event it is. The second component is always the serial number (type **unsigned long**) of the last request processed by the server. The third component is always a Boolean (type **Bool**) indicating whether the event came from a **SendEvent** protocol request. The fourth component is always a pointer to the display the event was read from. The fifth component is always a resource ID of one kind or another, usually a window, carefully selected to be useful to toolkit dispatchers. The fifth component should always exist, even if the event does not have a natural destination; if there is no value from the protocol to put in this component, initialize it to zero.

Note

> There is an implementation limit such that your host event structure size cannot be bigger than the size of the **XEvent** union of structures. There also is no way to guarantee that more than 24 elements or 96 characters in the structure will be fully portable between machines.

```
int (*XESetWireToEvent(display, event_number, proc))()
    Display *display;
    int event_number;
    Status (*proc)();
```

display	Specifies the connection to the X server.
event_number	Specifies the event code.
proc	Specifies the procedure to call when converting an event.

The **XESetWireToEvent** function defines a procedure to be called when an event needs to be converted from wire format (**xEvent**) to host format (**XEvent**). The event number defines which protocol event number to install a conversion procedure for. **XESetWireToEvent** returns any previously defined procedure.

Note

> You can replace a core event conversion function with one of your own, although this is not encouraged. It would, however, allow you to intercept a core event and modify it before being placed in the queue or otherwise examined.

When Xlib needs to convert an event from wire format to host format, your procedure is called with these arguments:

```
Status (*proc)(display, re, event)
        Display *display;
        XEvent *re;
        xEvent *event;
```

Your procedure must return status to indicate if the conversion succeeded. The re argument is a pointer to where the host format event should be stored, and the event argument is the 32-byte wire event structure. In the **XEvent** structure you are creating, you must fill in the five required members of the event structure. You should fill in the type member with the type specified for the **xEvent** structure. You should copy all other members from the **xEvent** structure (wire format) to the **XEvent** structure (host format). Your conversion procedure should return **True** if the event should be placed in the queue or **False** if it should not be placed in the queue.

To initialize the serial number component of the event, call **_XSetLastRequestRead** with the event and use the return value.

```
unsigned long _XSetLastRequestRead(display, rep)
      Display *display;
      xGenericReply *rep;
```

display	Specifies the connection to the X server.
rep	Specifies the wire event structure.

The **_XSetLastRequestRead** function computes and returns a complete serial number from the partial serial number in the event.

```
Status (*XESetEventToWire(display, event_number, proc))()
      Display *display;
      int event_number;
      int (*proc)();
```

display	Specifies the connection to the X server.
event_number	Specifies the event code.
proc	Specifies the procedure to call when converting an event.

The **XESetEventToWire** function defines a procedure to be called when an event needs to be converted from host format (**XEvent**) to wire format (**xEvent**) form. The event number defines which protocol event number to install a conversion procedure for. **XESetEventToWire** returns any previously defined procedure. It returns zero if the conversion fails or nonzero otherwise.

Note

> You can replace a core event conversion function with one of your own, although this is not encouraged. It would, however, allow you to intercept a core event and modify it before being sent to another client.

When Xlib needs to convert an event from host format to wire format, your procedure is called with these arguments:

```
(*proc)(display, re, event)
          Display *display;
          XEvent *re;
          xEvent *event;
```

The re argument is a pointer to the host format event, and the event argument is a pointer to where the 32-byte wire event structure should be stored. You should fill in the type with the type from the **XEvent** structure. All other members then should be copied from the host format to the **xEvent** structure.

```
Bool (*XESetWireToError(display, error_number, proc)()
    Display *display;
    int error_number;
    Bool (*proc)();
```

display	Specifies the connection to the X server.
error_number	Specifies the error code.
proc	Specifies the procedure to call when an error is received.

The **XESetWireToError** function defines a procedure to be called when an extension error needs to be converted from wire format to host format. The error number defines which protocol error code to install the conversion procedure for. **XESetWireToError** returns any previously defined procedure.

Use this function for extension errors that contain additional error values beyond those in a core X error, when multiple wire errors must be combined into a single Xlib error, or when it is necessary to intercept an X error before it is otherwise examined.

When Xlib needs to convert an error from wire format to host format, the procedure is called with these arguments:

```
Bool (*proc)(display, he, we)
        Display *display;
        XErrorEvent *he;
        xError *we;
```

The he argument is a pointer to where the host format error should be stored. The structure pointed at by he is guaranteed to be as large as an **XEvent** structure and so can be cast to a type larger than an **XErrorEvent** to store additional values. If the error is to be completely ignored by Xlib (for example, several protocol error structures will be combined into one Xlib error), then the function should return **False**; otherwise, it should return **True**.

```
int (*XESetError(display, extension, proc))()
    Display *display;
    int extension;
    int (*proc)();
```

display	Specifies the connection to the X server.
extension	Specifies the extension number.
proc	Specifies the procedure to call when an error is received.

Inside Xlib, there are times that you may want to suppress the calling of the external error handling when an error occurs. This allows status to be returned on a call at the cost of the call being synchronous (though most such functions are query operations, in any case, and are typically programmed to be synchronous).

When Xlib detects a protocol error in **_XReply**, it calls your procedure with these arguments:

```
int (*proc)(display, err, codes, ret_code)
      Display *display;
      xError *err;
      XExtCodes *codes;
      int *ret_code;
```

The err argument is a pointer to the 32-byte wire format error. The codes argument is a pointer to the extension codes structure. The ret_code argument is the return code you may want **_XReply** returned to.

If your procedure returns a zero value, the error is not suppressed, and the client's error handler is called. (For further information, see section 11.8.2.) If your procedure returns nonzero, the error is suppressed, and **_XReply** returns the value of ret_code.

```
char *(*XESetErrorString(display, extension, proc))()
   Display *display;
   int extension;
   char *(*proc)();
```

display	Specifies the connection to the X server.
extension	Specifies the extension number.
proc	Specifies the procedure to call to obtain an error string.

The **XGetErrorText** function returns a string to the user for an error. **XESetErrorString** allows you to define a procedure to be called that should return a pointer to the error message. The following is an example.

```
(*proc)(display, code, codes, buffer, nbytes)
      Display *display;
      int code;
      XExtCodes *codes;
      char *buffer;
      int nbytes;
```

Your procedure is called with the error code for every error detected. You should copy nbytes of a null-terminated string containing the error message into buffer.

```
void (*XESetPrintErrorValues(display, extension, proc))()
   Display *display;
   int extension;
   void (*proc)();
```

display	Specifies the connection to the X server.
extension	Specifies the extension number.
proc	Specifies the procedure to call when an error is printed.

The **XESetPrintErrorValues** function defines a procedure to be called when an extension error is printed, to print the error values. Use this function for extension errors that contain additional error values beyond those in a core X error. It returns any previously defined procedure.

When Xlib needs to print an error, the procedure is called with these arguments:

```
void (*proc)(display, ev, fp)
      Display *display;
      XErrorEvent *ev;
      void *fp;
```

The structure pointed at by ev is guaranteed to be as large as an **XEvent** structure and so can be cast to a type larger than an **XErrorEvent** to obtain additional values set by using **XESetWireToError**. The underlying type of the fp argument is system dependent; on a POSIX-compliant system, fp should be cast to type FILE*.

```
int (*XESetFlushGC(display, extension, proc))()
   Display *display;
   int extension;
   int *(*proc)();
```

display	Specifies the connection to the X server.
extension	Specifies the extension number.
proc	Specifies the procedure to call when a GC is flushed.

The procedure set by the **XESetFlushGC** function has the same interface as the procedure set by the **XESetCopyGC** function, but is called when a GC cache needs to be updated in the server.

```
int (*XESetBeforeFlush(display, extension, proc))()
   Display *display;
   int extension;
   int *(*proc)();
```

display	Specifies the connection to the X server.
extension	Specifies the extension number.
proc	Specifies the procedure to call when a buffer is flushed.

The **XESetBeforeFlush** function defines a procedure to be called when data is about to be sent to the server. When data is about to be sent, your procedure is called one or more times with these arguments:

```
void (*proc)(display, codes, data, len)
        Display *display;
        XExtCodes *codes;
        char *data;
        long len;
```

The data argument specifies a portion of the outgoing data buffer, and its length in bytes is specified by the len argument. Your procedure must not alter the contents of the data, and must not do additional protocol requests to the same display.

Hooks onto Xlib Data Structures

Various Xlib data structures have provisions for extension procedures to chain extension supplied data onto a list. These structures are **GC**, **Visual**, **Screen**, **ScreenFormat**, **Display**, and **XFontStruct**. Because the list pointer is always the first member in the structure, a single set of procedures can be used to manipulate the data on these lists.

The following structure is used in the functions in this section and is defined in **<X11/Xlib.h>**:

```
typedef struct _XExtData {
        int number;                        /* number returned by XInitExtension */
        struct _XExtData *next;            /* next item on list of data for structure */
        int (*free_private)();             /* if defined,  called to free private */
        XPointer private_data;             /* data private to this extension. */
} XExtData;
```

When any of the data structures listed above are freed, the list is walked, and the structure's free procedure (if any) is called. If free is NULL, then the library frees both the data pointed to by the private_data member and the structure itself.

```
union { Display *display;
        GC gc;
        Visual *visual;
        Screen *screen;
        ScreenFormat *pixmap_format;
        XFontStruct *font } XEDataObject;
```

```
XExtData **XEHeadOfExtensionList(object)
        XEDataObject object;
```

object	Specifies the object.

The **XEHeadOfExtensionList** function returns a pointer to the list of extension structures attached to the specified object. In concert with **XAddToExtensionList**, **XEHeadOfExtensionList** allows an extension to attach arbitrary data to any of the structures of types contained in **XEDataObject**.

```
XAddToExtensionList(structure, ext_data)
      XExtData **structure;
      XExtData *ext_data;
```

structure	Specifies the extension list.
ext_data	Specifies the extension data structure to add.

