X Toolkit Intrinsics — C Language Interface

X Window System

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Joel McCormack
Western Software Laboratory
Digital Equipment Corporation

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Donna Converse
X Consortium
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About This Manual

*X Toolkit Intrinsics — C Language Interface* is intended to be read by both application programmers who will use one or more of the many widget sets built with the Intrinsics and by widget programmers who will use the Intrinsics to build widgets for one of the widget sets. Not all the information in this manual, however, applies to both audiences. That is, because the application programmer is likely to use only a number of the Intrinsics functions in writing an application and because the widget programmer is likely to use many more, if not all, of the Intrinsics functions in building a widget, an attempt has been made to highlight those areas of information that are deemed to be of special interest for the application programmer. (It is assumed the widget programmer will have to be familiar with all the information.) Therefore, all entries in the table of contents that are printed in **bold** indicate the information that should be of special interest to an application programmer.

It is also assumed that, as application programmers become more familiar with the concepts discussed in this manual, they will find it more convenient to implement portions of their applications as special-purpose or custom widgets. It is possible, nonetheless, to use widgets without knowing how to build them.

Conventions Used in this Manual

This document uses the following conventions:

- **Global symbols** are printed in **this special font**. These can be either function names, symbols defined in include files, data types, or structure names. Arguments to functions, procedures, or macros are printed in *italics*.

- 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. General discussion of the function, if any is required, follows the arguments.

- 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*. 
Chapter 1

Intrinsics and Widgets

The Intrinsics are a programming library tailored to the special requirements of user interface construction within a network window system, specifically the X Window System. The Intrinsics and a widget set make up an X Toolkit.

1.1. Intrinsics

The Intrinsics provide the base mechanism necessary to build a wide variety of interoperating widget sets and application environments. The Intrinsics are a layer on top of Xlib, the C Library X Interface. They extend the fundamental abstractions provided by the X Window System while still remaining independent of any particular user interface policy or style.

The Intrinsics use object-oriented programming techniques to supply a consistent architecture for constructing and composing user interface components, known as widgets. This allows programmers to extend a widget set in new ways, either by deriving new widgets from existing ones (sub-classing) or by writing entirely new widgets following the established conventions.

When the Intrinsics were first conceived, the root of the object hierarchy was a widget class named Core. In Release 4 of the Intrinsics, three nonwidget superclasses were added above Core. These superclasses are described in Chapter 12. The name of the class now at the root of the Intrinsics class hierarchy is Object. The remainder of this specification refers uniformly to widgets and Core as if they were the base class for all Intrinsics operations. The argument descriptions for each Intrinsics procedure and Chapter 12 describe which operations are defined for the nonwidget superclasses of Core. The reader may determine by context whether a specific reference to widget actually means “widget” or “object.”

1.2. Languages

The Intrinsics are intended to be used for two programming purposes. Programmers writing widgets will be using most of the facilities provided by the Intrinsics to construct user interface components from the simple, such as buttons and scrollbars, to the complex, such as control panels and property sheets. Application programmers will use a much smaller subset of the Intrinsics procedures in combination with one or more sets of widgets to construct and present complete user interfaces on an X display. The Intrinsics programming interfaces primarily intended for application use are designed to be callable from most procedural programming languages. Therefore, most arguments are passed by reference rather than by value. The interfaces primarily intended for widget programmers are expected to be used principally from the C language. In these cases, the usual C programming conventions apply. In this specification, the term client refers to any module, widget, or application that calls an Intrinsics procedure.

Applications that use the Intrinsics mechanisms must include the header files <X11/Intrinsic.h> and <X11/StringDefs.h>, or their equivalent, and they may also include <X11/Xatoms.h> and <X11/Shell.h>. In addition, widget implementations should include <X11/IntrinsicP.h> instead of <X11/Intrinsic.h>.

The applications must also include the additional header files for each widget class that they are to use (for example, <X11/Xaw/Label.h> or <X11/Xaw/Scrollbar.h>). On a POSIX-based system, the Intrinsics object library file is named libXt.a and is usually referenced as -lXt when linking the application.
1.3. Procedures and Macros

All functions defined in this specification except those specified below may be implemented as C macros with arguments. C applications may use “#undef” to remove a macro definition and ensure that the actual function is referenced. Any such macro will expand to a single expression that has the same precedence as a function call and that evaluates each of its arguments exactly once, fully protected by parentheses, so that arbitrary expressions may be used as arguments.

The following symbols are macros that do not have function equivalents and that may expand their arguments in a manner other than that described above: XtCheckSubclass, XtNew, XtNumber, XtOffsetOf, XtOffset, and XtSetArg.

1.4. Widgets

The fundamental abstraction and data type of the X Toolkit is the widget, which is a combination of an X window and its associated input and display semantics and which is dynamically allocated and contains state information. Some widgets display information (for example, text or graphics), and others are merely containers for other widgets (for example, a menu box). Some widgets are output-only and do not react to pointer or keyboard input, and others change their display in response to input and can invoke functions that an application has attached to them.

Every widget belongs to exactly one widget class, which is statically allocated and initialized and which contains the operations allowable on widgets of that class. Logically, a widget class is the procedures and data associated with all widgets belonging to that class. These procedures and data can be inherited by subclasses. Physically, a widget class is a pointer to a structure. The contents of this structure are constant for all widgets of the widget class but will vary from class to class. (Here, “constant” means the class structure is initialized at compile time and never changed, except for a one-time class initialization and in-place compilation of resource lists, which takes place when the first widget of the class or subclass is created.) For further information, see Section 2.5.

The distribution of the declarations and code for a new widget class among a public .h file for application programmer use, a private .h file for widget programmer use, and the implementation .c file is described in Section 1.6. The predefined widget classes adhere to these conventions.

A widget instance is composed of two parts:

- A data structure which contains instance-specific values.
- A class structure which contains information that is applicable to all widgets of that class.

Much of the input/output of a widget (for example, fonts, colors, sizes, or border widths) is customizable by users.

This chapter discusses the base widget classes, Core, Composite, and Constraint, and ends with a discussion of widget classing.

1.4.1. Core Widgets

The Core widget class contains the definitions of fields common to all widgets. All widgets classes are subclasses of the Core class, which is defined by the CoreClassPart and CorePart structures.

1.4.1.1. CoreClassPart Structure

All widget classes contain the fields defined in the CoreClassPart structure.
typedef struct {
    WidgetClass superclass; See Section 1.6
    String class_name; See Chapter 9
    Cardinal widget_size; See Section 1.6
    XtProc class_initialize; See Section 1.6
    XtWidgetClassProc class_part_initialize; See Section 1.6
    XtEnum class_inited; See Section 1.6
    XtInitProc initialize; See Section 2.5
    XtArgsProc initialize_hook; See Section 2.5
    XtRealizeProc realize; See Section 2.6
    XtActionList actions; See Chapter 10
    Cardinal num_actions; See Chapter 10
    XtResourceList resources; See Chapter 9
    Cardinal num_resources; See Chapter 9
    XrmClass xrm_class; Private to resource manager
    Boolean compress_motion; See Section 7.9
    XtEnum compress_exposure; See Section 7.9
    Boolean compress_enterleave; See Section 7.9
    Boolean visible_interest; See Section 7.10
    XtWidgetProc destroy; See Section 2.8
    XtWidgetProc resize; See Chapter 6
    XtExposeProc expose; See Section 7.10
    XtSetValuesFunc set_values; See Section 9.7
    XtArgsFunc set_values_hook; See Section 9.7
    XtAlmostProc set_values_almost; See Section 9.7
    XtArgsProc get_values_hook; See Section 9.7
    XtAcceptFocusProc accept_focus; See Section 7.3
    XtVersionType version; See Section 1.6
    XtPointer callback_private; Private to callbacks
    String tm_table; See Chapter 10
    XtGeometryHandler query_geometry; See Chapter 6
    XtStringProc display_accelerator; See Chapter 10
    XtPointer extension; See Section 1.6
} CoreClassPart;

All widget classes have the Core class fields as their first component. The prototypical WidgetClass and CoreWidgetClass are defined with only this set of fields.

typedef struct {
    CoreClassPart core_class;
} WidgetClassRec, *WidgetClass, CoreClassRec, *CoreWidgetClass;

Various routines can cast widget class pointers, as needed, to specific widget class types. The single occurrences of the class record and pointer for creating instances of Core are:

In IntrinsicP.h:

extern WidgetClassRec widgetClassRec;
define coreClassRec widgetClassRec
In *Intrinsic.h*:

```c
extern WidgetClass widgetClass, coreWidgetClass;
```

The opaque types **Widget** and **WidgetClass** and the opaque variable **widgetClass** are defined for generic actions on widgets. In order to make these types opaque and ensure that the compiler does not allow applications to access private data, the Intrinsics use incomplete structure definitions in *Intrinsic.h*:

```c
typedef struct _WidgetClassRec *WidgetClass, *CoreWidgetClass;
```

### 1.4.1.2. CorePart Structure

All widget instances contain the fields defined in the **CorePart** structure.

```c
typedef struct _CorePart {
    Widget self;                          // Described below
    WidgetClass widget_class;            // See Section 1.6
    Widget parent;                       // See Section 2.5
    Boolean being_destroyed;             // See Section 2.8
    XtCallbackList destroy_callbacks;    // See Section 2.8
    XtPointer constraints;               // See Section 3.6
    Position x;                          // See Chapter 6
    Position y;                          // See Chapter 6
    Dimension width;                     // See Chapter 6
    Dimension height;                    // See Chapter 6
    Dimension border_width;              // See Chapter 6
    Boolean managed;                     // See Chapter 3
    Boolean sensitive;                   // See Section 7.7
    Boolean ancestor_sensitive;          // See Section 7.7
    XtTranslations accelerators;         // See Chapter 10
    Pixel border_pixel;                  // See Section 2.6
   Pixmap border_pixmap;                 // See Section 2.6
    WidgetList popup_list;               // See Chapter 5
    Cardinal num_popups;                 // See Chapter 5
    String name;                         // See Chapter 9
    Screen *screen;                      // See Section 2.6
    Colormap colormap;                   // See Section 2.6
    Window window;                       // See Section 2.6
    Cardinal depth;                      // See Section 2.6
    Pixel background_pixel;              // See Section 2.6
   Pixmap background_pixmap;             // See Section 2.6
    Boolean visible;                     // See Section 7.10
    Boolean mapped_when_managed;         // See Chapter 3
} CorePart;
```

All widget instances have the Core fields as their first component. The prototypical type **Widget**
is defined with only this set of fields.

typedef struct {
  CorePart core;
} WidgetRec, *Widget, CoreRec, *CoreWidget;

Various routines can cast widget pointers, as needed, to specific widget types. In order to make these types opaque and ensure that the compiler does not allow applications to access private data, the Intrinsics use incomplete structure definitions in Intrinsic.h.

typedef struct _WidgetRec *Widget, *CoreWidget;

1.4.1.3. Core Resources

The resource names, classes, and representation types specified in the coreClassRec resource list are

<table>
<thead>
<tr>
<th>Name</th>
<th>Class</th>
<th>Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>XtNaccelerators</td>
<td>XtCAccelerators</td>
<td>XtRAcceleratorTable</td>
</tr>
<tr>
<td>XtNbackground</td>
<td>XtCBackground</td>
<td>XtRPixel</td>
</tr>
<tr>
<td>XtNbackgroundPixmap</td>
<td>XtCPixmap</td>
<td>XtRPixmap</td>
</tr>
<tr>
<td>XtNborderColor</td>
<td>XtCBorderColor</td>
<td>XtRPixel</td>
</tr>
<tr>
<td>XtNborderPixmap</td>
<td>XtCPixmap</td>
<td>XtRPixmap</td>
</tr>
<tr>
<td>XtNcolormap</td>
<td>XtCColormap</td>
<td>XtRColormap</td>
</tr>
<tr>
<td>XtNdepth</td>
<td>XtCDepth</td>
<td>XtRInt</td>
</tr>
<tr>
<td>XtNmappedWhenManaged</td>
<td>XtCMappedWhenManaged</td>
<td>XtRBoolean</td>
</tr>
<tr>
<td>XtNscreen</td>
<td>XtCScreen</td>
<td>XtRScreen</td>
</tr>
<tr>
<td>XtNtranslations</td>
<td>XtCTranslations</td>
<td>XtRTranslationTable</td>
</tr>
</tbody>
</table>

Additional resources are defined for all widgets via the objectClassRec and rectObjClassRec resource lists; see Sections 12.2 and 12.3 for details.

1.4.1.4. CorePart Default Values

The default values for the Core fields, which are filled in by the Intrinsics, from the resource lists, and by the initialize procedures, are

<table>
<thead>
<tr>
<th>Field</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>self</td>
<td>Address of the widget structure (may not be changed).</td>
</tr>
<tr>
<td>widget_class</td>
<td>widget_class argument to XtCreateWidget (may not be changed).</td>
</tr>
<tr>
<td>parent</td>
<td>parent argument to XtCreateWidget (may not be changed).</td>
</tr>
<tr>
<td>being_destroyed</td>
<td>Parent’s being_destroyed value.</td>
</tr>
<tr>
<td>destroy callbacks</td>
<td>NULL</td>
</tr>
<tr>
<td>constraints</td>
<td>NULL</td>
</tr>
<tr>
<td>x</td>
<td>0</td>
</tr>
</tbody>
</table>
y 0
width 0
height 0
border_width 1
managed False
sensitive True
ancestor_sensitive logical AND of parent’s sensitive and ancestor_sensitive values.
accelerators NULL
border_pixel XtDefaultForeground
border_pixmap XtUnspecifiedPixmap
popup_list NULL
num_popups 0
name name argument to XtCreateWidget (may not be changed).
screen Parent’s screen; top-level widget gets screen from display specifier (may not be changed).
colormap Parent’s colormap value.
window NULL
depth Parent’s depth; top-level widget gets root window depth.
background_pixel XtDefaultBackground
background_pixmap XtUnspecifiedPixmap
visible True
mapped_when_managed True

XtUnspecifiedPixmap is a symbolic constant guaranteed to be unequal to any valid Pixmap id, None, and ParentRelative.

1.4.2. Composite Widgets
The Composite widget class is a subclass of the Core widget class (see Chapter 3). Composite widgets are intended to be containers for other widgets. The additional data used by composite widgets are defined by the CompositeClassPart and CompositePart structures.