The structure argument is a pointer to one of the data structures enumerated above. You must initialize ext_data->number with the extension number before calling this function.

```
XExtData *XFindOnExtensionList(structure, number)
      struct _XExtData **structure;
      int number;
```

structure	Specifies the extension list.
number	Specifies the extension number from **XInitExtension**.

The **XFindOnExtensionList** function returns the first extension data structure for the extension numbered number. It is expected that an extension will add at most one extension data structure to any single data structure's extension data list. There is no way to find additional structures.

The **XAllocID** macro, which allocates and returns a resource ID, is defined in **<X11/Xlib.h>**.

```
XAllocID(display)
     Display *display;
```

display	Specifies the connection to the X server.

This macro is a call through the **Display** structure to an internal resource ID allocator. It returns a resource ID that you can use when creating new resources.

The **XAllocIDs** macro allocates and returns an array of resource ID.

```
XAllocIDs(display, ids_return, count)
     Display *display;
     XID *ids_return;
     int count;
```

display	Specifies the connection to the X server.
ids_return	Returns the resource IDs.
rep	Specifies the number of resource IDs requested.

This macro is a call through the **Display** structure to an internal resource ID allocator. It returns resource IDs to the array supplied by the caller. To correctly handle automatic reuse of resource IDs, you must call **XAllocIDs** when requesting multiple resource IDs. This call might generate protocol requests.

GC Caching

GCs are cached by the library to allow merging of independent change requests to the same GC into single protocol requests. This is typically called a write-back cache. Any extension procedure whose behavior depends on the contents of a GC must flush the GC cache to make sure the server has up-to-date contents in its GC.

The **FlushGC** macro checks the dirty bits in the library's GC structure and calls **_XFlushGCCache** if any elements have changed. The **FlushGC** macro is defined as follows:

FlushGC(*display*, *gc*)
    Display **display*;
    GC *gc*;

display	Specifies the connection to the X server.
gc	Specifies the GC.

Note that if you extend the GC to add additional resource ID components, you should ensure that the library stub sends the change request immediately. This is because a client can free a resource immediately after using it, so if you only stored the value in the cache without forcing a protocol request, the resource might be destroyed before being set into the GC. You can use the **_XFlushGCCache** procedure to force the cache to be flushed. The **_XFlushGCCache** procedure is defined as follows:

_XFlushGCCache(*display*, *gc*)
    Display **display*;
    GC *gc*;

display	Specifies the connection to the X server.
gc	Specifies the GC.

Graphics Batching

If you extend X to add more poly graphics primitives, you may be able to take advantage of facilities in the library to allow back-to-back single calls to be transformed into poly requests. This may dramatically improve performance of programs that are not written using poly requests. A pointer to an **xReq**, called last_req in the display structure, is the last request being processed. By checking that the last request type, drawable, gc, and other options are the same as the new one and that there is enough space left in the buffer, you may be able to just extend the previous graphics request by extending the length field of the request and appending the data to the buffer. This can improve performance by five times or more in naive programs. For example, here is the source for the **XDrawPoint** stub. (Writing extension stubs is discussed in the next section.)

```
#include <X11/Xlibint.h>

/* precompute the maximum size of batching request allowed */

static int size = sizeof(xPolyPointReq) + EPERBATCH * sizeof(xPoint);

XDrawPoint(dpy, d, gc, x, y)
   register Display *dpy;
   Drawable d;
   GC gc;
   int x, y; /* INT16 */
{
   xPoint *point;
   LockDisplay(dpy);
   FlushGC(dpy, gc);
   {
   register xPolyPointReq *req = (xPolyPointReq *) dpy->last_req;
   /* if same as previous request, with same drawable, batch requests */
   if (
        (req->reqType == X_PolyPoint)
     && (req->drawable == d)
     && (req->gc == gc->gid)
     && (req->coordMode == CoordModeOrigin)
     && ((dpy->bufptr + sizeof (xPoint)) <= dpy->bufmax)
     && (((char *)dpy->bufptr - (char *)req) < size) ) {
      point = (xPoint *) dpy->bufptr;
      req->length += sizeof (xPoint) >> 2;
      dpy->bufptr += sizeof (xPoint);
      }

   else {
      GetReqExtra(PolyPoint, 4, req); /* 1 point = 4 bytes */
      req->drawable = d;
      req->gc = gc->gid;
      req->coordMode = CoordModeOrigin;
      point = (xPoint *) (req + 1);
      }
   point->x = x;
   point->y = y;
   }
   UnlockDisplay(dpy);
   SyncHandle();
}
```

To keep clients from generating very long requests that may monopolize the server, there is a symbol defined in **<X11/Xlibint.h>** of EPERBATCH on the number of requests batched. Most of the performance benefit occurs in the first few merged requests. Note that **FlushGC** is called *before* picking up the value of last_req, because it may modify this field.

Writing Extension Stubs

All X requests always contain the length of the request, expressed as a 16-bit quantity of 32 bits. This means that a single request can be no more than 256K bytes in length. Some servers may not support single requests of such a length. The value of dpy->max_request_size contains the maximum length as defined by the server implementation. For further information, see “X Window System Protocol.”

Requests, Replies, and Xproto.h

The **<X11/Xproto.h>** file contains three sets of definitions that are of interest to the stub implementor: request names, request structures, and reply structures.

You need to generate a file equivalent to **<X11/Xproto.h>** for your extension and need to include it in your stub procedure. Each stub procedure also must include **<X11/Xlibint.h>**.

The identifiers are deliberately chosen in such a way that, if the request is called X_DoSomething, then its request structure is xDoSomethingReq, and its reply is xDoSomethingReply. The GetReq family of macros, defined in **<X11/Xlibint.h>**, takes advantage of this naming scheme.

For each X request, there is a definition in **<X11/Xproto.h>** that looks similar to this:

```
#define X_DoSomething   42
```

In your extension header file, this will be a minor opcode, instead of a major opcode.

Request Format

Every request contains an 8-bit major opcode and a 16-bit length field expressed in units of four bytes. Every request consists of four bytes of header (containing the major opcode, the length field, and a data byte) followed by zero or more additional bytes of data. The length field defines the total length of the request, including the header. The length field in a request must equal the minimum length required to contain the request. If the specified length is smaller or larger than the required length, the server should generate a **BadLength** error. Unused bytes in a request are not required to be zero. Extensions should be designed in such a way that long protocol requests can be split up into smaller requests, if it is possible to exceed the maximum request size of the server. The protocol guarantees the maximum request size to be no smaller than 4096 units (16384 bytes).

Major opcodes 128 through 255 are reserved for extensions. Extensions are intended to contain multiple requests, so extension requests typically have an additional minor opcode encoded in the second data byte in the request header, but the placement and interpretation of this minor opcode as well as all other fields in extension requests are not defined by the core protocol. Every request is implicitly assigned a sequence number (starting with one) used in replies, errors, and events.

To help but not cure portability problems to certain machines, the **B16** and **B32** macros have been defined so that they can become bitfield specifications on some machines. For example, on a Cray, these should be used for all 16-bit and 32-bit quantities, as discussed below.

Most protocol requests have a corresponding structure typedef in **<X11/Xproto.h>**, which looks like:

```
typedef struct _DoSomethingReq {
        CARD8 reqType;                  /* X_DoSomething */
        CARD8 someDatum;                /* used differently in different requests */
        CARD16 length B16;              /* total # of bytes in request, divided by 4 */
        ...
        /* request-specific data */
        ...
} xDoSomethingReq;
```

If a core protocol request has a single 32-bit argument, you need not declare a request structure in your extension header file. Instead, such requests use the **xResourceReq** structure in **<X11/Xproto.h>**. This structure is used for any request whose single argument is a **Window**, **Pixmap**, **Drawable**, **GContext**, **Font**, **Cursor**, **Colormap**, **Atom**, or **VisualID**.

```
typedef struct _ResourceReq {
        CARD8 reqType;                  /* the request type, e.g. X_DoSomething */
        BYTE pad;                       /* not used */
        CARD16 length B16;              /* 2 (= total # of bytes in request, divided by 4) */
        CARD32 id B32;                  /* the Window, Drawable, Font, GContext, etc. */
} xResourceReq;
```

If convenient, you can do something similar in your extension header file.

In both of these structures, the reqType field identifies the type of the request (for example, X_MapWindow or X_CreatePixmap). The length field tells how long the request is in units of 4-byte longwords. This length includes both the request structure itself and any variable length data, such as strings or lists, that follow the request structure. Request structures come in different sizes, but all requests are padded to be multiples of four bytes long.

A few protocol requests take no arguments at all. Instead, they use the **xReq** structure in **<X11/Xproto.h>**, which contains only a reqType and a length (and a pad byte).

If the protocol request requires a reply, then **<X11/Xproto.h>** also contains a reply structure typedef:

```
typedef struct _DoSomethingReply {
        BYTE type;                      /* always X_Reply */
        BYTE someDatum;                 /* used differently in different requests */
        CARD16 sequenceNumber B16;      /* # of requests sent so far */
        CARD32 length B32;              /* # of additional bytes, divided by 4 */
        ...
        /* request-specific data */
        ...
} xDoSomethingReply;
```

Most of these reply structures are 32 bytes long. If there are not that many reply values, then they contain a sufficient number of pad fields to bring them up to 32 bytes. The length field is the total number of bytes in the request minus 32, divided by 4. This length will be nonzero only if:

- The reply structure is followed by variable length data such as a list or string.
- The reply structure is longer than 32 bytes.

Only **GetWindowAttributes**, **QueryFont**, **QueryKeymap**, and **GetKeyboardControl** have reply structures longer than 32 bytes in the core protocol.

A few protocol requests return replies that contain no data. **<X11/Xproto.h>** does not define reply structures for these. Instead, they use the **xGenericReply** structure, which contains only a type, length, and sequence number (and sufficient padding to make it 32 bytes long).

Starting to Write a Stub Procedure

An Xlib stub procedure should start like this:

```
#include "<X11/Xlibint.h>

XDoSomething (arguments, ... )
/* argument declarations */
{

register XDoSomethingReq *req;
...
```

If the protocol request has a reply, then the variable declarations should include the reply structure for the request. The following is an example:

```
xDoSomethingReply rep;
```

Locking Data Structures

To lock the display structure for systems that want to support multithreaded access to a single display connection, each stub will need to lock its critical section. Generally, this section is the point from just before the appropriate GetReq call until all arguments to the call have been stored into the buffer. The precise instructions needed for this locking depend upon the machine architecture. Two calls, which are generally implemented as macros, have been provided.

LockDisplay(*display*)
    Display **display*;

UnlockDisplay(*display*)
    Display **display*;

display	Specifies the connection to the X server.

Sending the Protocol Request and Arguments

After the variable declarations, a stub procedure should call one of four macros defined in **<X11/Xlibint.h>**: **GetReq**, **GetReqExtra**, **GetResReq**, or **GetEmptyReq**. All of these macros take, as their first argument, the name of the protocol request as declared in **<X11/Xproto.h>** except with X_ removed. Each one declares a **Display** structure pointer, called dpy, and a pointer to a request structure, called req, which is of the appropriate type. The macro then appends the request structure to the output buffer, fills in its type and length field, and sets req to point to it.

If the protocol request has no arguments (for instance, X_GrabServer), then use **GetEmptyReq**.

```
GetEmptyReq (DoSomething, req);
```

If the protocol request has a single 32-bit argument (such as a **Pixmap**, **Window**, **Drawable**, **Atom**, and so on), then use **GetResReq**. The second argument to the macro is the 32-bit object. **X_MapWindow** is a good example.

```
GetResReq (DoSomething, rid, req);
```

The rid argument is the **Pixmap**, **Window**, or other resource ID.

If the protocol request takes any other argument list, then call **GetReq**. After the **GetReq**, you need to set all the other fields in the request structure, usually from arguments to the stub procedure.

```
GetReq (DoSomething, req);
/* fill in arguments here */
req->arg1 = arg1;
req->arg2 = arg2;
...
```

A few stub procedures (such as **XCreateGC** and **XCreatePixmap**) return a resource ID to the caller but pass a resource ID as an argument to the protocol request. Such procedures use the macro **XAllocID** to allocate a resource ID from the range of IDs that were assigned to this client when it opened the connection.

```
rid = req->rid = XAllocID();
...
return (rid);
```

Finally, some stub procedures transmit a fixed amount of variable length data after the request. Typically, these procedures (such as **XMoveWindow** and **XSetBackground**) are special cases of more general functions like **XMoveResizeWindow** and **XChangeGC**. These procedures use **GetReqExtra**, which is the same as **GetReq** except that it takes an additional argument (the number of extra bytes to allocate in the output buffer after the request structure). This number should always be a multiple of four.

Variable Length Arguments

Some protocol requests take additional variable length data that follow the **xDoSomethingReq** structure. The format of this data varies from request to request. Some requests require a sequence of 8-bit bytes, others a sequence of 16-bit or 32-bit entities, and still others a sequence of structures.

It is necessary to add the length of any variable length data to the length field of the request structure. That length field is in units of 32-bit longwords. If the data is a string or other sequence of 8-bit bytes, then you must round the length up and shift it before adding:

```
req->length += (nbytes+3)>>2;
```

To transmit variable length data, use the **Data** macros. If the data fits into the output buffer, then this macro copies it to the buffer. If it does not fit, however, the **Data** macro calls **_XSend**, which transmits first the contents of the buffer and then your data. The **Data** macros take three arguments: the display, a pointer to the beginning of the data, and the number of bytes to be sent.

Data(*display*, (char *) *data*, *nbytes*);

Data16(*display*, (short *) *data*, *nbytes*);

Data32(*display*, (long *) *data*, *nbytes*);

Data, **Data16**, and **Data32** are macros that may use their last argument more than once, so that argument should be a variable rather than an expression such as ‘‘nitems*sizeof(item)’’. You should do that kind of computation in a separate statement before calling them. Use the appropriate macro when sending byte, short, or long data.

If the protocol request requires a reply, then call the procedure **_XSend** instead of the **Data** macro. **_XSend** takes the same arguments, but because it sends your data immediately instead of copying it into the output buffer (which would later be flushed anyway by the following call on **_XReply**), it is faster.

Replies

If the protocol request has a reply, then call **_XReply** after you have finished dealing with all the fixed and variable length arguments. **_XReply** flushes the output buffer and waits for an **xReply** packet to arrive. If any events arrive in the meantime, **_XReply** places them in the queue for later use.

Status _XReply(*display*, *rep*, *extra*, *discard*)
  Display **display*;
  xReply **rep*;
  int *extra*;
  Bool *discard*;

display	Specifies the connection to the X server.
rep	Specifies the reply structure.
extra	Specifies the number of 32-bit words expected after the replay.
discard	Specifies if any data beyond that specified in the extra argument should be discarded.

The **_XReply** function waits for a reply packet and copies its contents into the specified rep. **_XReply** handles error and event packets that occur before the reply is received. **_XReply** takes four arguments:

- A **Display** * structure
- A pointer to a reply structure (which must be cast to an **xReply** *)
- The number of additional 32-bit words (beyond sizeof(**xReply**) = 32 bytes) in the reply structure
- A Boolean that indicates whether **_XReply** is to discard any additional bytes beyond those it was told to read

Because most reply structures are 32 bytes long, the third argument is usually 0. The only core protocol exceptions are the replies to **GetWindowAttributes**, **QueryFont**, **QueryKeymap**, and **GetKeyboardControl**, which have longer replies.

The last argument should be **False** if the reply structure is followed by additional variable length data (such as a list or string). It should be **True** if there is not any variable length data.

Note

> This last argument is provided for upward-compatibility reasons to allow a client to communicate properly with a hypothetical later version of the server that sends more data than the client expected. For example, some later version of **GetWindowAttributes** might use a larger, but compatible, **xGetWindowAttributesReply** that contains additional attribute data at the end.

_XReply returns **True** if it received a reply successfully or **False** if it received any sort of error.

For a request with a reply that is not followed by variable length data, you write something like:

```
_XReply(display, (xReply *)&rep, 0, True);
*ret1 = rep.ret1;
*ret2 = rep.ret2;
*ret3 = rep.ret3;
...
UnlockDisplay(dpy);
SyncHandle();
return (rep.ret4);
}
```

If there is variable length data after the reply, change the **True** to **False**, and use the appropriate **_XRead** function to read the variable length data.

_XRead(*display*, *data_return*, *nbytes*)
    Display **display*;
    char **data_return*;
    long *nbytes*;

display	Specifies the connection to the X server.
data_return	Specifies the buffer.
nbytes	Specifies the number of bytes required.

The **_XRead** function reads the specified number of bytes into data_return.

_XRead16(*display*, *data_return*, *nbytes*)
    Display **display*;
    short **data_return*;
    long *nbytes*;

display	Specifies the connection to the X server.
data_return	Specifies the buffer.
nbytes	Specifies the number of bytes required.

The **_XRead16** function reads the specified number of bytes, unpacking them as 16-bit quantities, into the specified array as shorts.

```
_XRead32(display, data_return, nbytes)
      Display *display;
      long *data_return;
      long nbytes;
```

display	Specifies the connection to the X server.
data_return	Specifies the buffer.
nbytes	Specifies the number of bytes required.

The **_XRead32** function reads the specified number of bytes, unpacking them as 32-bit quantities, into the specified array as longs.

```
_XRead16Pad(display, data_return, nbytes)
      Display *display;
      short *data_return;
      long nbytes;
```

display	Specifies the connection to the X server.
data_return	Specifies the buffer.
nbytes	Specifies the number of bytes required.

The **_XRead16Pad** function reads the specified number of bytes, unpacking them as 16-bit quantities, into the specified array as shorts. If the number of bytes is not a multiple of four, **_XRead16Pad** reads and discards up to two additional pad bytes.

```
_XReadPad(display, data_return, nbytes)
      Display *display;
      char *data_return;
      long nbytes;
```

display	Specifies the connection to the X server.
data_return	Specifies the buffer.
nbytes	Specifies the number of bytes required.

The **_XReadPad** function reads the specified number of bytes into data_return. If the number of bytes is not a multiple of four, **_XReadPad** reads and discards up to three additional pad bytes.

Each protocol request is a little different. For further information, see the Xlib sources for examples.

Synchronous Calling

Each procedure should have a call, just before returning to the user, to a macro called **SyncHandle**. If synchronous mode is enabled (see **XSynchronize**), the request is sent immediately. The library, however, waits until any error the procedure could generate at the server has been handled.

Allocating and Deallocating Memory

To support the possible reentry of these procedures, you must observe several conventions when allocating and deallocating memory, most often done when returning data to the user from the window system of a size the caller could not know in advance (for example, a list of fonts or a list of extensions). The standard C library functions on many systems are not protected against signals or other multithreaded uses. The following analogies to standard I/O library functions have been defined:

Xmalloc()	Replaces **malloc**()
XFree()	Replaces **free**()
Xcalloc()	Replaces **calloc**()

These should be used in place of any calls you would make to the normal C library functions.