1.4.2.1. CompositeClassPart Structure
In addition to the Core class fields, widgets of the Composite class have the following class fields.

typedef struct {
    XtGeometryHandler geometry_manager; See Chapter 6
    XtWidgetProc change_managed; See Chapter 3
    XtWidgetProc insert_child; See Chapter 3
    XtWidgetProc delete_child; See Chapter 3
    XtPointer extension; See Section 1.6
} CompositeClassPart;

The extension record defined for CompositeClassPart with record_type equal to NULLQUARK is CompositeClassExtensionRec.
typedef struct {
    XtPointer next_extension;   See Section 1.6.12
    XrmQuark record_type;      See Section 1.6.12
    long version;              See Section 1.6.12
    Cardinal record_size;      See Section 1.6.12
    Boolean accepts_objects;   See Section 2.5.2
    Boolean allows_change_managed_set; See Section 3.4.3
} CompositeClassExtensionRec, *CompositeClassExtension;

Composite classes have the Composite class fields immediately following the Core class fields.

typedef struct {
    CoreClassPart core_class;
    CompositeClassPart composite_class;
} CompositeClassRec, *CompositeWidgetClass;

The single occurrences of the class record and pointer for creating instances of Composite are
In IntrinsicP.h:

extern CompositeClassRec compositeClassRec;

In Intrinsic.h:

extern WidgetClass compositeWidgetClass;

The opaque types CompositeWidget and CompositeWidgetClass and the opaque variable
compositeWidgetClass are defined for generic operations on widgets whose class is Composite
or a subclass of Composite. The symbolic constant for the CompositeClassExtension version
identifier is XtCompositeExtensionVersion (see Section 1.6.12). Intrinsic.h uses an incom-
plete structure definition to ensure that the compiler catches attempts to access private data.

typedef struct _CompositeClassRec *CompositeWidgetClass;

1.4.2.2. CompositePart Structure
In addition to the Core instance fields, widgets of the Composite class have the following instance
fields defined in the CompositePart structure.
typedef struct {
    WidgetList children; See Chapter 3
    Cardinal num_children; See Chapter 3
    Cardinal num_slots; See Chapter 3
    XtOrderProc insert_position; See Section 3.2
} CompositePart;

Composite widgets have the Composite instance fields immediately following the Core instance fields.

typedef struct {
    CorePart core;
    CompositePart composite;
} CompositeRec, *CompositeWidget;

_Intrinsic.h_ uses an incomplete structure definition to ensure that the compiler catches attempts to access private data.

typedef struct _CompositeRec *CompositeWidget;

### 1.4.2.3. Composite Resources

The resource names, classes, and representation types that are specified in the _compositeClassRec_ resource list are:

<table>
<thead>
<tr>
<th>Name</th>
<th>Class</th>
<th>Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>XtNchildren</td>
<td>XtCReadOnly</td>
<td>XtRWidgetList</td>
</tr>
<tr>
<td>XtNinsertPosition</td>
<td>XtCInsertPosition</td>
<td>XtRFunction</td>
</tr>
<tr>
<td>XtNnumChildren</td>
<td>XtCReadOnly</td>
<td>XtRCardinal</td>
</tr>
</tbody>
</table>

### 1.4.2.4. CompositePart Default Values

The default values for the Composite fields, which are filled in from the Composite resource list and by the Composite initialize procedure, are:

<table>
<thead>
<tr>
<th>Field</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>children</td>
<td>NULL</td>
</tr>
<tr>
<td>num_children</td>
<td>0</td>
</tr>
<tr>
<td>num_slots</td>
<td>0</td>
</tr>
<tr>
<td>insert_position</td>
<td>Internal function to insert at end</td>
</tr>
</tbody>
</table>

The _children, num_children, and insert_position_ fields are declared as resources; _XtNinsertPosition_ is a settable resource, _XtNchildren_ and _XtNnumChildren_ may be read by any client but
1.4.3. Constraint Widgets

The Constraint widget class is a subclass of the Composite widget class (see Section 3.6). Constraint widgets maintain additional state data for each child; for example, client-defined constraints on the child’s geometry. The additional data used by constraint widgets are defined by the ConstraintClassPart and ConstraintPart structures.

1.4.3.1. ConstraintClassPart Structure

In addition to the Core and Composite class fields, widgets of the Constraint class have the following class fields.

```c
typedef struct {
    XtResourceList resources; See Chapter 9
    Cardinal num_resources; See Chapter 9
    Cardinal constraint_size; See Section 3.6
    XtInitProc initialize; See Section 3.6
    XtWidgetProc destroy; See Section 3.6
    XtSetValuesFunc set_values; See Section 9.7.2
    XtPointer extension; See Section 1.6
} ConstraintClassPart;
```

The extension record defined for ConstraintClassPart with record_type equal to NULLQUARK is ConstraintClassExtensionRec.

```c
typedef struct {
    XtPointer next_extension; See Section 1.6.12
    XrmQuark record_type; See Section 1.6.12
    long version; See Section 1.6.12
    Cardinal record_size; See Section 1.6.12
    XtArgsProc get_values_hook; See Section 9.7.1
} ConstraintClassExtensionRec, *ConstraintClassExtension;
```

Constraint classes have the Constraint class fields immediately following the Composite class fields.

```c
typedef struct _ConstraintClassRec {
    CoreClassPart core_class;
    CompositeClassPart composite_class;
    ConstraintClassPart constraint_class;
} ConstraintClassRec, *ConstraintWidgetClass;
```

The single occurrences of the class record and pointer for creating instances of Constraint are In IntrinsicP.h:

should only be modified by the composite widget class procedures.
extern ConstraintClassRec constraintClassRec;

In Intrinsic.h:

extern WidgetClass constraintWidgetClass;

The opaque types ConstraintWidget and ConstraintWidgetClass and the opaque variable constraintWidgetClass are defined for generic operations on widgets whose class is Constraint or a subclass of Constraint. The symbolic constant for the ConstraintClassExtension version identifier is XtConstraintExtensionVersion (see Section 1.6.12). Intrinsic.h uses an incomplete structure definition to ensure that the compiler catches attempts to access private data.

typedef struct _ConstraintClassRec *ConstraintWidgetClass;

1.4.3.2. ConstraintPart Structure

In addition to the Core and Composite instance fields, widgets of the Constraint class have the following unused instance fields defined in the ConstraintPart structure:

typedef struct {
    int empty;
} ConstraintPart;

Constraint widgets have the Constraint instance fields immediately following the Composite instance fields.

typedef struct {
    CorePart core;
    CompositePart composite;
    ConstraintPart constraint;
} ConstraintRec, *ConstraintWidget;

Intrinsic.h uses an incomplete structure definition to ensure that the compiler catches attempts to access private data.

typedef struct _ConstraintRec *ConstraintWidget;

1.4.3.3. Constraint Resources

The constraintClassRec core_class and constraint_class resources fields are NULL, and the num_resources fields are zero; no additional resources beyond those declared by the superclasses are defined for Constraint.
1.5. Implementation-Specific Types

To increase the portability of widget and application source code between different system environments, the Intrinsics define several types whose precise representation is explicitly dependent upon, and chosen by, each individual implementation of the Intrinsics.

These implementation-defined types are:

- **Boolean**: A datum that contains a zero or nonzero value. Unless explicitly stated, clients should not assume that the nonzero value is equal to the symbolic value `True`.

- **Cardinal**: An unsigned integer datum with a minimum range of \([0..2^{16}-1]\).

- **Dimension**: An unsigned integer datum with a minimum range of \([0..2^{16}-1]\).

- **Position**: A signed integer datum with a minimum range of \([-2^{15}..2^{15}-1]\).

- **XtPointer**: A datum large enough to contain the largest of a char*, int*, function pointer, structure pointer, or long value. A pointer to any type or function, or a long value may be converted to an `XtPointer` and back again and the result will compare equal to the original value. In ANSI C environments it is expected that `XtPointer` will be defined as `void*`.

- **XtArgVal**: A datum large enough to contain an `XtPointer`, `Cardinal`, `Dimension`, or `Position` value.

- **XtEnum**: An integer datum large enough to encode at least 128 distinct values, two of which are the symbolic values `True` and `False`. The symbolic values `TRUE` and `FALSE` are also defined to be equal to `True` and `False`, respectively.

In addition to these specific types, the precise order of the fields within the structure declarations for any of the instance part records `ObjectPart`, `RectObjPart`, `CorePart`, `CompositePart`, `ShellPart`, `WMShellPart`, `TopLevelShellPart`, and `ApplicationShellPart` is implementation-defined. These structures may also have additional private fields internal to the implementation. The `ObjectPart`, `RectObjPart`, and `CorePart` structures must be defined so that any member with the same name appears at the same offset in `ObjectRec`, `RectObjRec`, and `CoreRec` (`WidgetRec`). No other relations between the offsets of any two fields may be assumed.

1.6. Widget Classing

The `widget_class` field of a widget points to its widget class structure, which contains information that is constant across all widgets of that class. As a consequence, widgets usually do not implement directly callable procedures; rather, they implement procedures, called methods, that are available through their widget class structure. These methods are invoked by generic procedures that envelop common actions around the methods implemented by the widget class. Such procedures are applicable to all widgets of that class and also to widgets whose classes are subclasses of that class.

All widget classes are a subclass of `Core` and can be subclassed further. Subclassing reduces the amount of code and declarations necessary to make a new widget class that is similar to an existing class. For example, you do not have to describe every resource your widget uses in an `XtResourceList`. Instead, you describe only the resources your widget has that its superclass does not. Subclasses usually inherit many of their superclasses’ procedures (for example, the expose procedure or geometry handler).

Subclassing, however, can be taken too far. If you create a subclass that inherits none of the procedures of its superclass, you should consider whether you have chosen the most appropriate superclass.

To make good use of subclassing, widget declarations and naming conventions are highly stylized. A widget consists of three files:

- A public `.h` file, used by client widgets or applications.
• A private .h file, used by widgets whose classes are subclasses of the widget class.
• A .c file, which implements the widget.

1.6.1. Widget Naming Conventions

The Intrinsics provide a vehicle by which programmers can create new widgets and organize a collection of widgets into an application. To ensure that applications need not deal with as many styles of capitalization and spelling as the number of widget classes it uses, the following guidelines should be followed when writing new widgets:

• Use the X library naming conventions that are applicable. For example, a record component name is all lowercase and uses underscores (_) for compound words (for example, background_pixmap). Type and procedure names start with uppercase and use capitalization for compound words (for example, ArgList or XtSetValues).
• A resource name is spelled identically to the field name except that compound names use capitalization rather than underscore. To let the compiler catch spelling errors, each resource name should have a symbolic identifier prefixed with “XtN”. For example, the background_pixmap field has the corresponding identifier XtNbackgroundPixmap, which is defined as the string “backgroundPixmap”. Many predefined names are listed in <X11/StringDefs.h>. Before you invent a new name, you should make sure there is not already a name that you can use.
• A resource class string starts with a capital letter and uses capitalization for compound names (for example, “BorderWidth”). Each resource class string should have a symbolic identifier prefixed with “XtC” (for example, XtCBorderWidth). Many predefined classes are listed in <X11/StringDefs.h>.
• A resource representation string is spelled identically to the type name (for example, “TranslationTable”). Each representation string should have a symbolic identifier prefixed with “XtR” (for example, XtRTranslationTable). Many predefined representation types are listed in <X11/StringDefs.h>.
• New widget classes start with a capital and use uppercase for compound words. Given a new class name AbcXyz, you should derive several names:
  – Additional widget instance structure part name AbcXyzPart.
  – Complete widget instance structure names AbcXyzRec and _AbcXyzRec.
  – Widget instance structure pointer type name AbcXyzWidget.
  – Additional class structure part name AbcXyzClassPart.
  – Complete class structure names AbcXyzClassRec and _AbcXyzClassRec.
  – Class structure pointer type name AbcXyzWidgetClass.
  – Class structure variable abcXyzClassRec.
  – Class structure pointer variable abcXyzWidgetClass.
• Action procedures available to translation specifications should follow the same naming conventions as procedures. That is, they start with a capital letter, and compound names use uppercase (for example, “Highlight” and “NotifyClient”).

The symbolic identifiers XtN..., XtC..., and XtR... may be implemented as macros, as global symbols, or as a mixture of the two. The (implicit) type of the identifier is String. The pointer value itself is not significant; clients must not assume that inequality of two identifiers implies inequality of the resource name, class, or representation string. Clients should also note that although global symbols permit savings in literal storage in some environments, they also introduce the possibility of multiple definition conflicts when applications attempt to use independently developed widgets simultaneously.
1.6.2. Widget Subclassing in Public .h Files

The public .h file for a widget class is imported by clients and contains

- A reference to the public .h file for the superclass.
- Symbolic identifiers for the names and classes of the new resources that this widget adds to its superclass. The definitions should have a single space between the definition name and the value and no trailing space or comment in order to reduce the possibility of compiler warnings from similar declarations in multiple classes.
- Type declarations for any new resource data types defined by the class.
- The class record pointer variable used to create widget instances.
- The C type that corresponds to widget instances of this class.
- Entry points for new class methods.

For example, the following is the public .h file for a possible implementation of a Label widget:

```c
#ifndef LABEL_H
#define LABEL_H

/* New resources */
#define XtNjustify "justify"
#define XtNforeground "foreground"
#define XtNlabel "label"
#define XtNfont "font"
#define XtNinternalWidth "internalWidth"
#define XtNinternalHeight "internalHeight"

/* Class record pointer */
extern WidgetClass labelWidgetClass;

/* C Widget type definition */
typedef struct _LabelRec *LabelWidget;

/* New class method entry points */
extern void LabelSetText();
/* Widget w */
extern String LabelGetText();
/* Widget w */

#undef LABEL_H
#endif
```

The conditional inclusion of the text allows the application to include header files for different widgets without being concerned that they already may be included as a superclass of another widget.

To accommodate operating systems with file name length restrictions, the name of the public .h file is the first ten characters of the widget class. For example, the public .h file for the Constraint widget class is `Constraint.h`.

1.6.3. Widget Subclassing in Private .h Files

The private .h file for a widget is imported by widget classes that are subclasses of the widget and contains
• A reference to the public .h file for the class.
• A reference to the private .h file for the superclass.
• Symbolic identifiers for any new resource representation types defined by the class. The definitions should have a single space between the definition name and the value and no trailing space or comment.
• A structure part definition for the new fields that the widget instance adds to its superclass’s widget structure.
• The complete widget instance structure definition for this widget.
• A structure part definition for the new fields that this widget class adds to its superclass’s constraint structure if the widget class is a subclass of Constraint.
• The complete constraint structure definition if the widget class is a subclass of Constraint.
• Type definitions for any new procedure types used by class methods declared in the widget class part.
• A structure part definition for the new fields that this widget class adds to its superclass’s widget class structure.
• The complete widget class structure definition for this widget.
• The complete widget class extension structure definition for this widget, if any.
• The symbolic constant identifying the class extension version, if any.
• The name of the global class structure variable containing the generic class structure for this class.
• An inherit constant for each new procedure in the widget class part structure.

For example, the following is the private .h file for a possible Label widget:

```c
#ifndef LABELP_H
#define LABELP_H

#include <X11/Label.h>

/* New representation types used by the Label widget */
#define XtRJustify "Justify"

/* New fields for the Label widget record */
typedef struct {
/* Settable resources */
    Pixel foreground;
    XFontStruct *font;
    String label; /* text to display */
    XtJustify justify;
    Dimension internal_width; /* # pixels horizontal border */
    Dimension internal_height; /* # pixels vertical border */

/* Data derived from resources */
    GC normal_GC;
    GC gray_GC;
   Pixmap gray_pixmap;
    Position label_x;
    Position label_y;
    Dimension label_width;
    Dimension label_height;
    Cardinal label_len;
```
/* Full instance record declaration */
typedef struct _LabelRec {
    CorePart core;
    LabelPart label;
} LabelRec;

/* Types for Label class methods */
typedef void (*LabelSetTextProc)();
/* Widget w */
/* String text */
typedef String (*LabelGetTextProc)();
/* Widget w */

/* New fields for the Label widget class record */
typedef struct {
    LabelSetTextProc set_text;
    LabelGetTextProc get_text;
    XtPointer extension;
} LabelClassPart;

/* Full class record declaration */
typedef struct _LabelClassRec {
    CoreClassPart core_class;
    LabelClassPart label_class;
} LabelClassRec;

/* Class record variable */
extern LabelClassRec labelClassRec;

#define LabelInheritSetText((LabelSetTextProc)_XtInherit)
#define LabelInheritGetText((LabelGetTextProc)_XtInherit)
#endif LABELP_H

To accommodate operating systems with file name length restrictions, the name of the private .h file is the first nine characters of the widget class followed by a capital P. For example, the private .h file for the Constraint widget class is ConstrainP.h.