If you need a single scratch buffer inside a critical section (for example, to pack and unpack data to and from the wire protocol), the general memory allocators may be too expensive to use (particularly in output functions, which are performance critical). The following function returns a scratch buffer for use within a critical section:

char *_XAllocScratch(*display*, *nbytes*)
    Display **display*;
    unsigned long *nbytes*;

display	Specifies the connection to the X server.
nbytes	Specifies the number of bytes required.

This storage must only be used inside of a critical section of your stub. The returned pointer cannot be assumed valid after any call that might permit another thread to execute inside Xlib. For example, the pointer cannot be assumed valid after any use of the **GetReq** or **Data** families of macros, after any use of **_XReply**, or after any use of the **_XSend** or **_XRead** families of functions.

The following function returns a scratch buffer for use across critical sections:

char *_XAllocTemp(*display*, *nbytes*)
    Display **display*;
    unsigned long *nbytes*;

display	Specifies the connection to the X server.
nbytes	Specifies the number of bytes required.

This storage can be used across calls that might permit another thread to execute inside Xlib. The storage must be explicitly returned to Xlib. The following function returns the storage:

void _XFreeTemp(*display*, *buf*, *nbytes*)
    Display **display*;
    char **buf*;
    unsigned long *nbytes*;

display	Specifies the connection to the X server.
buf	Specifies the buffer to return.
nbytes	Specifies the size of the buffer.

You must pass back the same pointer and size that were returned by **_XAllocTemp**.

Portability Considerations

Many machine architectures, including many of the more recent RISC architectures, do not correctly access data at unaligned locations; their compilers pad out structures to preserve this characteristic. Many other machines capable of unaligned references pad inside of structures as well to preserve alignment, because accessing aligned data is usually much faster. Because the library and the server use structures to access data at arbitrary points in a byte stream, all data in request and reply packets *must* be naturally aligned; that is, 16-bit data starts on 16-bit boundaries in the request and 32-bit data on 32-bit boundaries. All requests *must* be a multiple of 32 bits in length to preserve the natural alignment in the data stream. You must pad structures out to 32-bit boundaries. Pad information does not have to be zeroed unless you want to preserve such fields for future use in your protocol requests. Floating point varies radically between machines and should be avoided completely if at all possible.

This code may run on machines with 16-bit ints. So, if any integer argument, variable, or return value either can take only nonnegative values or is declared as a **CARD16** in the protocol, be sure to declare it as **unsigned int** and not as **int**. (This, of course, does not apply to Booleans or enumerations.)

Similarly, if any integer argument or return value is declared **CARD32** in the protocol, declare it as an **unsigned long** and not as **int** or **long**. This also goes for any internal variables that may take on values larger than the maximum 16-bit **unsigned int**.

The library currently assumes that a **char** is 8 bits, a **short** is 16 bits, an **int** is 16 or 32 bits, and a **long** is 32 bits. The **PackData** macro is a half-hearted attempt to deal with the possibility of 32 bit shorts. However, much more work is needed to make this work properly.

Deriving the Correct Extension Opcode

The remaining problem a writer of an extension stub procedure faces that the core protocol does not face is to map from the call to the proper major and minor opcodes. While there are a number of strategies, the simplest and fastest is outlined below.

1. Declare an array of pointers, _NFILE long (this is normally found in **<stdio.h>** and is the number of file descriptors supported on the system) of type **XExtCodes**. Make sure these are all initialized to NULL.
2. When your stub is entered, your initialization test is just to use the display pointer passed in to access the file descriptor and an index into the array. If the entry is NULL, then this is the first time you are entering the procedure for this display. Call your initialization procedure and pass to it the display pointer.
3. Once in your initialization procedure, call **XInitExtension**; if it succeeds, store the pointer returned into this array. Make sure to establish a close display handler to allow you to zero

the entry. Do whatever other initialization your extension requires. (For example, install event handlers and so on.) Your initialization procedure would normally return a pointer to the **XExtCodes** structure for this extension, which is what would normally be found in your array of pointers.

4. After returning from your initialization procedure, the stub can now continue normally, because it has its major opcode safely in its hand in the **XExtCodes** structure.

Appendix D

Compatibility Functions

The X Version 11 and X Version 10 functions discussed in this appendix are obsolete, have been superseded by newer X Version 11 functions, and are maintained for compatibility reasons only.

X Version 11 Compatibility Functions

You can use the X Version 11 compatibility functions to:

- Set standard properties
- Set and get window sizing hints
- Set and get an **XStandardColormap** structure
- Parse window geometry
- Get X environment defaults

Setting Standard Properties

To specify a minimum set of properties describing the simplest application, use **XSetStandardProperties**. This function has been superseded by **XSetWMProperties** and sets all or portions of the WM_NAME, WM_ICON_NAME, WM_HINTS, WM_COMMAND, and WM_NORMAL_HINTS properties.

```
XSetStandardProperties(display, w, window_name, icon_name, icon_pixmap, argv, argc, hints)
    Display *display;
    Window w;
    char *window_name;
    char *icon_name;
    Pixmap icon_pixmap;
    char **argv;
    int argc;
    XSizeHints *hints;
```

display	Specifies the connection to the X server.
w	Specifies the window.
window_name	Specifies the window name, which should be a null-terminated string.
icon_name	Specifies the icon name, which should be a null-terminated string.
icon_pixmap	Specifies the bitmap that is to be used for the icon or **None**.
argv	Specifies the application's argument list.
argc	Specifies the number of arguments.
hints	Specifies a pointer to the size hints for the window in its normal state.

The **XSetStandardProperties** function provides a means by which simple applications set the most essential properties with a single call. **XSetStandardProperties** should be used to give a window manager some information about your program's preferences. It should not be used by applications that need to communicate more information than is possible with **XSetStandardProperties**. (Typically, argv is the argv array of your main program.) If the strings are not in the Host Portable Character Encoding, the result is implementation dependent.

XSetStandardProperties can generate **BadAlloc** and **BadWindow** errors.

Setting and Getting Window Sizing Hints

Xlib provides functions that you can use to set or get window sizing hints. The functions discussed in this section use the flags and the **XSizeHints** structure, as defined in the **<X11/Xutil.h>** header file, and use the WM_NORMAL_HINTS property.

To set the size hints for a given window in its normal state, use **XSetNormalHints**. This function has been superseded by **XSetWMNormalHints**.

```
XSetNormalHints(display, w, hints)
    Display *display;
    Window w;
    XSizeHints *hints;
```

display	Specifies the connection to the X server.
w	Specifies the window.
hints	Specifies a pointer to the size hints for the window in its normal state.

The **XSetNormalHints** function sets the size hints structure for the specified window. Applications use **XSetNormalHints** to inform the window manager of the size or position desirable for that window. In addition, an application that wants to move or resize itself should call **XSetNormalHints** and specify its new desired location and size as well as making direct Xlib calls to move or resize. This is because window managers may ignore redirected configure requests, but they pay attention to property changes.

To set size hints, an application not only must assign values to the appropriate members in the hints structure but also must set the flags member of the structure to indicate which information is present and where it came from. A call to **XSetNormalHints** is meaningless, unless the flags member is set to indicate which members of the structure have been assigned values.

XSetNormalHints can generate **BadAlloc** and **BadWindow** errors.

To return the size hints for a window in its normal state, use **XGetNormalHints**. This function has been superseded by **XGetWMNormalHints**.

```
Status XGetNormalHints(display, w, hints_return)
    Display *display;
    Window w;
    XSizeHints *hints_return;
```

display	Specifies the connection to the X server.
w	Specifies the window.
hints_return	Returns the size hints for the window in its normal state.

The **XGetNormalHints** function returns the size hints for a window in its normal state. It returns a nonzero status if it succeeds or zero if the application specified no normal size hints for this window.

XGetNormalHints can generate a **BadWindow** error.

The next two functions set and read the WM_ZOOM_HINTS property.

To set the zoom hints for a window, use **XSetZoomHints**. This function is no longer supported by the *Inter-Client Communication Conventions Manual*.

```
XSetZoomHints(display, w, zhints)
    Display *display;
    Window w;
    XSizeHints *zhints;
```

display	Specifies the connection to the X server.
w	Specifies the window.
zhints	Specifies a pointer to the zoom hints.

Many window managers think of windows in one of three states: iconic, normal, or zoomed. The **XSetZoomHints** function provides the window manager with information for the window in the zoomed state.

XSetZoomHints can generate **BadAlloc** and **BadWindow** errors.

To read the zoom hints for a window, use **XGetZoomHints**. This function is no longer supported by the *Inter-Client Communication Conventions Manual*.

```
Status XGetZoomHints(display, w, zhints_return)
    Display *display;
    Window w;
    XSizeHints *zhints_return;
```

display	Specifies the connection to the X server.
w	Specifies the window.
zhints_return	Returns the zoom hints.

The **XGetZoomHints** function returns the size hints for a window in its zoomed state. It returns a nonzero status if it succeeds or zero if the application specified no zoom size hints for this window.

XGetZoomHints can generate a **BadWindow** error.

To set the value of any property of type WM_SIZE_HINTS, use **XSetSizeHints**. This function has been superseded by **XSetWMSizeHints**.

```
XSetSizeHints(display, w, hints, property)
      Display *display;
      Window w;
      XSizeHints *hints;
      Atom property;
```

display	Specifies the connection to the X server.
w	Specifies the window.
hints	Specifies a pointer to the size hints.
property	Specifies the property name.

The **XSetSizeHints** function sets the **XSizeHints** structure for the named property and the specified window. This is used by **XSetNormalHints** and **XSetZoomHints**, and can be used to set the value of any property of type WM_SIZE_HINTS. Thus, it may be useful if other properties of that type get defined.

XSetSizeHints can generate **BadAlloc**, **BadAtom**, and **BadWindow** errors.

To read the value of any property of type WM_SIZE_HINTS, use **XGetSizeHints**. This function has been superseded by **XGetWMSizeHints**.

```
Status XGetSizeHints(display, w, hints_return, property)
      Display *display;
      Window w;
      XSizeHints *hints_return;
      Atom property;
```

display	Specifies the connection to the X server.
w	Specifies the window.
hints_return	Returns the size hints.
property	Specifies the property name.

The **XGetSizeHints** function returns the **XSizeHints** structure for the named property and the specified window. This is used by **XGetNormalHints** and **XGetZoomHints**. It also can be used to retrieve the value of any property of type WM_SIZE_HINTS. Thus, it may be useful if other properties of that type get defined. **XGetSizeHints** returns a nonzero status if a size hint was defined or zero otherwise.

XGetSizeHints can generate **BadAtom** and **BadWindow** errors.

Getting and Setting an XStandardColormap Structure

To get the **XStandardColormap** structure associated with one of the described atoms, use **XGetStandardColormap**. This function has been superseded by **XGetRGBColormap**.

```
Status XGetStandardColormap(display, w, colormap_return, property)
      Display *display;
      Window w;
      XStandardColormap *colormap_return;
      Atom property;                              /* RGB_BEST_MAP, etc. */
```

display	Specifies the connection to the X server.
w	Specifies the window.
colormap_return	Returns the colormap associated with the specified atom.
property	Specifies the property name.

The **XGetStandardColormap** function returns the colormap definition associated with the atom supplied as the property argument. **XGetStandardColormap** returns a nonzero status if successful and zero otherwise. For example, to fetch the standard **GrayScale** colormap for a display, you use **XGetStandardColormap** with the following syntax:

```
XGetStandardColormap(dpy, DefaultRootWindow(dpy), &cmap, XA_RGB_GRAY_MAP);
```

See section 14.3 for the semantics of standard colormaps.

XGetStandardColormap can generate **BadAtom** and **BadWindow** errors.

To set a standard colormap, use **XSetStandardColormap**. This function has been superseded by **XSetRGBColormap**.

```
XSetStandardColormap(display, w, colormap, property)
      Display *display;
      Window w;
      XStandardColormap *colormap;
      Atom property;                              /* RGB_BEST_MAP, etc. */
```

display	Specifies the connection to the X server.
w	Specifies the window.
colormap	Specifies the colormap.
property	Specifies the property name.

The **XSetStandardColormap** function usually is only used by window or session managers.

XSetStandardColormap can generate **BadAlloc**, **BadAtom**, **BadDrawable**, and **BadWindow** errors.

Parsing Window Geometry

To parse window geometry given a user-specified position and a default position, use **XGeometry**. This function has been superseded by **XWMGeometry**.

```
int XGeometry(display, screen, position, default_position, bwidth, fwidth, fheight, xadder,
              yadder, x_return, y_return, width_return, height_return)
    Display *display;
    int screen;
    char *position, *default_position;
    unsigned int bwidth;
    unsigned int fwidth, fheight;
    int xadder, yadder;
    int *x_return, *y_return;
    int *width_return, *height_return;
```

display	Specifies the connection to the X server.
screen	Specifies the screen.
position *default_position*	Specify the geometry specifications.
bwidth	Specifies the border width.
fheight *fwidth*	Specify the font height and width in pixels (increment size).
xadder *yadder*	Specify additional interior padding needed in the window.
x_return *y_return*	Return the x and y offsets.
width_return *height_return*	Return the width and height determined.

You pass in the border width (bwidth), size of the increments fwidth and fheight (typically font width and height), and any additional interior space (xadder and yadder) to make it easy to compute the resulting size. The **XGeometry** function returns the position the window should be placed given a position and a default position. **XGeometry** determines the placement of a window using a geometry specification as specified by **XParseGeometry** and the additional information about the window. Given a fully qualified default geometry specification and an incomplete geometry specification, **XParseGeometry** returns a bitmask value as defined above in the **XParseGeometry** call, by using the position argument.

The returned width and height will be the width and height specified by default_position as overridden by any user-specified position. They are not affected by fwidth, fheight, xadder, or yadder. The x and y coordinates are computed by using the border width, the screen width and height, padding as specified by xadder and yadder, and the fheight and fwidth times the width and height from the geometry specifications.

Obtaining the X Environment Defaults

The **XGetDefault** function provides a primitive interface to the resource manager facilities discussed in chapter 15. It is only useful in very simple applications.

```
char *XGetDefault(display, program, option)
      Display *display;
      char *program;
      char *option;
```

display	Specifies the connection to the X server.
program	Specifies the program name for the Xlib defaults (usually argv[0] of the main program).
option	Specifies the option name.

The **XGetDefault** function returns the value of the resource *prog.option*, where *prog* is the program argument with the directory prefix removed and *option* must be a single component. Note that multilevel resources cannot be used with **XGetDefault**. The class "Program.Name" is always used for the resource lookup. If the specified option name does not exist for this program, **XGetDefault** returns NULL. The strings returned by **XGetDefault** are owned by Xlib and should not be modified or freed by the client.

If a database has been set with **XrmSetDatabase**, that database is used for the lookup. Otherwise, a database is created and is set in the display (as if by calling **XrmSetDatabase**). The database is created in the current locale. To create a database, **XGetDefault** uses resources from the RESOURCE_MANAGER property on the root window of screen zero. If no such property exists, a resource file in the user's home directory is used. On a POSIX-conformant system, this file is **$HOME/.Xdefaults**. After loading these defaults, **XGetDefault** merges additional defaults specified by the XENVIRONMENT environment variable. If XENVIRONMENT is defined, it contains a full path name for the additional resource file. If XENVIRONMENT is not defined, **XGetDefault** looks for **$HOME/.Xdefaults-***name*, where *name* specifies the name of the machine on which the application is running.

X Version 10 Compatibility Functions

You can use the X Version 10 compatibility functions to:

- Draw and fill polygons and curves
- Associate user data with a value

Drawing and Filling Polygons and Curves

Xlib provides functions that you can use to draw or fill arbitrary polygons or curves. These functions are provided mainly for compatibility with X Version 10 and have no server support. That is, they call other Xlib functions, not the server directly. Thus, if you just have straight lines to draw, using **XDrawLines** or **XDrawSegments** is much faster.

The functions discussed here provide all the functionality of the X Version 10 functions **XDraw**, **XDrawFilled**, **XDrawPatterned**, **XDrawDashed**, and **XDrawTiled**. They are as compatible as possible given X Version 11's new line drawing functions. One thing to note, however, is that **VertexDrawLastPoint** is no longer supported. Also, the error status returned is the opposite of what it was under X Version 10 (this is the X Version 11 standard error status). **XAppendVertex** and **XClearVertexFlag** from X Version 10 also are not supported.

Just how the graphics context you use is set up actually determines whether you get dashes or not, and so on. Lines are properly joined if they connect and include the closing of a closed figure (see **XDrawLines**). The functions discussed here fail (return zero) only if they run out of memory or are passed a **Vertex** list that has a **Vertex** with **VertexStartClosed** set that is not followed by a **Vertex** with **VertexEndClosed** set.

To achieve the effects of the X Version 10 **XDraw**, **XDrawDashed**, and **XDrawPatterned**, use **XDraw**.

```
#include <X11/X10.h>

Status XDraw(display, d, gc, vlist, vcount)
        Display *display;
        Drawable d;
        GC gc;
        Vertex *vlist;
        int vcount;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
vlist	Specifies a pointer to the list of vertices that indicate what to draw.
vcount	Specifies how many vertices are in vlist.

The **XDraw** function draws an arbitrary polygon or curve. The figure drawn is defined by the specified list of vertices (vlist). The points are connected by lines as specified in the flags in the vertex structure.

Each Vertex, as defined in **<X11/X10.h>**, is a structure with the following members:

```
typedef struct _Vertex {
        short x,y;
        unsigned short flags;
} Vertex;
```

The x and y members are the coordinates of the vertex that are relative to either the upper-left inside corner of the drawable (if **VertexRelative** is zero) or the previous vertex (if **VertexRelative** is one).

The flags, as defined in **<X11/X10.h>**, are as follows:

VertexRelative	0x0001	/* else absolute */
VertexDontDraw	0x0002	/* else draw */
VertexCurved	0x0004	/* else straight */
VertexStartClosed	0x0008	/* else not */
VertexEndClosed	0x0010	/* else not */

- If **VertexRelative** is not set, the coordinates are absolute (that is, relative to the drawable's origin). The first vertex must be an absolute vertex.
- If **VertexDontDraw** is one, no line or curve is drawn from the previous vertex to this one. This is analogous to picking up the pen and moving to another place before drawing another line.
- If **VertexCurved** is one, a spline algorithm is used to draw a smooth curve from the previous vertex through this one to the next vertex. Otherwise, a straight line is drawn from the previous vertex to this one. It makes sense to set **VertexCurved** to one only if a previous and next vertex are both defined (either explicitly in the array or through the definition of a closed curve).
- It is permissible for **VertexDontDraw** bits and **VertexCurved** bits both to be one. This is useful if you want to define the previous point for the smooth curve but do not want an actual curve drawing to start until this point.
- If **VertexStartClosed** is one, then this point marks the beginning of a closed curve. This vertex must be followed later in the array by another vertex whose effective coordinates are identical and that has a **VertexEndClosed** bit of one. The points in between form a cycle to determine predecessor and successor vertices for the spline algorithm.

This function uses these GC components: function, plane-mask, line-width, line-style, cap-style, join-style, fill-style, subwindow-mode, clip-x-origin, clip-y-origin, and clip-mask. It also uses these GC mode-dependent components: foreground, background, tile, stipple, tile-stipple-x-origin, tile-stipple-y-origin, dash-offset, and dash-list.

To achieve the effects of the X Version 10 **XDrawTiled** and **XDrawFilled**, use **XDrawFilled**.