1.6.4. Widget Subclassing in .c Files
The .c file for a widget contains the structure initializer for the class record variable, which contains the following parts:

- Class information (for example, superclass, class_name, widget_size, class_initialize, and class_initied).
- Data constants (for example, resources and num_resources, actions and num_actions, visible_interest, compress_motion, compress_exposure, and version).
- Widget operations (for example, initialize, realize, destroy, resize, expose, set_values, accept_focus, and any new operations specified to the widget).
The superclass field points to the superclass global class record, declared in the superclass private .h file. For direct subclasses of the generic core widget, superclass should be initialized to the address of the widgetClassRec structure. The superclass is used for class chaining operations and for inheriting or enveloping a superclass’s operations (see Sections 1.6.7, 1.6.9, and 1.6.10).

The class_name field contains the text name for this class, which is used by the resource manager. For example, the Label widget has the string “Label”. More than one widget class can share the same text class name. This string must be permanently allocated prior to or during the execution of the class initialization procedure and must not be subsequently deallocated.

The widget_size field is the size of the corresponding widget instance structure (not the size of the class structure).

The version field indicates the toolkit implementation version number and is used for runtime consistency checking of the X Toolkit and widgets in an application. Widget writers must set it to the implementation-defined symbolic value XtVersion in the widget class structure initialization. Those widget writers who believe that their widget binaries are compatible with other implementations of the Intrinsics can put the special value XtVersionDontCheck in the version field to disable version checking for those widgets. If a widget needs to compile alternative code for different revisions of the Intrinsics interface definition, it may use the symbol XtSpecificationRelease, as described in Chapter 13. Use of XtVersion allows the Intrinsics implementation to recognize widget binaries that were compiled with older implementations.

The extension field is for future upward compatibility. If the widget programmer adds fields to class parts, all subclass structure layouts change, requiring complete recompilation. To allow clients to avoid recompilation, an extension field at the end of each class part can point to a record that contains any additional class information required.

All other fields are described in their respective sections.

The .c file also contains the declaration of the global class structure pointer variable used to create instances of the class. The following is an abbreviated version of the .c file for a Label widget.

The resources table is described in Chapter 9.

/* Resources specific to Label */
static XtResource resources[] = {
    {XtNforeground, XtCForeground, XtRPixel, sizeof(Pixel),
     XtOffset(LabelWidget, label.foreground), XtRString,
     XtDefaultForeground},
    {XtNfont, XtCFont, XtRFontStruct, sizeof(XFontStruct *),
     XtOffset(LabelWidget, label.font),XtRString,
     XtDefaultFont},
    {XtNlabel, XtCLabel, XtRString, sizeof(String),
     XtOffset(LabelWidget, label.label), XtRString, NULL},
    .
    .
    .
}

/* Forward declarations of procedures */
static void ClassInitialize();
static void Initialize();
static void Realize();
static void SetText();
static void GetText();

.
/* Class record constant */
LabelClassRec labelClassRec = {
   /* core_class fields */
   /* superclass */ (WidgetClass)&coreClassRec,
   /* class_name */ "Label",
   /* widget_size */ sizeof(LabelRec),
   /* class_initialize */ ClassInitialize,
   /* class_part_initialize */ NULL,
   /* initialized */ False,
   /* initialize */ Initialize,
   /* initialize_hook */ NULL,
   /* realize */ NULL,
   /* actions */ 0,
   /* num_actions */ 0,
   /* resources */ resources,
   /* num_resources */ XtNumber(resources),
   /* xrm_class */ NULLQUARK,
   /* compress_motion */ True,
   /* compress_exposure */ True,
   /* compress_enterleave */ True,
   /* visible_interest */ False,
   /* destroy */ NULL,
   /* resize */ NULL,
   /* expose */ NULL,
   /* set_values */ NULL,
   /* set_values_hook */ NULL,
   /* set_values_almost */ XtInheritSetValuesAlmost,
   /* get_values_hook */ NULL,
   /* accept_focus */ NULL,
   /* version */ NULL,
   /* callback_offsets */ NULL,
   /* tm_table */ NULL,
   /* query_geometry */ NULL,
   /* display_accelerator */ NULL,
   /* extension */ NULL
};

/* Label_class fields */
/* get_text */ GetText,
/* set_text */ SetText,
/* extension */ NULL

/* Class record pointer */
WidgetClass labelWidgetClass = (WidgetClass) &labelClassRec;

/* New method access routines */
void LabelSetText(w, text)
   Widget w;
String text;
{
    Label WidgetClass lwc = (Label WidgetClass)XtClass(w);
    XtCheckSubclass(w, labelWidgetClass, NULL);
    *(lwc->label_class.set_text)(w, text)
}
/* Private procedures */

1.6.5. Widget Class and Superclass Look Up
To obtain the class of a widget, use XtClass.

WidgetClass XtClass(w)
    Widget w;
    w Specifies the widget. Must be of class Object or any subclass thereof.

The XtClass function returns a pointer to the widget’s class structure.

To obtain the superclass of a widget, use XtSuperclass.

WidgetClass XtSuperclass(w)
    Widget w;
    w Specifies the widget. Must be of class Object or any subclass thereof.

The XtSuperclass function returns a pointer to the widget’s superclass class structure.

1.6.6. Widget Subclass Verification
To check the subclass to which a widget belongs, use XtIsSubclass.

Boolean XtIsSubclass(w, widget_class)
    Widget w;
    WidgetClass widget_class;
    w Specifies the widget or object instance whose class is to be checked. Must be of
    class Object or any subclass thereof.
    widget_class Specifies the widget class for which to test. Must be objectClass or any subclass
    thereof.

The XtIsSubclass function returns True if the class of the specified widget is equal to or is a
subclass of the specified class. The widget’s class can be any number of subclasses down the
chain and need not be an immediate subclass of the specified class. Composite widgets that need
to restrict the class of the items they contain can use XtIsSubclass to find out if a widget belongs
to the desired class of objects.
To test if a given widget belongs to a subclass of an Intrinsics-defined class, the Intrinsics define macros or functions equivalent to `XtIsSubclass` for each of the built-in classes. These procedures are `XtIsObject`, `XtIsRectObj`, `XtIsWidget`, `XtIsComposite`, `XtIsConstraint`, `XtIsShell`, `XtIsOverrideShell`, `XtIsWMShell`, `XtIsVendorShell`, `XtIsTransientShell`, `XtIsTopLevelShell`, `XtIsApplicationShell`, and `XtIsSessionShell`.

All these macros and functions have the same argument description.

```c
Boolean XtIs<class>(w)
    Widget w;

    w Specifies the widget or object instance whose class is to be checked. Must be of class Object or any subclass thereof.
```

These procedures may be faster than calling `XtIsSubclass` directly for the built-in classes.

To check a widget’s class and to generate a debugging error message, use `XtCheckSubclass`, defined in `<X11/IntrinsicP.h>`:

```c
void XtCheckSubclass(w, widget_class, message)
    Widget w;
    WidgetClass widget_class;
    String message;

    w Specifies the widget or object whose class is to be checked. Must be of class Object or any subclass thereof.

    widget_class Specifies the widget class for which to test. Must be objectClass or any subclass thereof.

    message Specifies the message to be used.
```

The `XtCheckSubclass` macro determines if the class of the specified widget is equal to or is a subclass of the specified class. The widget’s class can be any number of subclasses down the chain and need not be an immediate subclass of the specified class. If the specified widget’s class is not a subclass, `XtCheckSubclass` constructs an error message from the supplied message, the widget’s actual class, and the expected class and calls `XtErrorMsg`. `XtCheckSubclass` should be used at the entry point of exported routines to ensure that the client has passed in a valid widget class for the exported operation.

`XtCheckSubclass` is only executed when the module has been compiled with the compiler symbol DEBUG defined; otherwise, it is defined as the empty string and generates no code.

### 1.6.7. Superclass Chaining

While most fields in a widget class structure are self-contained, some fields are linked to their corresponding fields in their superclass structures. With a linked field, the Intrinsics access the field’s value only after accessing its corresponding superclass value (called downward superclass chaining) or before accessing its corresponding superclass value (called upward superclass chaining). The self-contained fields are

In all widget classes:

- `class_name`
- `class_initialize`
- `widget_size`
- `realize`
- `visible_interest`
In Composite widget classes:  
- geometry_manager  
- change_managed  
- insert_child  
- delete_child  
- accepts_objects  
- allows_change_managed_set

In Constraint widget classes:  
- constraint_size

In Shell widget classes:  
- root_geometry_manager

With downward superclass chaining, the invocation of an operation first accesses the field from the Object, RectObj, and Core class structures, then from the subclass structure, and so on down the class chain to that widget’s class structure. These superclass-to-subclass field are:

- class_part_initialize  
- get_values_hook  
- initialize  
- initialize_hook  
- set_values  
- set_values_hook  
- resources

In addition, for subclasses of Constraint, the following fields of the ConstraintClassPart and ConstraintClassExtensionRec structures are chained from the Constraint class down to the subclass:

- resources  
- initialize  
- set_values  
- get_values_hook

With upward superclass chaining, the invocation of an operation first accesses the field from the widget class structure, then from the superclass structure, and so on up the class chain to the Core, RectObj, and Object class structures. The subclass-to-superclass field are:

- destroy  
- actions

For subclasses of Constraint, the following field of ConstraintClassPart is chained from the subclass up to the Constraint class:
1.6.8. Class Initialization: class_initialize and class_part_initialize Procedures

Many class records can be initialized completely at compile or link time. In some cases, however, a class may need to register type converters or perform other sorts of once-only runtime initialization.

Because the C language does not have initialization procedures that are invoked automatically when a program starts up, a widget class can declare a class_initialize procedure that will be automatically called exactly once by the Intrinsics. A class initialization procedure pointer is of type XtProc:

```c
typedef void (*XtProc)(void);
```

A widget class indicates that it has no class initialization procedure by specifying NULL in the class_initialize field.

In addition to the class initialization that is done exactly once, some classes perform initialization for fi elds in their parts of the class record. These are performed not just for the particular class, but for subclasses as well, and are done in the class’s class part initialization procedure, a pointer to which is stored in the class_part_initialize field. The class_part_initialize procedure pointer is of type XtWidgetClassProc.

```c
typedef void (*XtWidgetClassProc)(WidgetClass);

WidgetClass widget_class;
```

`widget_class` Points to the class structure for the class being initialized.

During class initialization, the class part initialization procedures for the class and all its superclasses are called in superclass-to-subclass order on the class record. These procedures have the responsibility of doing any dynamic initializations necessary to their class’s part of the record. The most common is the resolution of any inherited methods defined in the class. For example, if a widget class C has superclasses Core, Composite, A, and B, the class record for C first is passed to Core’s class_part_initialize procedure. This resolves any inherited Core methods and compiles the textual representations of the resource list and action table that are defined in the class record. Next, Composite’s class_part_initialize procedure is called to initialize the composite part of C’s class record. Finally, the class_part_initialize procedures for A, B, and C, in that order, are called. For further information, see Section 1.6.9. Classes that do not define any new class fi elds or that need no extra processing for them can specify NULL in the class_part_initialize field.

All widget classes, whether they have a class initialization procedure or not, must start with their class_initied fi eld False.

The first time a widget of a class is created, XtCreateWidget ensures that the widget class and all superclasses are initialized, in superclass-to-subclass order, by checking each class_initied fi eld and, if it is False, by calling the class_initialize and the class_part_initialize procedures for the class and all its superclasses. The Intrinsics then set the class_initied fi eld to a nonzero value. After the one-time initialization, a class structure is constant.

The following example provides the class initialization procedure for a Label class.

```c
static void ClassInitialize()
{
    XtSetTypeConverter(XtRString, XtRJustify, CvtStringToJustify,
        NULL, 0, XtCacheNone, NULL);
}
1.6.9. Initializing a Widget Class

A class is initialized when the first widget of that class or any subclass is created. To initialize a widget class without creating any widgets, use `XtInitializeWidgetClass`.

```c
void XtInitializeWidgetClass(object_class)
    WidgetClass object_class;
```

`object_class` specifies the object class to initialize. May be `objectClass` or any subclass thereof.

If the specified widget class is already initialized, `XtInitializeWidgetClass` returns immediately. If the class initialization procedure registers type converters, these type converters are not available until the first object of the class or subclass is created or `XtInitializeWidgetClass` is called (see Section 9.6).

1.6.10. Inheritance of Superclass Operations

A widget class is free to use any of its superclass’s self-contained operations rather than implementing its own code. The most frequently inherited operations are:

- expose
- realize
- insert_child
- delete_child
- geometry_manager
- set_values_almost

To inherit an operation `xyz`, specify the constant `XtInheritXYZ` in your class record.

Every class that declares a new procedure in its widget class part must provide for inheriting the procedure in its class_part_initialize procedure. The chained operations declared in Core and Constraint records are never inherited. Widget classes that do nothing beyond what their superclass does specify NULL for chained procedures in their class records.

Inheriting works by comparing the value of the field with a known, special value and by copying in the superclass’s value for that field if a match occurs. This special value, called the inheritance constant, is usually the Intrinsics internal value `_XtInherit` cast to the appropriate type. `_XtInherit` is a procedure that issues an error message if it is actually called.

For example, `CompositeP.h` contains these definitions:

```c
#define XtInheritGeometryManager ((XtGeometryHandler) _XtInherit)
#define XtInheritChangeManaged ((XtWidgetProc) _XtInherit)
#define XtInheritInsertChild ((XtArgsProc) _XtInherit)
#define XtInheritDeleteChild ((XtWidgetProc) _XtInherit)
```

Composite’s class_part_initialize procedure begins as follows:

```c
static void CompositeClassPartInitialize(widgetClass)
    WidgetClass widgetClass;
{
    CompositeWidgetClass wc = (CompositeWidgetClass)widgetClass;
```
CompositeWidgetClass super = (CompositeWidgetClass)wc->core_class.superclass;

if (wc->composite_class.geometry_manager == XtInheritGeometryManager) {
    wc->composite_class.geometry_manager = super->composite_class.geometry_manager;
}

if (wc->composite_class.change_managed == XtInheritChangeManaged) {
    wc->composite_class.change_managed = super->composite_class.change_managed;
}
.
.
.

Nonprocedure fields may be inherited in the same manner as procedure fields. The class may declare any reserved value it wishes for the inheritance constant for its new fields. The following inheritance constants are defined:

For Object:
   XtInheritAllocate
   XtInheritDeallocate

For Core:
   XtInheritRealize
   XtInheritResize
   XtInheritExpose
   XtInheritSetValuesAlmost
   XtInheritAcceptFocus
   XtInheritQueryGeometry
   XtInheritTranslations
   XtInheritDisplayAccelerator

For Composite:
   XtInheritGeometryManager
   XtInheritChangeManaged
   XtInheritInsertChild
   XtInheritDeleteChild

For Shell:
   XtInheritRootGeometryManager

1.6.11. Invocation of Superclass Operations

A widget sometimes needs to call a superclass operation that is not chained. For example, a widget’s expose procedure might call its superclass’s expose and then perform a little more work on its own. For example, a Composite class with predefined managed children can implement insert_child by first calling its superclass’s insert_child and then calling XtManageChild to add the child to the managed set.
Note

A class method should not use XSuperclass but should instead call the class method of its own specific superclass directly through the superclass record. That is, it should use its own class pointers only, not the widget’s class pointers, as the widget’s class may be a subclass of the class whose implementation is being referenced.

This technique is referred to as enveloping the superclass’s operation.

1.6.12. Class Extension Records

It may be necessary at times to add new fields to already existing widget class structures. To permit this to be done without requiring recompilation of all subclasses, the last field in a class part structure should be an extension pointer. If no extension field exists for a class have yet been defined, subclasses should initialize the value of the extension pointer to NULL.

If extension fields exist, as is the case with the Composite, Constraint, and Shell classes, subclasses can provide values for these fields by setting the extension pointer for the appropriate part in their class structure to point to a statically declared extension record containing the additional fields. Setting the extension field is never mandatory; code that uses fields in the extension record must always check the extension field and take some appropriate default action if it is NULL.

In order to permit multiple subclasses and libraries to chain extension records from a single extension field, extension records should be declared as a linked list, and each extension record definition should contain the following four fields at the beginning of the structure declaration:

```c
struct {
    XtPointer next_extension;
    XrmQuark record_type;
    long version;
    Cardinal record_size;
};
```

- `next_extension` specifies the next record in the list, or NULL.
- `record_type` specifies the particular structure declaration to which each extension record instance conforms.
- `version` specifies a version id symbolic constant supplied by the definer of the structure.
- `record_size` specifies the total number of bytes allocated for the extension record.

The `record_type` field identifies the contents of the extension record and is used by the definer of the record to locate its particular extension record in the list. The `record_type` field is normally assigned the result of XrmStringToQuark for a registered string constant. The Intrinsics reserve all record type strings beginning with the two characters “XT” for future standard uses. The value NULLQUARK may also be used by the class part owner in extension records attached to its own class part extension field to identify the extension record unique to that particular class.

The `version` field is an owner-defined constant that may be used to identify binary files that have been compiled with alternate definitions of the remainder of the extension record data structure. The private header file for a widget class should provide a symbolic constant for subclasses to use to initialize this field. The `record_size` field value includes the four common header fields and should normally be initialized with sizeof().

Any value stored in the class part extension field of CompositeClassPart, ConstraintClassPart, or ShellClassPart must point to an extension record conforming to this definition.
The Intrinsics provide a utility function for widget writers to locate a particular class extension record in a linked list, given a widget class and the offset of the extension field in the class record. To locate a class extension record, use **XtGetClassExtension**.

```c
XtPointer XtGetClassExtension(object_class, byte_offset, type, version, record_size)
    WidgetClass object_class;
    Cardinal byte_offset;
    XrmQuark type;
    long version;
    Cardinal record_size;
```

- `object_class` specifies the object class containing the extension list to be searched.
- `byte_offset` specifies the offset in bytes from the base of the class record of the extension field to be searched.
- `type` specifies the record_type of the class extension to be located.
- `version` specifies the minimum acceptable version of the class extension required for a match.
- `record_size` specifies the minimum acceptable length of the class extension record required for a match, or 0.

The list of extension records at the specified offset in the specified object class will be searched for a match on the specified type, a version greater than or equal to the specified version, and a record size greater than or equal the specified record_size if it is nonzero. **XtGetClassExtension** returns a pointer to a matching extension record or NULL if no match is found. The returned extension record must not be modified or freed by the caller if the caller is not the extension owner.
Chapter 2

Widget Instantiation

A hierarchy of widget instances constitutes a widget tree. The shell widget returned by \texttt{XtAppCreateShell} is the root of the widget tree instance. The widgets with one or more children are the intermediate nodes of that tree, and the widgets with no children of any kind are the leaves of the widget tree. With the exception of pop-up children (see Chapter 5), this widget tree instance defines the associated X Window tree.

Widgets can be either composite or primitive. Both kinds of widgets can contain children, but the Intrinsics provide a set of management mechanisms for constructing and interfacing between composite widgets, their children, and other clients.

Composite widgets, that is, members of the class \texttt{compositeWidgetClass}, are containers for an arbitrary, but widget implementation-defined, collection of children, which may be instantiated by the composite widget itself, by other clients, or by a combination of the two. Composite widgets also contain methods for managing the geometry (layout) of any child widget. Under unusual circumstances, a composite widget may have zero children, but it usually has at least one. By contrast, primitive widgets that contain children typically instantiate specific children of known classes themselves and do not expect external clients to do so. Primitive widgets also do not have general geometry management methods.

In addition, the Intrinsics recursively perform many operations (for example, realization and destruction) on composite widgets and all their children. Primitive widgets that have children must be prepared to perform the recursive operations themselves on behalf of their children.

A widget tree is manipulated by several Intrinsics functions. For example, \texttt{XtRealizeWidget} traverses the tree downward and recursively realizes all pop-up widgets and children of composite widgets. \texttt{XtDestroyWidget} traverses the tree downward and destroys all pop-up widgets and children of composite widgets. The functions that fetch and modify resources traverse the tree upward and determine the inheritance of resources from a widget’s ancestors. \texttt{XtMakeGeometryRequest} traverses the tree up one level and calls the geometry manager that is responsible for a widget child’s geometry.

To facilitate upward traversal of the widget tree, each widget has a pointer to its parent widget. The Shell widget that \texttt{XtAppCreateShell} returns has a \texttt{parent} pointer of NULL.

To facilitate downward traversal of the widget tree, the \texttt{children} field of each composite widget is a pointer to an array of child widgets, which includes all normal children created, not just the subset of children that are managed by the composite widget’s geometry manager. Primitive widgets that instantiate children are entirely responsible for all operations that require downward traversal below themselves. In addition, every widget has a pointer to an array of pop-up children.

2.1. Initializing the X Toolkit

Before an application can call any Intrinsics function other than \texttt{XtSetLanguageProc} and \texttt{XtToolkitThreadInitialize}, it must initialize the Intrinsics by using

- \texttt{XtToolkitInitialize}, which initializes the Intrinsics internals
- \texttt{XtCreateApplicationContext}, which initializes the per-application state
- \texttt{XtDisplayInitialize} or \texttt{XtOpenDisplay}, which initializes the per-display state
- \texttt{XtAppCreateShell}, which creates the root of a widget tree

Or an application can call the convenience procedure \texttt{XtOpenApplication}, which combines the functions of the preceding procedures. An application wishing to use the ANSI C locale
mechanism should call \texttt{XtSetLanguageProc} prior to calling \texttt{XtDisplayInitialize}, \texttt{XtOpenDisplay}, \texttt{XtOpenApplication}, or \texttt{XtAppInitialize}.

Multiple instances of X Toolkit applications may be implemented in a single address space. Each instance needs to be able to read input and dispatch events independently of any other instance. Further, an application instance may need multiple display connections to have widgets on multiple displays. From the application’s point of view, multiple display connections usually are treated together as a single unit for purposes of event dispatching. To accommodate both requirements, the Intrinsics define application contexts, each of which provides the information needed to distinguish one application instance from another. The major component of an application context is a list of one or more \texttt{X Display} pointers for that application. The Intrinsics handle all display connections within a single application context simultaneously, handling input in a round-robin fashion. The application context type \texttt{XtAppContext} is opaque to clients.

To initialize the Intrinsics internals, use \texttt{XtToolkitInitialize}.

\begin{verbatim}
void XtToolkitInitialize()

If \texttt{XtToolkitInitialize} was previously called, it returns immediately. When \texttt{XtToolkitThreadInitialize} is called before \texttt{XtToolkitInitialize}, the latter is protected against simultaneous activation by multiple threads.

To create an application context, use \texttt{XtCreateApplicationContext}.

\begin{verbatim}
XtAppContext XtCreateApplicationContext()

The \texttt{XtCreateApplicationContext} function returns an application context, which is an opaque type. Every application must have at least one application context.

To destroy an application context and close any remaining display connections in it, use \texttt{XtDestroyApplicationContext}.

\begin{verbatim}
void XtDestroyApplicationContext(app_context)
    XtAppContext app_context;

app_context Specifies the application context.

The \texttt{XtDestroyApplicationContext} function destroys the specified application context. If called from within an event dispatch (for example, in a callback procedure), \texttt{XtDestroyApplicationContext} does not destroy the application context until the dispatch is complete.

To get the application context in which a given widget was created, use \texttt{XtWidgetToApplicationContext}.

\begin{verbatim}
XtAppContext XtWidgetToApplicationContext(w)
    Widget w;

w Specifies the widget for which you want the application context. Must be of class \texttt{Object} or any subclass thereof.

The \texttt{XtWidgetToApplicationContext} function returns the application context for the specified
To initialize a display and add it to an application context, use **XtDisplayInitialize**.

```c
void XtDisplayInitialize(
    app_context, display, application_name, application_class,
    options, num_options, argc, argv)
```

- **app_context** specifies the application context.
- **display** specifies a previously opened display connection. Note that a single display connection can be in at most one application context.
- **application_name** specifies the name of the application instance.
- **application_class** specifies the class name of this application, which is usually the generic name for all instances of this application.
- **options** specifies how to parse the command line for any application-specific resources. The **options** argument is passed as a parameter to **XrmParseCommand**. For further information, see Section 15.9 in **Xlib — C Language X Interface** and Section 2.4 of this specification.
- **num_options** specifies the number of entries in the options list.
- **argc** specifies a pointer to the number of command line parameters.
- **argv** specifies the list of command line parameters.

The **XtDisplayInitialize** function retrieves the language string to be used for the specified display (see Section 11.11), calls the language procedure (if set) with that language string, builds the resource database for the default screen, calls the Xlib **XrmParseCommand** function to parse the command line, and performs other per-display initialization. After **XrmParseCommand** has been called, **argc** and **argv** contain only those parameters that were not in the standard option table or in the table specified by the **options** argument. If the modified **argc** is not zero, most applications simply print out the modified **argv** along with a message listing the allowable options. On POSIX-based systems, the application name is usually the final component of **argv[0]**. If the synchronous resource is **True**, **XtDisplayInitialize** calls the Xlib **XSynchronize** function to put Xlib into synchronous mode for this display connection and any others currently open in the application context. See Sections 2.3 and 2.4 for details on the **application_name**, **application_class**, **options**, and **num_options** arguments.

**XtDisplayInitialize** calls **XrmSetDatabase** to associate the resource database of the default screen with the display before returning.
To open a display, initialize it, and then add it to an application context, use **XtOpenDisplay**.

```c
Display *XtOpenDisplay(
    app_context,
    display_string,
    application_name,
    application_class,
    options, num_options, argc, argv)
```

- `app_context` Specifies the application context.
- `display_string` Specifies the display string, or NULL.
- `application_name` Specifies the name of the application instance, or NULL.
- `application_class` Specifies the class name of this application, which is usually the generic name for all instances of this application.
- `options` Specifies how to parse the command line for any application-specific resources. The options argument is passed as a parameter to **XrmParseCommand**.
- `num_options` Specifies the number of entries in the options list.
- `argc` Specifies a pointer to the number of command line parameters.
- `argv` Specifies the list of command line parameters.

The **XtOpenDisplay** function calls **XOpenDisplay** with the specified `display_string`. If `display_string` is NULL, **XtOpenDisplay** uses the current value of the −display option specified in `argv`. If no display is specified in `argv`, the user’s default display is retrieved from the environment. On POSIX-based systems, this is the value of the DISPLAY environment variable.

If this succeeds, **XtOpenDisplay** then calls **XtDisplayInitialize** and passes it the opened display and the value of the −name option specified in `argv` as the application name. If no −name option is specified and `application_name` is non-NULL, `application_name` is passed to **XtDisplayInitialize**. If `application_name` is NULL and if the environment variable RESOURCE_NAME is set, the value of RESOURCE_NAME is used. Otherwise, the application name is the name used to invoke the program. On implementations that conform to ANSI C Hosted Environment support, the application name will be `argv[0]` less any directory and file type components, that is, the final component of `argv[0]`, if specified. If `argv[0]` does not exist or is the empty string, the application name is “main”. **XtOpenDisplay** returns the newly opened display or NULL if it failed.

See Section 7.12 for information regarding the use of **XtOpenDisplay** in multiple threads.

To close a display and remove it from an application context, use **XtCloseDisplay**.

```c
void XtCloseDisplay(display)
    Display *display;
```

The **XtCloseDisplay** function calls **XCloseDisplay** with the specified `display` as soon as it is safe to do so. If called from within an event dispatch (for example, a callback procedure), **XtCloseDisplay** does not close the display until the dispatch is complete. Note that applications
need only call `XtCloseDisplay` if they are to continue executing after closing the display; otherwise, they should call `XtDestroyApplicationContext`.

See Section 7.12 for information regarding the use of `XtCloseDisplay` in multiple threads.

2.2. Establishing the Locale

Resource databases are specified to be created in the current process locale. During display initialization prior to creating the per-screen resource database, the Intrinsics will call out to a specified application procedure to set the locale according to options found on the command line or in the per-display resource specifications.

The callout procedure provided by the application is of type `XtLanguageProc`.

```c
typedef String (*XtLanguageProc)(Display*, String, XtPointer);
Display *display;
String language;
XtPointer client_data;
```

- `display` passes the display.
- `language` passes the initial language value obtained from the command line or server per-display resource specifications.
- `client_data` passes the additional client data specified in the call to `XtSetLanguageProc`.

The language procedure allows an application to set the locale to the value of the language resource determined by `XtDisplayInitialize`. The function returns a new language string that will be subsequently used by `XtDisplayInitialize` to establish the path for loading resource files. The returned string will be copied by the Intrinsics into new memory.

Initially, no language procedure is set by the Intrinsics. To set the language procedure for use by `XtDisplayInitialize`, use `XtSetLanguageProc`.

```c
XtLanguageProc XtSetLanguageProc(app_context, proc, client_data)
    XtAppContext app_context;
    XtLanguageProc proc;
    XtPointer client_data;
```

- `app_context` specifies the application context in which the language procedure is to be used, or NULL.
- `proc` specifies the language procedure.
- `client_data` specifies additional client data to be passed to the language procedure when it is called.

`XtSetLanguageProc` sets the language procedure that will be called from `XtDisplayInitialize` for all subsequent Displays initialized in the specified application context. If `app_context` is NULL, the specified language procedure is registered in all application contexts created by the calling process, including any future application contexts that may be created. If `proc` is NULL, a default language procedure is registered. `XtSetLanguageProc` returns the previously registered language procedure. If a language procedure has not yet been registered, the return value is unspecified, but if this return value is used in a subsequent call to `XtSetLanguageProc`, it will cause the default language procedure to be registered.

The default language procedure does the following:
• Sets the locale according to the environment. On ANSI C-based systems this is done by calling `setlocale(LC_ALL, language)`. If an error is encountered, a warning message is issued with `XtWarning`.

• Calls `XSupportsLocale` to verify that the current locale is supported. If the locale is not supported, a warning message is issued with `XtWarning` and the locale is set to “C”.

• Calls `XSetLocaleModifiers` specifying the empty string.

• Returns the value of the current locale. On ANSI C-based systems this is the return value from a final call to `setlocale(LC_ALL, NULL)`.

A client wishing to use this mechanism to establish locale can do so by calling `XtSetLanguageProc` prior to `XtDisplayInitialize`, as in the following example.