```
#include <X11/X10.h>

Status XDrawFilled(display, d, gc, vlist, vcount)
      Display *display;
      Drawable d;
      GC gc;
      Vertex *vlist;
      int vcount;
```

display	Specifies the connection to the X server.
d	Specifies the drawable.
gc	Specifies the GC.
vlist	Specifies a pointer to the list of vertices that indicate what to draw.
vcount	Specifies how many vertices are in vlist.

The **XDrawFilled** function draws arbitrary polygons or curves and then fills them.

This function uses these GC components: function, plane-mask, line-width, line-style, cap-style, join-style, fill-style, subwindow-mode, clip-x-origin, clip-y-origin, and clip-mask. It also uses these GC mode-dependent components: foreground, background, tile, stipple, tile-stipple-x-origin, tile-stipple-y-origin, dash-offset, dash-list, fill-style, and fill-rule.

Associating User Data with a Value

These functions have been superseded by the context management functions (see section 16.10). It is often necessary to associate arbitrary information with resource IDs. Xlib provides the **XAssocTable** functions that you can use to make such an association. Application programs often need to be able to easily refer to their own data structures when an event arrives. The **XAssocTable** system provides users of the X library with a method for associating their own data structures with X resources (**Pixmaps**, **Fonts**, **Windows**, and so on).

An **XAssocTable** can be used to type X resources. For example, the user may want to have three or four types of windows, each with different properties. This can be accomplished by associating each X window ID with a pointer to a window property data structure defined by the user. A generic type has been defined in the X library for resource IDs. It is called an XID.

There are a few guidelines that should be observed when using an **XAssocTable**:

- All XIDs are relative to the specified display.
- Because of the hashing scheme used by the association mechanism, the following rules for determining the size of a **XAssocTable** should be followed. Associations will be made and looked up more efficiently if the table size (number of buckets in the hashing system) is a power of two and if there are not more than 8 XIDs per bucket.

To return a pointer to a new **XAssocTable**, use **XCreateAssocTable**.

```
XAssocTable *XCreateAssocTable(size)
    int size;
```

size	Specifies the number of buckets in the hash system of **XAssocTable**.

The size argument specifies the number of buckets in the hash system of **XAssocTable**. For reasons of efficiency the number of buckets should be a power of two. Some size suggestions might be: use 32 buckets per 100 objects, and a reasonable maximum number of objects per buckets is 8. If an error allocating memory for the **XAssocTable** occurs, a NULL pointer is returned.

To create an entry in a given **XAssocTable**, use **XMakeAssoc**.

```
XMakeAssoc(display, table, x_id, data)
      Display *display;
      XAssocTable *table;
      XID x_id;
      char *data;
```

display	Specifies the connection to the X server.
table	Specifies the assoc table.
x_id	Specifies the X resource ID.
data	Specifies the data to be associated with the X resource ID.

The **XMakeAssoc** function inserts data into an **XAssocTable** keyed on an XID. Data is inserted into the table only once. Redundant inserts are ignored. The queue in each association bucket is sorted from the lowest XID to the highest XID.

To obtain data from a given **XAssocTable**, use **XLookUpAssoc**.

```
char *XLookUpAssoc(display, table, x_id)
      Display *display;
      XAssocTable *table;
      XID x_id;
```

display	Specifies the connection to the X server.
table	Specifies the assoc table.
x_id	Specifies the X resource ID.

The **XLookUpAssoc** function retrieves the data stored in an **XAssocTable** by its XID. If an appropriately matching XID can be found in the table, **XLookUpAssoc** returns the data associated with it. If the x_id cannot be found in the table, it returns NULL.

To delete an entry from a given **XAssocTable**, use **XDeleteAssoc**.

```
XDeleteAssoc(display, table, x_id)
      Display *display;
      XAssocTable *table;
      XID x_id;
```

display	Specifies the connection to the X server.
table	Specifies the assoc table.
x_id	Specifies the X resource ID.

The **XDeleteAssoc** function deletes an association in an **XAssocTable** keyed on its XID. Redundant deletes (and deletes of nonexistent XIDs) are ignored. Deleting associations in no way impairs the performance of an **XAssocTable**.

To free the memory associated with a given **XAssocTable**, use **XDestroyAssocTable**.

```
XDestroyAssocTable(table)
    XAssocTable *table;
```

table	Specifies the assoc table.

Glossary

Access control list

X maintains a list of hosts from which client programs can be run. By default, only programs on the local host and hosts specified in an initial list read by the server can use the display. This access control list can be changed by clients on the local host. Some server implementations can also implement other authorization mechanisms in addition to or in place of this mechanism. The action of this mechanism can be conditional based on the authorization protocol name and data received by the server at connection setup.

Active grab

A grab is active when the pointer or keyboard is actually owned by the single grabbing client.

Ancestors

If W is an inferior of A, then A is an ancestor of W.

Atom

An atom is a unique ID corresponding to a string name. Atoms are used to identify properties, types, and selections.

Background

An **InputOutput** window can have a background, which is defined as a pixmap. When regions of the window have their contents lost or invalidated, the server automatically tiles those regions with the background.

Backing store

When a server maintains the contents of a window, the pixels saved off-screen are known as a backing store.

Base font name

A font name used to select a family of fonts whose members may be encoded in various charsets. The **CharSetRegistry** and **CharSetEncoding** fields of an XLFD name identify the charset of the font. A base font name may be a full XLFD name, with all fourteen ’-’ delimiters, or an abbreviated XLFD name containing only the first 13 fields of an XLFD name, up to but not including **CharSetRegistry**, with or without the thirteenth ’-’, or a non-XLFD name. Any XLFD fields may contain wild cards.

When creating an **XFontSet**, Xlib accepts from the client a list of one or more base font names which select one or more font families. They are combined with charset names obtained from the encoding of the locale to load the fonts required to render text.

Bit gravity

When a window is resized, the contents of the window are not necessarily discarded. It is possible to request that the server relocate the previous contents to some region of the window (though no guarantees are made). This attraction of window contents for some location of a window is known as bit gravity.

Bit plane

When a pixmap or window is thought of as a stack of bitmaps, each bitmap is called a bit plane or plane.

Bitmap

A bitmap is a pixmap of depth one.

Border

An **InputOutput** window can have a border of equal thickness on all four sides of the window. The contents of the border are defined by a pixmap, and the server automatically maintains the contents of the border. Exposure events are never generated for border regions.

Button grabbing

Buttons on the pointer can be passively grabbed by a client. When the button is pressed, the pointer is then actively grabbed by the client.

Byte order

For image (pixmap/bitmap) data, the server defines the byte order, and clients with different native byte ordering must swap bytes as necessary. For all other parts of the protocol, the client defines the byte order, and the server swaps bytes as necessary.

Character

A member of a set of elements used for the organization, control, or representation of text (ISO2022, as adapted by XPG3). Note that in ISO2022 terms, a character is not bound to a coded value until it is identified as part of a coded character set.

Character glyph

The abstract graphical symbol for a character. Character glyphs may or may not map one-to-one to font glyphs, and may be context-dependent, varying with the adjacent characters. Multiple characters may map to a single character glyph.

Character set

A collection of characters.

Charset

An encoding with a uniform, state-independent mapping from characters to codepoints. A coded character set.

For display in X, there can be a direct mapping from a charset to one font, if the width of all characters in the charset is either one or two bytes. A text string encoded in an encoding such as Shift-JIS cannot be passed directly to the X server, because the text imaging requests accept only single-width charsets (either 8 or 16 bits). Charsets which meet these restrictions can serve as ‘‘font charsets’’. Font charsets strictly speaking map font indices to font glyphs, not characters to character glyphs.

Note that a single font charset is sometimes used as the encoding of a locale, for example, ISO8859-1.

Children

The children of a window are its first-level subwindows.

Class

Windows can be of different classes or types. See the entries for **InputOnly** and **InputOutput** windows for further information about valid window types.

Client

An application program connects to the window system server by some interprocess communication (IPC) path, such as a TCP connection or a shared memory buffer. This program is referred to as a client of the window system server. More precisely, the client is the IPC path itself. A program with multiple paths open to the server is viewed as multiple clients by the protocol. Resource lifetimes are controlled by connection lifetimes, not by program lifetimes.

Clipping region

In a graphics context, a bitmap or list of rectangles can be specified to restrict output to a particular region of the window. The image defined by the bitmap or rectangles is called a clipping region.

Coded character

A character bound to a codepoint.

Coded character set

A set of unambiguous rules that establishes a character set and the one-to-one relationship between each character of the set and its bit representation. (ISO2022, as adapted by XPG3) A definition of a one-to-one mapping of a set of characters to a set of codepoints.

Codepoint

The coded representation of a single character in a coded character set.

Colormap

A colormap consists of a set of entries defining color values. The colormap associated with a window is used to display the contents of the window; each pixel value indexes the colormap to produce an RGB value that drives the guns of a monitor. Depending on hardware limitations, one or more colormaps can be installed at one time so that windows associated with those maps display with true colors.

Connection

The IPC path between the server and client program is known as a connection. A client program typically (but not necessarily) has one connection to the server over which requests and events are sent.

Containment

A window contains the pointer if the window is viewable and the hotspot of the cursor is within a visible region of the window or a visible region of one of its inferiors. The border of the window is included as part of the window for containment. The pointer is in a window if the window contains the pointer but no inferior contains the pointer.

Coordinate system

The coordinate system has X horizontal and Y vertical, with the origin [0, 0] at the upper left. Coordinates are integral and coincide with pixel centers. Each window and pixmap has its own coordinate system. For a window, the origin is inside the border at the inside upper-left corner.

Cursor

A cursor is the visible shape of the pointer on a screen. It consists of a hotspot, a source bitmap, a shape bitmap, and a pair of colors. The cursor defined for a window controls the visible appearance when the pointer is in that window.

Depth

The depth of a window or pixmap is the number of bits per pixel it has. The depth of a graphics context is the depth of the drawables it can be used in conjunction with graphics output.

Device

Keyboards, mice, tablets, track-balls, button boxes, and so on are all collectively known as input devices. Pointers can have one or more buttons (the most common number is three). The core protocol only deals with two devices: the keyboard and the pointer.

DirectColor

DirectColor is a class of colormap in which a pixel value is decomposed into three separate subfields for indexing. The first subfield indexes an array to produce red intensity values. The second subfield indexes a second array to produce blue intensity values. The third subfield indexes a third array to produce green intensity values. The RGB (red, green, and blue) values in the colormap entry can be changed dynamically.

Display

A server, together with its screens and input devices, is called a display. The Xlib **Display** structure contains all information about the particular display and its screens as well as the state that Xlib needs to communicate with the display over a particular connection.

Drawable

Both windows and pixmaps can be used as sources and destinations in graphics operations. These windows and pixmaps are collectively known as drawables. However, an **InputOnly** window cannot be used as a source or destination in a graphics operation.

Encoding

A set of unambiguous rules that establishes a character set and a relationship between the characters and their representations. The character set does not have to be fixed to a finite pre-defined set of characters. The representations do not have to be of uniform length. Examples are an ISO2022 graphic set, a state-independent or state-dependent combination of graphic sets, possibly including control sets, and the X Compound Text encoding.

In X, encodings are identified by a string which appears as: the **CharSetRegistry** and **CharSetEncoding** components of an XLFD name; the name of a charset of the locale for which a font could not be found; or an atom which identifies the encoding of a text property or which names an encoding for a text selection target type. Encoding names should be composed of characters from the X Portable Character Set.

Escapement

The escapement of a string is the distance in pixels in the primary draw direction from the drawing origin to the origin of the next character (that is, the one following the given string) to be drawn.

Event

Clients are informed of information asynchronously by means of events. These events can be either asynchronously generated from devices or generated as side effects of client requests. Events are grouped into types. The server never sends an event to a client unless the client has specifically asked to be informed of that type of event. However, clients can force events to be sent to other clients. Events are typically reported relative to a window.

Event mask

Events are requested relative to a window. The set of event types a client requests relative to a window is described by using an event mask.

Event propagation

Device-related events propagate from the source window to ancestor windows until some client has expressed interest in handling that type of event or until the event is discarded explicitly.

Event synchronization

There are certain race conditions possible when demultiplexing device events to clients (in particular, deciding where pointer and keyboard events should be sent when in the middle of window management operations). The event synchronization mechanism allows synchronous processing of device events.

Event source

The deepest viewable window that the pointer is in is called the source of a device-related event.

Exposure event

Servers do not guarantee to preserve the contents of windows when windows are obscured or reconfigured. Exposure events are sent to clients to inform them when contents of regions of windows have been lost.

Extension

Named extensions to the core protocol can be defined to extend the system. Extensions to output requests, resources, and event types are all possible and expected.

Font

A font is an array of glyphs (typically characters). The protocol does no translation or interpretation of character sets. The client simply indicates values used to index the glyph array. A font contains additional metric information to determine interglyph and interline spacing.

Frozen events

Clients can freeze event processing during keyboard and pointer grabs.

Font glyph

The abstract graphical symbol for an index into a font.

GC

GC is an abbreviation for graphics context. See **Graphics context**.

Glyph

An identified abstract graphical symbol independent of any actual image. (ISO/IEC/DIS 9541-1) An abstract visual representation of a graphic character, not bound to a codepoint.

Glyph image

An image of a glyph, as obtained from a glyph representation displayed on a presentation surface. (ISO/IEC/DIS 9541-1)

Grab

Keyboard keys, the keyboard, pointer buttons, the pointer, and the server can be grabbed for exclusive use by a client. In general, these facilities are not intended to be used by normal applications but are intended for various input and window managers to implement various styles of user interfaces.

Graphics context

Various information for graphics output is stored in a graphics context (GC), such as foreground pixel, background pixel, line width, clipping region, and so on. A graphics context can only be used with drawables that have the same root and the same depth as the graphics context.

Gravity

The contents of windows and windows themselves have a gravity, which determines how the contents move when a window is resized. See **Bit gravity** and **Window gravity**.

GrayScale

GrayScale can be viewed as a degenerate case of **PseudoColor**, in which the red, green, and blue values in any given colormap entry are equal and thus, produce shades of gray. The gray values can be changed dynamically.

Host Portable Character Encoding

The encoding of the X Portable Character Set on the host. The encoding itself is not defined by this standard, but the encoding must be the same in all locales supported by Xlib on the host. If a string is said to be in the Host Portable Character Encoding, then it only contains characters from the X Portable Character Set, in the host encoding.

Hotspot

A cursor has an associated hotspot, which defines the point in the cursor corresponding to the coordinates reported for the pointer.

Identifier

An identifier is a unique value associated with a resource that clients use to name that resource. The identifier can be used over any connection to name the resource.

Inferiors

The inferiors of a window are all of the subwindows nested below it: the children, the children's children, and so on.

Input focus

The input focus is usually a window defining the scope for processing of keyboard input. If a generated keyboard event usually would be reported to this window or one of its inferiors, the event is reported as usual. Otherwise, the event is reported with respect to the focus window. The input focus also can be set such that all keyboard events are discarded and such that the focus window is dynamically taken to be the root window of whatever screen the pointer is on at each keyboard event.

Input manager

Control over keyboard input is typically provided by an input manager client, which usually is part of a window manager.

InputOnly window

An **InputOnly** window is a window that cannot be used for graphics requests. **InputOnly** windows are invisible and are used to control such things as cursors, input event generation, and grabbing. **InputOnly** windows cannot have **InputOutput** windows as inferiors.

InputOutput window

An **InputOutput** window is the normal kind of window that is used for both input and output. **InputOutput** windows can have both **InputOutput** and **InputOnly** windows as inferiors.

Internationalization

The process of making software adaptable to the requirements of different native languages, local customs, and character string encodings. Making a computer program adaptable to different locales without program source modifications or recompilation.

ISO2022

ISO standard for code extension techniques for 7-bit and 8-bit coded character sets.

Key grabbing

Keys on the keyboard can be passively grabbed by a client. When the key is pressed, the keyboard is then actively grabbed by the client.

Keyboard grabbing

A client can actively grab control of the keyboard, and key events will be sent to that client rather than the client the events would normally have been sent to.

Keysym

An encoding of a symbol on a keycap on a keyboard.

Latin-1

The coded character set defined by the ISO8859-1 standard.

Latin Portable Character Encoding