```c
Widget top;
XtSetLanguageProc(NULL, NULL, NULL);
top = XtOpenApplication(...);
...
```

### 2.3. Loading the Resource Database

The `XtDisplayInitialize` function first determines the language string to be used for the specified display. It then creates a resource database for the default screen of the display by combining the following sources in order, with the entries in the first named source having highest precedence:

• Application command line (`argc, argv`).
• Per-host user environment resource file on the local host.
• Per-screen resource specifications from the server.
• Per-display resource specifications from the server or from the user preference file on the local host.
• Application-specific user resource file on the local host.
• Application-specific class resource file on the local host.

When the resource database for a particular screen on the display is needed (either internally, or when `XtScreenDatabase` is called), it is created in the following manner using the sources listed above in the same order:

• A temporary database, the “server resource database”, is created from the string returned by `XResourceManagerString` or, if `XResourceManagerString` returns NULL, the contents of a resource file in the user’s home directory. On POSIX-based systems, the usual name for this user preference file is `$HOME/.Xdefaults`.

• If a language procedure has been set, `XtDisplayInitialize` first searches the command line for the option “-xnlLanguage”, or for a -xrm option that specifies the xnlLanguage/Xnl-Language resource, as specified by Section 2.4. If such a resource is found, the value is assumed to be entirely in XPCS, the X Portable Character Set. If neither option is specified on the command line, `XtDisplayInitialize` queries the server resource database (which is assumed to be entirely in XPCS) for the resource name.xnlLanguage, class Class.XnlLanguage where name and Class are the application_name and application_class specified to `XtDisplayInitialize`. The language procedure is then invoked with the resource value if found, else the empty string. The string returned from the language procedure is saved for all future references in the Intrinsics that require the per-display language string.
• The screen resource database is initialized by parsing the command line in the manner specified by Section 2.4.

• If a language procedure has not been set, the initial database is then queried for the resource name.xnllanguage, class Class.Xnllanguage as specified above. If this database query fails, the server resource database is queried; if this query also fails, the language is determined from the environment; on POSIX-based systems, this is done by retrieving the value of the LANG environment variable. If no language string is found, the empty string is used. This language string is saved for all future references in the Intrinsics that require the per-display language string.

• After determining the language string, the user’s environment resource file is then merged into the initial resource database if the file exists. This file is user-, host-, and process-specific and is expected to contain user preferences that are to override those specifications in the per-display and per-screen resources. On POSIX-based systems, the user’s environment resource file name is specified by the value of the XENVIRONMENT environment variable. If this environment variable does not exist, the user’s home directory is searched for a file named .Xdefaults-host, where host is the host name of the machine on which the application is running.

• The per-screen resource specifications are then merged into the screen resource database, if they exist. These specifications are the string returned by XScreenResourceString for the respective screen and are owned entirely by the user.

• Next, the server resource database created earlier is merged into the screen resource database. The server property, and corresponding user preference file, are owned and constructed entirely by the user.

• The application-specific user resource file from the local host is then merged into the screen resource database. This file contains user customizations and is stored in a directory owned by the user. Either the user or the application or both can store resource specific in the file. Each should be prepared to find and respect entries made by the other. The file name is found by calling XrmSetDatabase with the current screen resource database, after preserving the original display-associated database, then calling XtResolvePathname with the parameters (display, NULL, NULL, NULL, path, NULL, 0, NULL), where path is defined in an operating-system-specific way. On POSIX-based systems, path is defined to be the value of the environment variable XUSERFILESEARCHPATH if this is defined. If XUSERFILESEARCHPATH is not defined, an implementation-dependent default value is used. This default value is constrained in the following manner:

  − If the environment variable XAPPLRESDIR is not defined, the default XUSERFILESEARCHPATH must contain at least six entries. These entries must contain $HOME as the directory prefix, plus the following substitutions:

    1. %C, %N, %L or %C, %N, %l, %t, %c
    2. %C, %N, %l
    3. %C, %N
    4. %N, %L or %N, %l, %t, %c
    5. %N, %l
    6. %N

    The order of these six entries within the path must be as given above. The order and use of substitutions within a given entry are implementation-dependent.
If XAPPLRESDIR is defined, the default XUSERFILESEARCHPATH must contain at least seven entries. These entries must contain the following directory prefixes and substitutions:

1. $XAPPLRESDIR with %C, %N, %L or %C, %N, %l, %t, %c
2. $XAPPLRESDIR with %C, %N, %l
3. $XAPPLRESDIR with %C, %N
4. $XAPPLRESDIR with %N, %L or %N, %l, %t, %c
5. $XAPPLRESDIR with %N, %l
6. $XAPPLRESDIR with %N
7. $HOME with %N

The order of these seven entries within the path must be as given above. The order and use of substitutions within a given entry are implementation-dependent.

Last, the application-specific class resource file from the local host is merged into the screen resource database. This file is owned by the application and is usually installed in a system directory when the application is installed. It may contain sitewide customizations specified by the system manager. The name of the application class resource file is found by calling XtResolvePathname with the parameters (display, “app-defaults”, NULL, NULL, NULL, NULL, 0, NULL). This file is expected to be provided by the developer of the application and may be required for the application to function properly. A simple application that wants to be assured of having a minimal set of resources in the absence of its class resource file can declare fallback resource specifications with XtAppSetFallbackResources. Note that the customization substitution string is retrieved dynamically by XtResolvePathname so that the resolved file name of the application class resource file can be affected by any of the earlier sources for the screen resource database, even though the contents of the class resource file have lowest precedence. After calling XtResolvePathname, the original display-associated database is restored.

To obtain the resource database for a particular screen, use XtScreenDatabase.

```
XrmDatabase XtScreenDatabase(screen)
    Screen *screen;
    screen Specifies the screen whose resource database is to be returned.
```

The XtScreenDatabase function returns the fully merged resource database as specified above, associated with the specified screen. If the specified screen does not belong to a Display initialized by XtDisplayInitialize, the results are undefined.

To obtain the default resource database associated with a particular display, use XtDatabase.

```
XrmDatabase XtDatabase(display)
    Display *display;
    display Specifies the display.
```

The XtDatabase function is equivalent to XrmGetDatabase. It returns the database associated with the specified display, or NULL if a database has not been set.
To specify a default set of resource values that will be used to initialize the resource database if no application-specific class resource file is found (the last of the six sources listed above), use `XtAppSetFallbackResources`.

```c
void XtAppSetFallbackResources(app_context, specification_list)
    XtAppContext app_context;
    String *specification_list;

    app_context Specifie the application context in which the fallback specifications will be used.

    specification_list Specifie a NULL-terminated list of resource specifications to preload the database, or NULL.
```

Each entry in `specification_list` points to a string in the format of `XrmPutLineResource`. Following a call to `XtAppSetFallbackResources`, when a resource database is being created for a particular screen and the Intrinsics are not able to find or read an application-specific class resource file according to the rules given above and if `specification_list` is not NULL, the resource specifications in `specification_list` will be merged into the screen resource database in place of the application-specific class resource file. `XtAppSetFallbackResources` is not required to copy `specification_list`; the caller must ensure that the contents of the list and of the strings addressed by the list remain valid until all displays are initialized or until `XtAppSetFallbackResources` is called again. The value NULL for `specification_list` removes any previous fallback resource specification for the application context. The intended use for fallback resources is to provide a minimal number of resources that will make the application usable (or at least terminate with helpful diagnostic messages) when some problem exists in finding and loading the application defaults file.

### 2.4. Parsing the Command Line

The `XtOpenDisplay` function first parses the command line for the following options:

- `-display` Specifies the display name for `XOpenDisplay`.
- `-name` Sets the resource name prefix, which overrides the application name passed to `XtOpenDisplay`.
- `-xnllanguage` Specifies the initial language string for establishing locale and for finding application class resource files.

`XtDisplayInitialize` has a table of standard command line options that are passed to `XrmParseCommand` for adding resources to the resource database, and it takes as a parameter additional application-specific resource abbreviations. The format of this table is described in Section 15.9 in *Xlib — C Language X Interface*. 
typedef enum {
    XrmoptionNoArg, /* Value is specified in OptionDescRec.value */
    XrmoptionIsArg, /* Value is the option string itself */
    XrmoptionStickyArg, /* Value is characters immediately following option */
    XrmoptionSepArg, /* Value is next argument in argv */
    XrmoptionResArg, /* Use the next argument as input to XrmPutLineResource*/
    XrmoptionSkipArg, /* Ignore this option and the next argument in argv */
    XrmoptionSkipNArgs, /* Ignore this option and the next */
    /* OptionDescRec.value arguments in argv */
    XrmoptionSkipLine /* Ignore this option and the rest of argv */
} XrmOptionKind;

typedef struct {
    char *option; /* Option name in argv */
    char *specifier; /* Resource name (without application name) */
    XrmOptionKind argKind; /* Location of the resource value */
    XPointer value; /* Value to provide if XrmoptionNoArg */
} XrmOptionDescRec, *XrmOptionDescList;

The standard table contains the following entries:

<table>
<thead>
<tr>
<th>Option String</th>
<th>Resource Name</th>
<th>Argument Kind</th>
<th>Resource Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-background</td>
<td>*background</td>
<td>SepArg</td>
<td>next argument</td>
</tr>
<tr>
<td>-bd</td>
<td>*borderColor</td>
<td>SepArg</td>
<td>next argument</td>
</tr>
<tr>
<td>-bg</td>
<td>*background</td>
<td>SepArg</td>
<td>next argument</td>
</tr>
<tr>
<td>-borderwidth</td>
<td>.borderWidth</td>
<td>SepArg</td>
<td>next argument</td>
</tr>
<tr>
<td>-bordercolor</td>
<td>*borderColor</td>
<td>SepArg</td>
<td>next argument</td>
</tr>
<tr>
<td>-bw</td>
<td>.borderWidth</td>
<td>SepArg</td>
<td>next argument</td>
</tr>
<tr>
<td>-display</td>
<td>.display</td>
<td>SepArg</td>
<td>next argument</td>
</tr>
<tr>
<td>-fg</td>
<td>*foreground</td>
<td>SepArg</td>
<td>next argument</td>
</tr>
<tr>
<td>-fn</td>
<td>*font</td>
<td>SepArg</td>
<td>next argument</td>
</tr>
<tr>
<td>-font</td>
<td>*font</td>
<td>SepArg</td>
<td>next argument</td>
</tr>
<tr>
<td>-foreground</td>
<td>*foreground</td>
<td>SepArg</td>
<td>next argument</td>
</tr>
<tr>
<td>-geometry</td>
<td>.geometry</td>
<td>SepArg</td>
<td>next argument</td>
</tr>
<tr>
<td>-iconic</td>
<td>.iconic</td>
<td>NoArg</td>
<td>“true”</td>
</tr>
<tr>
<td>-name</td>
<td>.name</td>
<td>SepArg</td>
<td>next argument</td>
</tr>
<tr>
<td>-reverse</td>
<td>.reverseVideo</td>
<td>NoArg</td>
<td>“on”</td>
</tr>
<tr>
<td>-rv</td>
<td>.reverseVideo</td>
<td>NoArg</td>
<td>“on”</td>
</tr>
<tr>
<td>+rv</td>
<td>.reverseVideo</td>
<td>NoArg</td>
<td>“off”</td>
</tr>
<tr>
<td>-selectionTimeout</td>
<td>.selectionTimeout</td>
<td>SepArg</td>
<td>next argument</td>
</tr>
<tr>
<td>-synchronous</td>
<td>.synchronous</td>
<td>NoArg</td>
<td>“on”</td>
</tr>
<tr>
<td>+synchronous</td>
<td>.synchronous</td>
<td>NoArg</td>
<td>“off”</td>
</tr>
<tr>
<td>-title</td>
<td>.title</td>
<td>SepArg</td>
<td>next argument</td>
</tr>
<tr>
<td>-xnlLanguage</td>
<td>.xnlLanguage</td>
<td>SepArg</td>
<td>next argument</td>
</tr>
<tr>
<td>-xrm</td>
<td>next argument</td>
<td>ResArg</td>
<td>next argument</td>
</tr>
<tr>
<td>-xtsessionID</td>
<td>.sessionID</td>
<td>SepArg</td>
<td>next argument</td>
</tr>
</tbody>
</table>

Note that any unique abbreviation for an option name in the standard table or in the application table is accepted.
If reverseVideo is True, the values of XtDefaultForeground and XtDefaultBackground are exchanged for all screens on the Display.

The value of the synchronous resource specifies whether or not Xlib is put into synchronous mode. If a value is found in the resource database during display initialization, XtDisplayInitialize makes a call to XSync for all display connections currently open in the application context. Therefore, when multiple displays are initialized in the same application context, the most recent value specified for the synchronous resource is used for all displays in the application context.

The value of the selectionTimeout resource applies to all displays opened in the same application context. When multiple displays are initialized in the same application context, the most recent value specified is used for all displays in the application context.

The −xrm option provides a method of setting any resource in an application. The next argument should be a quoted string identical in format to a line in the user resource file. For example, to give a red background to all command buttons in an application named xmh, you can start it up as

    xmh −xrm 'xmh*Command.background: red'

When it parses the command line, XtDisplayInitialize merges the application option table with the standard option table before calling the Xlib XrmParseCommand function. An entry in the application table with the same name as an entry in the standard table overrides the standard table entry. If an option name is a prefix of another option name, both names are kept in the merged table. The Intrinsics reserve all option names beginning with the characters “−xt” for future standard uses.

2.5. Creating Widgets

The creation of widget instances is a three-phase process:

1. The widgets are allocated and initialized with resources and are optionally added to the managed subset of their parent.
2. All composite widgets are notified of their managed children in a bottom-up traversal of the widget tree.
3. The widgets create X windows, which then are mapped.

To start the first phase, the application calls XtCreateWidget for all its widgets and adds some (usually, most or all) of its widgets to their respective parents’ managed set by calling XtManageChild. To avoid an \( O(n^2) \) creation process where each composite widget lays itself out each time a widget is created and managed, parent widgets are not notified of changes in their managed set during this phase.

After all widgets have been created, the application calls XtRealizeWidget with the top-level widget to execute the second and third phases. XtRealizeWidget first recursively traverses the widget tree in a postorder (bottom-up) traversal and then notifies each composite widget with one or more managed children by means of its change_managed procedure.

Notifying a parent about its managed set involves geometry layout and possibly geometry negotiation. A parent deals with constraints on its size imposed from above (for example, when a user specifies the application window size) and suggestions made from below (for example, when a primitive child computes its preferred size). One difference between the two can cause geometry changes to ripple in both directions through the widget tree. The parent may force some of its children to change size and position and may issue geometry requests to its own parent in order to better accommodate all its children. You cannot predict where anything will go on the screen until this process finishes.
Consequently, in the first and second phases, no X windows are actually created, because it is likely that they will get moved around after creation. This avoids unnecessary requests to the X server.

Finally, `XtRealizeWidget` starts the third phase by making a preorder (top-down) traversal of the widget tree, allocates an X window to each widget by means of its realize procedure, and finally maps the widgets that are managed.

### 2.5.1. Creating and Merging Argument Lists

Many Intrinsics functions may be passed pairs of resource names and values. These are passed as an arglist, a pointer to an array of `Arg` structures, which contains