The encoding of the X Portable Character Set using the Latin-1 codepoints plus ASCII control characters. If a string is said to be in the Latin Portable Character Encoding, then it only contains characters from the X Portable Character Set, not all of Latin-1.

Locale

The international environment of a computer program defining the ‘‘localized’’ behavior of that program at run-time. This information can be established from one or more sets of localization data. ANSI C defines locale-specific processing by C system library calls. See ANSI C and the X/Open Portability Guide specifications for more details. In this specification, on implementations that conform to the ANSI C library, the ‘‘current locale’’ is the current setting of the LC_CTYPE **setlocale** category. Associated with each locale is a text encoding. When text is processed in the context of a locale, the text must be in the encoding of the locale. The current locale affects Xlib in its:

- Encoding and processing of input method text
- Encoding of resource files and values
- Encoding and imaging of text strings
- Encoding and decoding for inter-client text communication

Localization

The process of establishing information within a computer system specific to the operation of particular native languages, local customs and coded character sets. (XPG3)

Locale name

The identifier used to select the desired locale for the host C library and X library functions. On ANSI C library compliant systems, the locale argument to the **setlocale** function.

Mapped

A window is said to be mapped if a map call has been performed on it. Unmapped windows and their inferiors are never viewable or visible.

Modifier keys

Shift, Control, Meta, Super, Hyper, Alt, Compose, Apple, CapsLock, ShiftLock, and similar keys are called modifier keys.

Monochrome

Monochrome is a special case of **StaticGray** in which there are only two colormap entries.

Multibyte

A character whose codepoint is stored in more than one byte; any encoding which can contain multibyte characters; text in a multibyte encoding. The ‘‘char *’’ null-terminated string datatype in ANSI C. Note that references in this document to multibyte strings imply only that the strings *may* contain multibyte characters.

Obscure

A window is obscured if some other window obscures it. A window can be partially obscured and so still have visible regions. Window A obscures window B if both are viewable **InputOutput** windows, if A is higher in the global stacking order, and if the rectangle defined by the outside edges of A intersects the rectangle defined by the outside edges of B. Note the distinction between obscures and occludes. Also note that window borders are included in the calculation.

Occlude

A window is occluded if some other window occludes it. Window A occludes window B if both are mapped, if A is higher in the global stacking order, and if the rectangle defined by the outside edges of A intersects the rectangle defined by the outside edges of B. Note the distinction between occludes and obscures. Also note that window borders are included in the calculation and that **InputOnly** windows never obscure other windows but can occlude other windows.

Padding

Some padding bytes are inserted in the data stream to maintain alignment of the protocol requests on natural boundaries. This increases ease of portability to some machine architectures.

Parent window

If C is a child of P, then P is the parent of C.

Passive grab

Grabbing a key or button is a passive grab. The grab activates when the key or button is actually pressed.

Pixel value

A pixel is an N-bit value, where N is the number of bit planes used in a particular window or pixmap (that is, is the depth of the window or pixmap). A pixel in a window indexes a colormap to derive an actual color to be displayed.

Pixmap

A pixmap is a three-dimensional array of bits. A pixmap is normally thought of as a two-dimensional array of pixels, where each pixel can be a value from 0 to 2^N-1, and where N is the depth (z axis) of the pixmap. A pixmap can also be thought of as a stack of N bitmaps. A pixmap can only be used on the screen that it was created in.

Plane

When a pixmap or window is thought of as a stack of bitmaps, each bitmap is called a plane or bit plane.

Plane mask

Graphics operations can be restricted to only affect a subset of bit planes of a destination. A plane mask is a bit mask describing which planes are to be modified. The plane mask is stored in a graphics context.

Pointer

The pointer is the pointing device currently attached to the cursor and tracked on the screens.

Pointer grabbing

A client can actively grab control of the pointer. Then button and motion events will be sent to that client rather than the client the events would normally have been sent to.

Pointing device

A pointing device is typically a mouse, tablet, or some other device with effective dimensional motion. The core protocol defines only one visible cursor, which tracks whatever pointing device is attached as the pointer.

POSIX

Portable Operating System Interface, ISO/IEC 9945-1 (IEEE Std 1003.1).

POSIX Portable Filename Character Set

The set of 65 characters which can be used in naming files on a POSIX-compliant host that are correctly processed in all locales. The set is:

a..z A..Z 0..9 ._-

Property

Windows can have associated properties that consist of a name, a type, a data format, and some data. The protocol places no interpretation on properties. They are intended as a general-purpose naming mechanism for clients. For example, clients might use properties to share information such as resize hints, program names, and icon formats with a window manager.

Property list

The property list of a window is the list of properties that have been defined for the window.

PseudoColor

PseudoColor is a class of colormap in which a pixel value indexes the colormap entry to produce an independent RGB value; that is, the colormap is viewed as an array of triples (RGB values). The RGB values can be changed dynamically.

Rectangle

A rectangle specified by [x,y,w,h] has an infinitely thin outline path with corners at [x,y], [x+w,y], [x+w,y+h], and [x, y+h]. When a rectangle is filled, the lower-right edges are not drawn. For example, if w=h=0, nothing would be drawn. For w=h=1, a single pixel would be drawn.

Redirecting control

Window managers (or client programs) may enforce window layout policy in various ways. When a client attempts to change the size or position of a window, the operation may be redirected to a specified client rather than the operation actually being performed.

Reply

Information requested by a client program using the X protocol is sent back to the client with a reply. Both events and replies are multiplexed on the same connection. Most requests do not generate replies, but some requests generate multiple replies.

Request

A command to the server is called a request. It is a single block of data sent over a connection.

Resource

Windows, pixmaps, cursors, fonts, graphics contexts, and colormaps are known as resources. They all have unique identifiers associated with them for naming purposes. The lifetime of a resource usually is bounded by the lifetime of the connection over which the resource was created.

RGB values

RGB values are the red, green, and blue intensity values that are used to define a color. These values are always represented as 16-bit, unsigned numbers, with 0 the minimum intensity and 65535 the maximum intensity. The X server scales these values to match the display hardware.

Root

The root of a pixmap or graphics context is the same as the root of whatever drawable was used when the pixmap or GC was created. The root of a window is the root window under which the window was created.

Root window

Each screen has a root window covering it. The root window cannot be reconfigured or unmapped, but otherwise it acts as a full-fledged window. A root window has no parent.

Save set

The save set of a client is a list of other clients' windows that, if they are inferiors of one of the client's windows at connection close, should not be destroyed and that should be remapped if currently unmapped. Save sets are typically used by window managers to avoid lost windows if the manager should terminate abnormally.

Scanline

A scanline is a list of pixel or bit values viewed as a horizontal row (all values having the same y coordinate) of an image, with the values ordered by increasing the x coordinate.

Scanline order

An image represented in scanline order contains scanlines ordered by increasing the y coordinate.

Screen

A server can provide several independent screens, which typically have physically independent monitors. This would be the expected configuration when there is only a single keyboard and pointer shared among the screens. A **Screen** structure contains the information about that screen and is linked to the **Display** structure.

Selection

A selection can be thought of as an indirect property with dynamic type. That is, rather than having the property stored in the X server, it is maintained by some client (the owner). A selection is global and is thought of as belonging to the user and being maintained by clients, rather than being private to a particular window subhierarchy or a particular set of clients. When a client asks for the contents of a selection, it specifies a selection target type, which can be used to control the transmitted representation of the contents. For example, if the selection is ‘‘the last thing the user clicked on,’’ and that is currently an image, then the target type might specify whether the contents of the image should be sent in XY format or Z format.

The target type can also be used to control the class of contents transmitted; for example, asking for the ‘‘looks’’ (fonts, line spacing, indentation, and so forth) of a paragraph selection, rather than the text of the paragraph. The target type can also be used for other purposes. The protocol does not constrain the semantics.

Server

The server, which is also referred to as the X server, provides the basic windowing mechanism. It handles IPC connections from clients, multiplexes graphics requests onto the screens, and demultiplexes input back to the appropriate clients.

Server grabbing

The server can be grabbed by a single client for exclusive use. This prevents processing of any requests from other client connections until the grab is completed. This is typically only a transient state for such things as rubber-banding, pop-up menus, or executing requests indivisibly.

Shift sequence

ISO2022 defines control characters and escape sequences which temporarily (single shift) or permanently (locking shift) cause a different character set to be in effect (‘‘invoking’’ a character set).

Sibling

Children of the same parent window are known as sibling windows.

Stacking order

Sibling windows, similar to sheets of paper on a desk, can stack on top of each other. Windows above both obscure and occlude lower windows. The relationship between sibling windows is known as the stacking order.

State-dependent encoding

An encoding in which an invocation of a charset can apply to multiple characters in sequence. A state-dependent encoding begins in an ‘‘initial state’’ and enters other ‘‘shift states’’ when specific ‘‘shift sequences’’ are encountered in the byte sequence. In ISO2022 terms, this means use of locking shifts, not single shifts.

State-independent encoding

Any encoding in which the invocations of the charsets are fixed, or span only a single character. In ISO2022 terms, this means use of at most single shifts, not locking shifts.

StaticColor

StaticColor can be viewed as a degenerate case of **PseudoColor** in which the RGB values are predefined and read-only.

StaticGray

StaticGray can be viewed as a degenerate case of **GrayScale** in which the gray values are predefined and read-only. The values are typically linear or near-linear increasing ramps.

Status

Many Xlib functions return a success status. If the function does not succeed, however, its arguments are not disturbed.

Stipple

A stipple pattern is a bitmap that is used to tile a region to serve as an additional clip mask for a fill operation with the foreground color.

STRING encoding

Latin-1, plus tab and newline.

String Equivalence

Two ISO Latin-1 STRING8 values are considered equal if they are the same length and if corresponding bytes are either equal or are equivalent as follows: decimal values 65 to 90 inclusive (characters ''A'' to ''Z'') are pairwise equivalent to decimal values 97 to 122 inclusive (characters ''a'' to ''z''), decimal values 192 to 214 inclusive (characters ''A grave'' to ''O diaeresis'') are pairwise equivalent to decimal values 224 to 246 inclusive (characters ''a grave'' to ''o diaeresis''), and decimal values 216 to 222 inclusive (characters ''O oblique'' to ''THORN'') are pairwise equivalent to decimal values 246 to 254 inclusive (characters ''o oblique'' to ''thorn'').

Tile

A pixmap can be replicated in two dimensions to tile a region. The pixmap itself is also known as a tile.

Timestamp

A timestamp is a time value expressed in milliseconds. It is typically the time since the last server reset. Timestamp values wrap around (after about 49.7 days). The server, given its current time is represented by timestamp T, always interprets timestamps from clients by treating half of the timestamp space as being earlier in time than T and half of the timestamp space as being later in time than T. One timestamp value, represented by the constant **CurrentTime**, is never generated by the server. This value is reserved for use in requests to represent the current server time.

TrueColor

TrueColor can be viewed as a degenerate case of **DirectColor** in which the subfields in the pixel value directly encode the corresponding RGB values. That is, the colormap has predefined read-only RGB values. The values are typically linear or near-linear increasing ramps.

Type

A type is an arbitrary atom used to identify the interpretation of property data. Types are completely uninterpreted by the server. They are solely for the benefit of clients. X predefines type atoms for many frequently used types, and clients also can define new types.

Viewable

A window is viewable if it and all of its ancestors are mapped. This does not imply that any portion of the window is actually visible. Graphics requests can be performed on a window when it is not viewable, but output will not be retained unless the server is maintaining backing store.

Visible

A region of a window is visible if someone looking at the screen can actually see it; that is, the window is viewable and the region is not occluded by any other window.

Whitespace

Any spacing character. On implementations that conform to the ANSI C library, whitespace is any character for which **isspace** returns true.

Window gravity

When windows are resized, subwindows may be repositioned automatically relative to some position in the window. This attraction of a subwindow to some part of its parent is known as window gravity.

Window manager

Manipulation of windows on the screen and much of the user interface (policy) is typically provided by a window manager client.

X Portable Character Set

A basic set of 97 characters which are assumed to exist in all locales supported by Xlib. This set contains the following characters:

a..z A..Z 0..9 !"#$%&’()*+,-./:;<=>?@[\]ˆ_‘{|}˜ <space>, <tab>, and <newline>

This is the left/lower half (also called the G0 set) of the graphic character set of ISO8859-1 plus <space>, <tab>, and <newline>. It is also the set of graphic characters in 7-bit ASCII plus the same three control characters. The actual encoding of these characters on the host is system dependent; see the Host Portable Character Encoding.

XLFD

The X Logical Font Description Conventions that define a standard syntax for structured font names.

XY format

The data for a pixmap is said to be in XY format if it is organized as a set of bitmaps representing individual bit planes with the planes appearing from most-significant to least-significant bit order.

Z format

The data for a pixmap is said to be in Z format if it is organized as a set of pixel values in scanline order.

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