```c
typedef struct {
    String name;
    XtArgVal value;
} Arg, *ArgList;
```

where `XtArgVal` is as defined in Section 1.5.

If the size of the resource is less than or equal to the size of an `XtArgVal`, the resource value is stored directly in `value`; otherwise, a pointer to it is stored in `value`.

To set values in an `ArgList`, use `XtSetArg`:

```c
void XtSetArg(arg, name, value)
    Arg arg;
    String name;
    XtArgVal value;

    arg    Specifies the name/value pair to set.
    name   Specifies the name of the resource.
    value  Specifies the value of the resource if it will fit in an `XtArgVal`, else the address.
```

The `XtSetArg` function is usually used in a highly stylized manner to minimize the probability of making a mistake; for example:

```c
Arg args[20];
int n;

n = 0;
XtSetArg(args[n], XtNheight, 100); n++;
XtSetArg(args[n], XtNwidth, 200); n++;
XtSetValues(widget, args, n);
```

Alternatively, an application can statically declare the argument list and use `XtNumber`:

```c
static Args args[] = {
    {XtNheight, (XtArgVal) 100},
    {XtNwidth, (XtArgVal) 200},
};
XtSetValues(Widget, args, XtNumber(args));
```
Note that you should not use expressions with side effects such as auto-increment or auto-decrement within the first argument to XtSetArg. XtSetArg can be implemented as a macro that evaluates the first argument twice.

To merge two arglist arrays, use XtMergeArgLists.

ArgList XtMergeArgLists(args1, num_args1, args2, num_args2)
  ArgList args1;
  Cardinal num_args1;
  ArgList args2;
  Cardinal num_args2;
  args1 Specifies the first argument list.
  num_args1 Specifies the number of entries in the first argument list.
  args2 Specifies the second argument list.
  num_args2 Specifies the number of entries in the second argument list.

The XtMergeArgLists function allocates enough storage to hold the combined arglist arrays and copies them into it. Note that it does not check for duplicate entries. The length of the returned list is the sum of the lengths of the specified lists. When it is no longer needed, free the returned storage by using XtFree.

All Intrinsics interfaces that require ArgList arguments have analogs conforming to the ANSI C variable argument list (traditionally called “varargs”) calling convention. The name of the analog is formed by prefixing “Va” to the name of the corresponding ArgList procedure; e.g., XtVaCreateWidget. Each procedure named XtVasomething takes as its last arguments, in place of the corresponding ArgList/Cardinal parameters, a variable parameter list of resource name and value pairs where each name is of type String and each value is of type XtArgVal. The end of the list is identified by a name entry containing NULL. Developers writing in the C language wishing to pass resource name and value pairs to any of these interfaces may use the ArgList and varargs forms interchangeably.

Two special names are defined for use only in varargs lists: XtVaTypedArg and XtVaNestedList.

#define XtVaTypedArg "XtVaTypedArg"

If the name XtVaTypedArg is specified in place of a resource name, then the following four arguments are interpreted as a name/type/value/size tuple where name is of type String, type is of type String, value is of type XtArgVal, and size is of type int. When a varargs list containing XtVaTypedArg is processed, a resource type conversion (see Section 9.6) is performed if necessary to convert the value into the format required by the associated resource. If type is XtRString, then value contains a pointer to the string and size contains the number of bytes allocated, including the trailing null byte. If type is not XtRString, then if size is less than or equal to sizeof(XtArgVal), the value should be the data cast to the type XtArgVal, otherwise value is a pointer to the data. If the type conversion fails for any reason, a warning message is issued and the list entry is skipped.
#define XtVaNestedList "XtVaNestedList"

If the name **XtVaNestedList** is specified in place of a resource name, then the following argument is interpreted as an **XtVarArgsList** value, which specifies another varargs list that is logically inserted into the original list at the point of declaration. The end of the nested list is identified with a name entry containing NULL. Varargs lists may nest to any depth.

To dynamically allocate a varargs list for use with **XtVaNestedList** in multiple calls, use **XtVaCreateArgsList**.

```c
typedef XtPointer XtVarArgsList;

XtVarArgsList XtVaCreateArgsList(unused, ...)
    XtPointer unused;

unused    This argument is not currently used and must be specified as NULL.
...
Specifies a variable parameter list of resource name and value pairs.
```

The **XtVaCreateArgsList** function allocates memory and copies its arguments into a single list pointer, which may be used with **XtVaNestedList**. The end of both lists is identified by a name entry containing NULL. Any entries of type **XtVaTypedArg** are copied as specified without applying conversions. Data passed by reference (including Strings) are not copied, only the pointers themselves; the caller must ensure that the data remain valid for the lifetime of the created varargs list. The list should be freed using **XtFree** when no longer needed.

Use of resource files and of the resource database is generally encouraged over lengthy arglist or varargs lists whenever possible in order to permit modification without recompilation.

### 2.5.2. Creating a Widget Instance

To create an instance of a widget, use **XtCreateWidget**.

```c
Widget XtCreateWidget(name, object_class, parent, args, num_args)
    String name;
    WidgetClass object_class;
    Widget parent;
    ArgList args;
    Cardinal num_args;

name        Specifies the resource instance name for the created widget, which is used for retrieving resources and, for that reason, should not be the same as any other widget that is a child of the same parent.
object_class Specifies the widget class pointer for the created object. Must be **objectClass** or any subclass thereof.
parent      Specifies the parent widget. Must be of class Object or any subclass thereof.
args        Specifies the argument list to override any other resource specifications.
num_args    Specifies the number of entries in the argument list.
```
The **XtCreateWidget** function performs all the boilerplate operations of widget creation, doing the following in order:

- Checks to see if the class_initialize procedure has been called for this class and for all superclasses and, if not, calls those necessary in a superclass-to-subclass order.
- If the specified class is not **coreWidgetClass** or a subclass thereof, and the parent’s class is a subclass of **compositeWidgetClass** and either no extension record in the parent’s composite class part extension field exists with the **record_type** NULLQUARK or the **accepts_objects** field in the extension record is **False**, **XtCreateWidget** issues a fatal error; see Section 3.1 and Chapter 12.
- If the specified class contains an extension record in the object class part extension field with **record_type** NULLQUARK and the **allocate** field is not NULL, the procedure is invoked to allocate memory for the widget instance. If the parent is a member of the class **constraintWidgetClass**, the procedure also allocates memory for the parent’s constraints and stores the address of this memory into the **constraints** field. If no allocate procedure is found, the Intrinsics allocate memory for the widget and, when applicable, the constraints, and initializes the **constraints** field.
- Initializes the Core nonresource data fields **self**, **parent**, **widget_class**, **being_destroyed**, **name**, **managed**, **window**, **visible**, **popup_list**, and **num_popups**.
- Initializes the resource fields (for example, **background_pixel**) by using the **CoreClassPart** resource lists specified for this class and all superclasses.
- If the parent is a member of the class **constraintWidgetClass**, initializes the resource fields of the constraints record by using the **ConstraintClassPart** resource lists specified for the parent’s class and all superclasses up to **constraintWidgetClass**.
- Calls the initialize procedures for the widget starting at the Object initialize procedure on down to the widget’s initialize procedure.
- If the parent is a member of the class **constraintWidgetClass**, calls the **ConstraintClassPart** initialize procedures, starting at **constraintWidgetClass** on down to the parent’s **ConstraintClassPart** initialize procedure.
- If the parent is a member of the class **compositeWidgetClass**, puts the widget into its parent’s children list by calling its parent’s insert_child procedure. For further information, see Section 3.1.

To create an instance of a widget using varargs lists, use **XtVaCreateWidget**.

```c
Widget XtVaCreateWidget(name, object_class, parent, ...)

String name;
WidgetClass object_class;
Widget parent;

name Specifies the resource name for the created widget.
object_class Specifies the widget class pointer for the created object. Must be objectClass or any subclass thereof.
parent Specifies the parent widget. Must be of class Object or any subclass thereof.
... Specifies the variable argument list to override any other resource specifications.
```

The **XtVaCreateWidget** procedure is identical in function to **XtCreateWidget** with the **args** and **num_args** parameters replaced by a varargs list, as described in Section 2.5.1.
2.5.3. Creating an Application Shell Instance

An application can have multiple top-level widgets, each of which specifies a unique widget tree that can potentially be on different screens or displays. An application uses `XtAppCreateShell` to create independent widget trees.

```c
Widget XtAppCreateShell(name, application_class, widget_class, display, args, num_args)
    String name;
    String application_class;
    WidgetClass widget_class;
    Display *display;
    ArgList args;
    Cardinal num_args;
```

- `name`: Specifies the instance name of the shell widget. If `name` is NULL, the application name passed to `XtDisplayInitialize` is used.
- `application_class`: Specifies the resource class string to be used in place of the widget `class_name` string when `widget_class` is `applicationShellWidgetClass` or a subclass thereof.
- `widget_class`: Specifies the widget class for the top-level widget (e.g., `applicationShellWidgetClass`).
- `display`: Specifies the display for the default screen and for the resource database used to retrieve the shell widget resources.
- `args`: Specifies the argument list to override any other resource specifications.
- `num_args`: Specifies the number of entries in the argument list.

The `XtAppCreateShell` function creates a new shell widget instance as the root of a widget tree. The screen resource for this widget is determined by first scanning `args` for the `XtNscreen` argument. If no `XtNscreen` argument is found, the resource database associated with the default screen of the specified display is queried for the resource `name.screen`, class `Class.Screen` where `Class` is the specified `application_class` if `widget_class` is `applicationShellWidgetClass` or a subclass thereof. If `widget_class` is not `applicationShellWidgetClass` or a subclass, `Class` is the class field in the `CoreClassPart` of the specified `widget_class`. If this query fails, the default screen of the specified display is used. Once the screen is determined, the resource database associated with that screen is used to retrieve all remaining resources for the shell widget not specified in `args`. The widget name and `Class` as determined above are used as the leftmost (i.e., root) components in all fully qualified resource names for objects within this widget tree.

If the specified `widget_class` is a subclass of WMShell, the name and `Class` as determined above will be stored into the `WM_CLASS` property on the widget’s window when it becomes realized. If the specified `widget_class` is `applicationShellWidgetClass` or a subclass thereof, the `WM_COMMAND` property will also be set from the values of the `XtNargv` and `XtNargc` resources.

To create multiple top-level shells within a single (logical) application, you can use one of two methods:

- Designate one shell as the real top-level shell and create the others as pop-up children of it by using `XtCreatePopupShell`.
- Have all shells as pop-up children of an unrealized top-level shell.

The first method, which is best used when there is a clear choice for what is the main window, leads to resource specifications like the following:
To create a top-level widget that is the root of a widget tree using varargs lists, use `XtVaAppCreateShell`.

```c
Widget XtVaAppCreateShell(name, application_class, widget_class, display, ...)

String name;
String application_class;
WidgetClass widget_class;
Display *display;
```

- `name`: Specifies the instance name of the shell widget. If `name` is NULL, the application name passed to `XtDisplayInitialize` is used.
- `application_class`: Specifies the resource class string to be used in place of the widget `class_name` string when `widget_class` is `applicationShellWidgetClass` or a subclass thereof.
- `widget_class`: Specifies the widget class for the top-level widget.
- `display`: Specifies the display for the default screen and for the resource database used to retrieve the shell widget resources.
- `...`: Specifies the variable argument list to override any other resource specifications.

The `XtVaAppCreateShell` procedure is identical in function to `XtAppCreateShell` with the `args` and `num_args` parameters replaced by a varargs list, as described in Section 2.5.1.

### 2.5.4. Convenience Procedure to Initialize an Application

To initialize the Intrinsics internals, create an application context, open and initialize a display, and create the initial root shell instance, an application may use `XtOpenApplication` or `XtVaOpenApplication`. 

```c
X Toolkit Intrinsics X11 Release 6.7
```
Widget XtOpenApplication(app_context_return, application_class, options, num_options, argc_in_out, argv_in_out, fallback_resources, widget_class, args, num_args)

XtAppContext *app_context_return;
String application_class;
XrmOptionDescList options;
Cardinal num_options;
int *argc_in_out;
String *argv_in_out;
String *fallback_resources;
WidgetClass widget_class;
ArgList args;
Cardinal num_args;

app_context_return Returns the application context, if non-NULL.
application_class Specifies the class name of the application.
options Specifies the command line options table.
num_options Specifies the number of entries in options.
argc_in_out Specifies a pointer to the number of command line arguments.
argv_in_out Specifies a pointer to the command line arguments.
fallback_resources Specifies resource values to be used if the application class resource file cannot be opened or read, or NULL.
widget_class Specifies the class of the widget to be created. Must be shellWidgetClass or a subclass.
args Specifies the argument list to override any other resource specifications for the created shell widget.
num_args Specifies the number of entries in the argument list.

The XtOpenApplication function calls XtToolkitInitialize followed by XtCreateApplicationContext, then calls XtOpenDisplay with display_string NULL and application_name NULL, and finally calls XtAppCreateShell with name NULL, the specified widget_class, an argument list and count, and returns the created shell. The recommended widget_class is sessionShellWidgetClass. The argument list and count are created by merging the specified args and num_args with a list containing the specified argc and argv. The modified argc and argv returned by XtDisplayInitialize are returned in argc_in_out and argv_in_out. If app_context_return is not NULL, the created application context is also returned. If the display specified by the command line cannot be opened, an error message is issued and XtOpenApplication terminates the application. If fallback_resources is non-NULL, XtAppSetFallbackResources is called with the value prior to calling XtOpenDisplay.
Widget XtVaOpenApplication(app_context_return, application_class, options, num_options, argc_in_out, argv_in_out, fallback_resources, widget_class, ...)

XtAppContext *app_context_return;
String application_class;
XrmOptionDescList options;
Cardinal num_options;
int *argc_in_out;
String *argv_in_out;
String *fallback_resources;
WidgetClass widget_class;

app_context_return Returns the application context, if non-NULL.
application_class Specifies the class name of the application.
options Specifies the command line options table.
um_options Specifies the number of entries in options.
argc_in_out Specifies a pointer to the number of command line arguments.
argv_in_out Specifies the command line arguments array.
fallback_resources Specifies resource values to be used if the application class resource file cannot be opened, or NULL.
widget_class Specifies the class of the widget to be created. Must be shellWidgetClass or a subclass.
...

The XtVaOpenApplication procedure is identical in function to XtOpenApplication with the args and num_args parameters replaced by a varargs list, as described in Section 2.5.1.

2.5.5. Widget Instance Allocation: The allocate Procedure

A widget class may optionally provide an instance allocation procedure in the ObjectClassExtension record.

When the call to create a widget includes a varargs list containing XtVaTypedArg, these arguments will be passed to the allocation procedure in an XtTypedArgList.

typedef struct {
   String name;
   String type;
   XtArgVal value;
   int size;
} XtTypedArg, *XtTypedArgList;

The allocate procedure pointer in the ObjectClassExtension record is of type XtAllocateProc.
XtTypedArgList, Cardinal*, Widget*, XtPointer*);

WidgetClass widget_class;
Cardinal* constraint_size;
Cardinal* more_bytes;
ArgList args;
Cardinal* num_args;
XtTypedArgList typed_args,
Cardinal* num_typed_args;
Widget* new_return;
XtPointer* more_bytes_return;

widget_class Specifies the widget class of the instance to allocate.
constraint_size Specifies the size of the constraint record to allocate, or 0.
more_bytes Specifies the number of auxiliary bytes of memory to allocate.
args Specifies the argument list as given in the call to create the widget.
num_args Specifies the number of arguments.
typed_args Specifies the list of typed arguments given in the call to create the widget.
num_typed_args Specifies the number of typed arguments.
new_return Returns a pointer to the newly allocated instance, or NULL in case of error.
more_bytes_return Returns the auxiliary memory if it was requested, or NULL if requested and an error occurred; otherwise, unchanged.

At widget allocation time, if an extension record with record_type equal to NULLQUARK is located through the object class part extension field and the allocate field is not NULL, the XtAllocateProc will be invoked to allocate memory for the widget. If no ObjectClassPart extension record is declared with record_type equal to NULLQUARK, then XtInheritAllocate and XtInheritDeallocate are assumed. If no XtAllocateProc is found, the Intrinsics will allocate memory for the widget.

An XtAllocateProc must perform the following:

- Allocate memory for the widget instance and return it in new_return. The memory must be at least wc->core_class.widget_size bytes in length, double-word aligned.
- Initialize the core.constraints fi eld in the instance record to NULL or to point to a constraint record. If constraint_size is not 0, the procedure must allocate memory for the constraint record. The memory must be double-word aligned.
- If more_bytes is not 0, then the address of a block of memory at least more_bytes in size, double-word aligned, must be returned in the more_bytes_return parameter, or NULL to indicate an error.

A class allocation procedure that envelops the allocation procedure of a superclass must rely on the enveloped procedure to perform the instance and constraint allocation. Allocation procedures should refrain from initializing fields in the widget record except to store pointers to newly allocated additional memory. Under no circumstances should an allocation procedure that envelopes its superclass allocation procedure modify fields in the instance part of any superclass.
2.5.6. Widget Instance Initialization: The initialize Procedure

The initialize procedure pointer in a widget class is of type `XtInitProc`.

```c
typedef void (*XtInitProc)(Widget, Widget, ArgList, Cardinal*);
```

- `request` Specified as a copy of the widget with resource values as requested by the argument list, the resource database, and the widget defaults.
- `new` Specified as the widget with the new values, both resource and nonresource, that are actually allowed.
- `args` Specified as the argument list passed by the client, for computing derived resource values. If the client created the widget using a varargs form, any resources specified via `XtVaTypedArg` are converted to the widget representation and the list is transformed into the `ArgList` format.
- `num_args` Specified as the number of entries in the argument list.

An initialization procedure performs the following:

- Allocates space for and copies any resources referenced by address that the client is allowed to free or modify after the widget has been created. For example, if a widget has a field that is a `String`, it may choose not to depend on the characters at that address remaining constant but dynamically allocate space for the string and copy it to the new space. Widgets that do not copy one or more resources referenced by address should clearly state in their user documentation.

  **Note**
  
  It is not necessary to allocate space for or to copy callback lists.

- Computes values for unspecified resource fields. For example, if `width` and `height` are zero, the widget should compute an appropriate width and height based on its other resources.

  **Note**
  
  A widget may directly assign only its own `width` and `height` within the initialize, `initialize_hook`, `set_values`, and `set_values_hook` procedures; see Chapter 6.

- Computes values for uninitialized nonresource fields that are derived from resource fields. For example, graphics contexts (GCs) that the widget uses are derived from resources like background, foreground, and font.

An initialization procedure also can check certain fields for internal consistency. For example, it makes no sense to specify a colormap for a depth that does not support that colormap.

Initialization procedures are called in superclass-to-subclass order after all fields specified in the resource lists have been initialized. The initialize procedure does not need to examine `args` and `num_args` if all public resources are declared in the resource list. Most of the initialization code for a specific widget class deals with fields defined in that class and not with fields defined in its superclasses.

If a subclass does not need an initialization procedure because it does not need to perform any of the above operations, it can specify NULL for the `initialize` field in the class record.
Sometimes a subclass may want to overwrite values filled in by its superclass. In particular, size calculations of a superclass often are incorrect for a subclass, and in this case, the subclass must modify or recalculate fields declared and computed by its superclass.

As an example, a subclass can visually surround its superclass display. In this case, the width and height calculated by the superclass initialize procedure are too small and need to be incremented by the size of the surround. The subclass needs to know if its superclass’s size was calculated by the superclass or was specified explicitly. All widgets must place themselves into whatever size is explicitly given, but they should compute a reasonable size if no size is requested.

The request and new arguments provide the necessary information for a subclass to determine the difference between an explicitly specified field and a field computed by a superclass. The request widget is a copy of the widget as initialized by the arglist and resource database. The new widget starts with the values in the request, but it has been updated by all superclass initialization procedures called so far. A subclass initialize procedure can compare these two to resolve any potential conflicts.

In the above example, the subclass with the visual surround can see if the width and height in the request widget are zero. If so, it adds its surround size to the width and height fields in the new widget. If not, it must make do with the size originally specified.

The new widget will become the actual widget instance record. Therefore, the initialization procedure should do all its work on the new widget; the request widget should never be modified. If the initialize procedure needs to call any routines that operate on a widget, it should specify new as the widget instance.

2.5.7. Constraint Instance Initialization: The ConstraintClassPart initialize Procedure

The constraint initialization procedure pointer, found in the ConstraintClassPart initialize field of the widget class record, is of type XtInitProc. The values passed to the parent constraint initialization procedures are the same as those passed to the child’s class widget initialization procedures.

The constraints field of the request widget points to a copy of the constraints record as initialized by the arglist and resource database.

The constraint initialization procedure should compute any constraint fields derived from constraint resources. It can make further changes to the new widget to make the widget and any other constraint fields conform to the specified constraints, for example, changing the widget’s size or position.

If a constraint class does not need a constraint initialization procedure, it can specify NULL for the initialize field of the ConstraintClassPart in the class record.

2.5.8. Nonwidget Data Initialization: The initialize_hook Procedure

Note

The initialize_hook procedure is obsolete, as the same information is now available to the initialize procedure. The procedure has been retained for those widgets that used it in previous releases.

The initialize_hook procedure pointer is of type XtArgsProc:
typedef void (*XtArgsProc)(Widget, ArgList, Cardinal*);
    Widget w;
    ArgList args;
    Cardinal *num_args;

    w Specifies the widget.
    args Specifies the argument list passed by the client. If the client created the widget
        using a varargs form, any resources specified via XtVaTypedArg are converted
        to the widget representation and the list is transformed into the ArgList format.
    num_args Specifies the number of entries in the argument list.

If this procedure is not NULL, it is called immediately after the corresponding initialize proce-
dure or in its place if the initialize field is NULL.
The initialize_hook procedure allows a widget instance to initialize nonresource data using information from the specified argument list as if it were a resource.

2.6. Realizing Widgets
To realize a widget instance, use XtRealizeWidget.

void XtRealizeWidget(w)
    Widget w;
    w Specifies the widget. Must be of class Core or any subclass thereof.

If the widget is already realized, XtRealizeWidget simply returns. Otherwise it performs the following:
• Binds all action names in the widget’s translation table to procedures (see Section 10.1.2).
• Makes a postorder traversal of the widget tree rooted at the specified widget and calls each
    non-NULL change_managed procedure of all composite widgets that have one or more
    managed children.
• Constructs an XSetWindowAttributes structure filled in with information derived from
    the Core widget fields and calls the realize procedure for the widget, which adds any wid-
    get-specific attributes and creates the X window.
• If the widget is not a subclass of compositeWidgetClass, XtRealizeWidget returns; other-
    wise it continues and performs the following:
    − Descends recursively to each of the widget’s managed children and calls the realize
        procedures. Primitive widgets that instantiate children are responsible for realizing
        those children themselves.
    − Maps all of the managed children windows that have mapped_when_managed True.
        If a widget is managed but mapped_when_managed is False, the widget is allocated
        visual space but is not displayed.

If the widget is a top-level shell widget (that is, it has no parent), and mapped_when_managed is
True, XtRealizeWidget maps the widget window.
XtCreateWidget, XtVaCreateWidget, XtRealizeWidget, XtManageChildren,
XtUnmanageChildren, XtUnrealizeWidget, XtSetMappedWhenManaged, and XtDestroy-
Widget maintain the following invariants:
• If a composite widget is realized, then all its managed children are realized.
• If a composite widget is realized, then all its managed children that have
  \textit{mapped\_when\_managed} \textbf{True} are mapped.

All Intrinsics functions and all widget routines should accept either realized or unrealized widgets. When calling the realize or change\_managed procedures for children of a composite widget, \texttt{XtRealizeWidget} calls the procedures in reverse order of appearance in the \texttt{CompositePart}\ children list. By default, this ordering of the realize procedures will result in the stacking order of any newly created subwindows being top-to-bottom in the order of appearance on the list, and the most recently created child will be at the bottom.

To check whether or not a widget has been realized, use \texttt{XtIsRealized}.

\begin{verbatim}
Boolean XtIsRealized(w)
    Widget w;
    w Speciﬁes the widget. Must be of class Object or any subclass thereof.

The \texttt{XtIsRealized} function returns \textbf{True} if the widget has been realized, that is, if the widget has a nonzero window ID. If the specified object is not a widget, the state of the nearest widget ancestor is returned.

Some widget procedures (for example, set\_values) might wish to operate differently after the widget has been realized.

2.6.1. Widget Instance Window Creation: The realize Procedure
The realize procedure pointer in a widget class is of type \texttt{XtRealizeProc}.

\begin{verbatim}
typedef void (*XtRealizeProc)(Widget, XtValueMask*, XSetWindowAttributes*);
    Widget w;
    XtValueMask *value_mask;
    XSetWindowAttributes *attributes;
    w Speciﬁes the widget.
    value_mask Speciﬁes which ﬁelds in the attributes structure are used.
    attributes Speciﬁes the window attributes to use in the \texttt{XCreateWindow} call.

The realize procedure must create the widget’s window.

Before calling the class realize procedure, the generic \texttt{XtRealizeWidget} function ﬁlls in a mask and a corresponding \texttt{XSetWindowAttributes} structure. It sets the following ﬁelds in \texttt{attributes} and corresponding bits in \texttt{value\_mask} based on information in the widget core structure:

\begin{itemize}
  \item The \textit{background\_pixmap} (or \textit{background\_pixel} if \textit{background\_pixmap} is \texttt{XtUnspeciﬁed\_Pixmap}) is ﬁlled in from the corresponding ﬁeld.
  \item The \textit{border\_pixmap} (or \textit{border\_pixel} if \textit{border\_pixmap} is \texttt{XtUnspeciﬁed\_Pixmap}) is ﬁlled in from the corresponding ﬁeld.
  \item The \textit{colormap} is ﬁlled in from the corresponding ﬁeld.
  \item The \textit{event\_mask} is ﬁlled in based on the event handlers registered, the event translations speciﬁed, whether the \textit{expose} ﬁeld is non-\texttt{NULL}, and whether \textit{visible\_interest} is \textbf{True}.
  \item The \textit{bit\_gravity} is set to \texttt{NorthWestGravity} if the \textit{expose} ﬁeld is \texttt{NULL}.
\end{itemize}

These or any other ﬁelds in \texttt{attributes} and the corresponding bits in \texttt{value\_mask} can be set by the realize procedure.

\end{verbatim}
Note that because realize is not a chained operation, the widget class realize procedure must update the **XSetWindowAttributes** structure with all the appropriate fields from non-Core superclasses.

A widget class can inherit its realize procedure from its superclass during class initialization. The realize procedure defined for **coreWidgetClass** calls **XtCreateWindow** with the passed value_mask and attributes and with window_class and visual set to **CopyFromParent**. Both **compositeWidgetClass** and **constraintWidgetClass** inherit this realize procedure, and most new widget subclasses can do the same (see Section 1.6.10).

The most common noninherited realize procedures set **bit_gravity** in the mask and attributes to the appropriate value and then create the window. For example, depending on its justification, Label might set **bit_gravity** to **WestGravity**, **CenterGravity**, or **EastGravity**. Consequently, shrinking it would just move the bits appropriately, and no exposure event is needed for repainting.

If a composite widget’s children should be realized in an order other than that specified (to control the stacking order, for example), it should call **XtRealizeWidget** on its children itself in the appropriate order from within its own realize procedure.

Widgets that have children and whose class is not a subclass of **compositeWidgetClass** are responsible for calling **XtRealizeWidget** on their children, usually from within the realize procedure.

Realize procedures cannot manage or unmanage their descendants.

### 2.6.2. Window Creation Convenience Routine

Rather than call the Xlib **XCreateWindow** function explicitly, a realize procedure should normally call the Intrinsics analog **XtCreateWindow**, which simplifies the creation of windows for widgets.

```c
void XtCreateWindow(w, window_class, visual, value_mask, attributes)

  Widget w;
  unsigned int window_class;
  Visual *visual;
  XtValueMask value_mask;
  XSetWindowAttributes *attributes;

  w specifies the widget that defines the additional window attributed. Must be of class Core or any subclass thereof.
  window_class specifies the Xlib window class (for example, **InputOutput**, **InputOnly**, or **CopyFromParent**).
  visual specifies the visual type (usually **CopyFromParent**).
  value_mask specifies which fields in the attributes structure are used.
  attributes specifies the window attributes to use in the **XCreateWindow** call.
```

The **XtCreateWindow** function calls the Xlib **XCreateWindow** function with values from the widget structure and the passed parameters. Then, it assigns the created window to the widget’s window field.

**XtCreateWindow** evaluates the following fields of the widget core structure: **depth**, **screen**, **parent->core.window**, **x**, **y**, **width**, **height**, and **border_width**.
2.7. Obtaining Window Information from a Widget
The Core widget class definition contains the screen and window ids. The window field may be NULL for a while (see Sections 2.5 and 2.6).
The display pointer, the parent widget, screen pointer, and window of a widget are available to the widget writer by means of macros and to the application writer by means of functions.

Display *XtDisplay(w)
    Widget w;

w Specifies the widget. Must be of class Core or any subclass thereof.

XtDisplay returns the display pointer for the specified widget.

Widget XtParent(w)
    Widget w;

w Specifies the widget. Must be of class Object or any subclass thereof.

XtParent returns the parent object for the specified widget. The returned object will be of class Object or a subclass.

Screen *XtScreen(w)
    Widget w;

w Specifies the widget. Must be of class Core or any subclass thereof.

XtScreen returns the screen pointer for the specified widget.

Window XtWindow(w)
    Widget w;

w Specifies the widget. Must be of class Core or any subclass thereof.

XtWindow returns the window of the specified widget.

The display pointer, screen pointer, and window of a widget or of the closest widget ancestor of a nonwidget object are available by means of XtDisplayOfObject, XtScreenOfObject, and XtWindowOfObject.

Display *XtDisplayOfObject(object)
    Widget object;

object Specifies the object. Must be of class Object or any subclass thereof.

XtDisplayOfObject is identical in function to XtDisplay if the object is a widget; otherwise XtDisplayOfObject returns the display pointer for the nearest ancestor of object that is of class Widget or a subclass thereof.
Screen *XtScreenOfObject(object)

Object object);

object Specifies the object. Must be of class Object or any subclass thereof.

XtScreenOfObject is identical in function to XtScreen if the object is a widget; otherwise
XtScreenOfObject returns the screen pointer for the nearest ancestor of object that is of class
Widget or a subclass thereof.

Window XtWindowOfObject(object)

Object object);

object Specifies the object. Must be of class Object or any subclass thereof.

XtWindowOfObject is identical in function to XtWindow if the object is a widget; otherwise
XtWindowOfObject returns the window for the nearest ancestor of object that is of class Widget
or a subclass thereof.

To retrieve the instance name of an object, use XtName.

String XtName(object)

Object object);

object Specifies the object whose name is desired. Must be of class Object or any subclass
ter thereof.

XtName returns a pointer to the instance name of the specified object. The storage is owned by
the Intrinsics and must not be modified. The name is not qualified by the names of any of the
object’s ancestors.

Several window attributes are locally cached in the widget instance. Thus, they can be set by the
resource manager and XtSetValues as well as used by routines that derive structures from these
values (for example, depth for deriving pixmaps, background_pixel for deriving GCs, and so on) or
in the XtCreateWindow call.

The x, y, width, height, and border_width window attributes are available to geometry managers.
These fields are maintained synchronously inside the Intrinsics. When an XConfigureWindow
is issued by the Intrinsics on the widget’s window (on request of its parent), these values are
updated immediately rather than some time later when the server generates a ConfigureNotify
event. (In fact, most widgets do not select SubstructureNotify events.) This ensures that all
geometry calculations are based on the internally consistent toolkit world rather than on either an
inconsistent world updated by asynchronous ConfigureNotify events or a consistent, but slow,
world in which geometry managers ask the server for window sizes whenever they need to lay out
their managed children (see Chapter 6).

2.7.1. Unrealizing Widgets
To destroy the windows associated with a widget and its non-pop-up descendants, use XtUnreal-
izeWidget.
void XtUnrealizeWidget(w)
    Widget w;

w Specifies the widget. Must be of class Core or any subclass thereof.

If the widget is currently unrealized, XtUnrealizeWidget simply returns. Otherwise it performs the following:

- Unmanages the widget if the widget is managed.
- Makes a postorder (child-to-parent) traversal of the widget tree rooted at the specified widget and, for each widget that has declared a callback list resource named "unrealizeCallback", executes the procedures on the XtUnrealizeCallback list.
- Destroys the widget's window and any subwindows by calling XDestroyWindow with the specified widget's window field.

Any events in the queue or which arrive following a call to XtUnrealizeWidget will be dispatched as if the window(s) of the unrealized widget(s) had never existed.

2.8. Destroying Widgets
The Intrinsics provide support

- To destroy all the pop-up children of the widget being destroyed and destroy all children of composite widgets.
- To remove (and unmap) the widget from its parent.
- To call the callback procedures that have been registered to trigger when the widget is destroyed.
- To minimize the number of things a widget has to deallocate when destroyed.
- To minimize the number of XDestroyWindow calls when destroying a widget tree.

To destroy a widget instance, use XtDestroyWidget.

void XtDestroyWidget(w)
    Widget w;

w Specifies the widget. Must be of class Object or any subclass thereof.

The XtDestroyWidget function provides the only method of destroying a widget, including widgets that need to destroy themselves. It can be called at any time, including from an application callback routine of the widget being destroyed. This requires a two-phase destroy process in order to avoid dangling references to destroyed widgets.

In phase 1, XtDestroyWidget performs the following:

- If the being_destroyed field of the widget is True, it returns immediately.
- Recursively descends the widget tree and sets the being_destroyed field to True for the widget and all normal and pop-up children.
- Adds the widget to a list of widgets (the destroy list) that should be destroyed when it is safe to do so.

Entries on the destroy list satisfy the invariant that if w2 occurs after w1 on the destroy list, then w2 is not a descendent, either normal or pop-up, of w1.

Phase 2 occurs when all procedures that should execute as a result of the current event have been called, including all procedures registered with the event and translation managers, that is, when
the current invocation of XtDispatchEvent is about to return, or immediately if not in Xt DispatchEvent.

In phase 2, XtDestroyWidget performs the following on each entry in the destroy list in the order specified:

- If the widget is not a pop-up child and the widget’s parent is a subclass of composite-WidgetClass, and if the parent is not being destroyed, it calls XtUnmanageChild on the widget and then calls the widget’s parent’s delete_child procedure (see Section 3.3).
- Calls the destroy callback procedures registered on the widget and all normal and pop-up descendants in postorder (it calls child callbacks before parent callbacks).

The XtDestroyWidget function then makes a second traversal of the widget and all normal and pop-up descendants to perform the following three items on each widget in postorder:

- If the widget is not a pop-up child and the widget’s parent is a subclass of constraint-WidgetClass, it calls the ConstraintClassPart destroy procedure for the parent, then for the parent’s superclass, until finally it calls the ConstraintClassPart destroy procedure for constraintWidgetClass.
- Calls the CoreClassPart destroy procedure declared in the widget class, then the destroy procedure declared in its superclass, until finally it calls the destroy procedure declared in the Object class record. Callback lists are deallocated.
- If the widget class object class part contains an ObjectClassExtension record with the record_type NULLQUARK and the deallocate field is not NULL, calls the deallocate procedure to deallocate the instance and if one exists, the constraint record. Otherwise, the Intrinsics will deallocate the widget instance record and if one exists, the constraint record.
- Calls XDestroyWindow if the specified widget is realized (that is, has an X window). The server recursively destroys all normal descendant windows. (Windows of realized pop-up Shell children, and their descendants, are destroyed by a shell class destroy procedure.)

2.8.1. Adding and Removing Destroy Callbacks

When an application needs to perform additional processing during the destruction of a widget, it should register a destroy callback procedure for the widget. The destroy callback procedures use the mechanism described in Chapter 8. The destroy callback list is identified by the resource name XtNdestroyCallback.

For example, the following adds an application-supplied destroy callback procedure ClientDestroy with client data to a widget by calling XtAddCallback.

XtAddCallback(w, XtNdestroyCallback, ClientDestroy, client_data)

Similarly, the following removes the application-supplied destroy callback procedure ClientDestroy by calling XtRemoveCallback.

XtRemoveCallback(w, XtNdestroyCallback, ClientDestroy, client_data)

The ClientDestroy argument is of type XtCallbackProc; see Section 8.1.

2.8.2. Dynamic Data Deallocation: The destroy Procedure

The destroy procedure pointers in the ObjectClassPart, RectObjClassPart, and CoreClassPart structures are of type XtWidgetProc.
typedef void (*XtWidgetProc)(Widget);
  Widget w;

  w Specifies the widget being destroyed.

The destroy procedures are called in subclass-to-superclass order. Therefore, a widget’s destroy procedure should deallocate only storage that is specific to the subclass and should ignore the storage allocated by any of its superclasses. The destroy procedure should deallocate only resources that have been explicitly created by the subclass. Any resource that was obtained from the resource database or passed in an argument list was not created by the widget and therefore should not be destroyed by it. If a widget does not need to deallocate any storage, the destroy procedure entry in its class record can be NULL.

Deallocating storage includes, but is not limited to, the following steps:
- Calling XtFree on dynamic storage allocated with XtMalloc, XtCalloc, and so on.
- Calling XFreePixmap on pixmaps created with direct X calls.
- Calling XtReleaseGC on GCs allocated with XtGetGC.
- Calling XFreeGC on GCs allocated with direct X calls.
- Calling XtRemoveEventHandler on event handlers added to other widgets.
- Calling XtRemoveTimeOut on timers created with XtAppAddTimeOut.
- Calling XtDestroyWidget for each child if the widget has children and is not a subclass of compositeWidgetClass.

During destroy phase 2 for each widget, the Intrinsics remove the widget from the modal cascade, unregister all event handlers, remove all key, keyboard, button, and pointer grabs and remove all callback procedures registered on the widget. Any outstanding selection transfers will time out.

2.8.3. Dynamic Constraint Data Deallocation: The ConstraintClassPart destroy Procedure
The constraint destroy procedure identified in the ConstraintClassPart structure is called for a widget whose parent is a subclass of constraintWidgetClass. This constraint destroy procedure pointer is of type XtWidgetProc. The constraint destroy procedures are called in subclass-to-superclass order, starting at the class of the widget’s parent and ending at constraintWidgetClass. Therefore, a parent’s constraint destroy procedure should deallocate only storage that is specific to the constraint subclass and not storage allocated by any of its superclasses. If a parent does not need to deallocate any constraint storage, the constraint destroy procedure entry in its class record can be NULL.

2.8.4. Widget Instance Deallocation: The deallocate Procedure
The deallocate procedure pointer in the ObjectClassExtension record is of type XtDeallocateProc.
typedef void (*XtDeallocateProc)(Widget, XtPointer);
    Widget widget;
    XtPointer more_bytes;

    widget  Specifies the widget being destroyed.
    more_bytes  Specifies the auxiliary memory received from the corresponding allocator along with the widget, or NULL.

When a widget is destroyed, if an ObjectClassExtension record exists in the object class part extension field with record_type NULLQUARK and the deallocate field is not NULL, the XtDeallocateProc will be called. If no ObjectClassPart extension record is declared with record_type equal to NULLQUARK, then XtInheritAllocate and XtInheritDeallocate are assumed. The responsibilities of the deallocate procedure are to deallocate the memory specified by more_bytes if it is not NULL, to deallocate the constraints record as specified by the widget’s core.constraints field if it is not NULL, and to deallocate the widget instance itself.

If no XtDeallocateProc is found, it is assumed that the Intrinsics originally allocated the memory and is responsible for freeing it.

2.9. Exiting from an Application

All X Toolkit applications should terminate by calling XtDestroyApplicationContext and then exiting using the standard method for their operating system (typically, by calling exit for POSIX-based systems). The quickest way to make the windows disappear while exiting is to call XtUnmapWidget on each top-level shell widget. The Intrinsics have no resources beyond those in the program image, and the X server will free its resources when its connection to the application is broken.

Depending upon the widget set in use, it may be necessary to explicitly destroy individual widgets or widget trees with XtDestroyWidget before calling XtDestroyApplicationContext in order to ensure that any required widget cleanup is properly executed. The application developer must refer to the widget documentation to learn if a widget needs to perform cleanup beyond that performed automatically by the operating system. If the client is a session participant (see Section 4.2), then the client may wish to resign from the session before exiting. See Section 4.2.4 for details.
Chapter 3

Composite Widgets and Their Children

Composite widgets (widgets whose class is a subclass of `compositeWidgetClass`) can have an arbitrary number of children. Consequently, they are responsible for much more than primitive widgets. Their responsibilities (either implemented directly by the widget class or indirectly by Intrinsics functions) include:

- Overall management of children from creation to destruction.
- Destruction of descendants when the composite widget is destroyed.
- Physical arrangement (geometry management) of a displayable subset of children (that is, the managed children).
- Mapping and unmapping of a subset of the managed children.

Overall management is handled by the generic procedures `XtCreateWidget` and `XtDestroyWidget`. `XtCreateWidget` adds children to their parent by calling the parent’s `insert_child` procedure. `XtDestroyWidget` removes children from their parent by calling the parent’s `delete_child` procedure and ensures that all children of a destroyed composite widget also get destroyed.

Only a subset of the total number of children is actually managed by the geometry manager and hence possibly visible. For example, a composite editor widget supporting multiple editing buffers might allocate one child widget for each file buffer, but it might display only a small number of the existing buffers. Widgets that are in this displayable subset are called managed widgets and enter into geometry manager calculations. The other children are called unmanaged widgets and, by definition, are not mapped by the Intrinsics.

Children are added to and removed from their parent’s managed set by using `XtManageChild`, `XtManageChildren`, `XtUnmanageChild`, `XtUnmanageChildren`, and `XtChangeManagedSet`, which notify the parent to recalculate the physical layout of its children by calling the parent’s `changeManaged` procedure. The `XtCreateManagedWidget` convenience function calls `XtCreateWidget` and `XtManageChild` on the result.

Most managed children are mapped, but some widgets can be in a state where they take up physical space but do not show anything. Managed widgets are not mapped automatically if their `map_when_managed` field is `False`. The default is `True` and is changed by using `XtSetMapWhenManaged`.

Each composite widget class declares a geometry manager, which is responsible for figuring out where the managed children should appear within the composite widget’s window. Geometry management techniques fall into four classes:

- **Fixed boxes**: Fixed boxes have a fixed number of children created by the parent. All these children are managed, and none ever makes geometry manager requests.

- **Homogeneous boxes**: Homogeneous boxes treat all children equally and apply the same geometry constraints to each child. Many clients insert and delete widgets freely.

- **Heterogeneous boxes**: Heterogeneous boxes have a specific location where each child is placed. This location usually is not specified in pixels, because the window may be resized, but is expressed rather in terms of the relationship between a child and the parent or between the child and other specific children. The class of heterogeneous boxes is usually a subclass of Constraint.
Shell boxes typically have only one child, and the child’s size is usually exactly the size of the shell. The geometry manager must communicate with the window manager, if it exists, and the box must also accept ConfigureNotify events when the window size is changed by the window manager.

3.1. Addition of Children to a Composite Widget: The insert_child Procedure

To add a child to the parent’s list of children, the XtCreateWidget function calls the parent’s class routine insert_child. The insert_child procedure pointer in a composite widget is of type XtWidgetProc.

```c
typedef void (*XtWidgetProc)(Widget);

Widget w;
```

The insert_child procedure must handle the new child by calling the create_child procedure and updating the child list. If there is not enough room to insert the child in the children array (that is, num_children is equal to num_slots), the insert_child procedure must first reallocate the array and update num_slots. Then it places the child at the appropriate position in the array and increments the num_children field.

3.2. Insertion Order of Children: The insert_position Procedure

Instances of composite widgets sometimes need to specify more about the order in which their children are kept. For example, an application may want a set of command buttons in some logical order grouped by function, and it may want buttons that represent file names to be kept in alphabetical order without constraining the order in which the buttons are created.

An application controls the presentation order of a set of children by supplying an XtNinsertPosition resource. The insert_position procedure pointer in a composite widget instance is of type XtOrderProc.

```c
typedef Cardinal (*XtOrderProc)(Widget);

Widget w;
```

The insert_position procedure is used to determine the appropriate position for a new child in the children array. If there is not enough room to insert the child, the procedure must reallocate the array and update num_slots. Then it places the child at the appropriate position in the array and increments the num_children field.
insert_position procedure resource when it creates each composite widget instance.
The return value of the insert_position procedure indicates how many children should go before
the widget. Returning zero indicates that the widget should go before all other children, and
returning num_children indicates that it should go after all other children. The default
insert_position function returns num_children and can be overridden by a specific composite wid-
get’s resource list or by the argument list provided when the composite widget is created.

3.3. Deletion of Children: The delete_child Procedure
To remove the child from the parent’s children list, the XtDestroyWidget function eventually
causes a call to the Composite parent’s class delete_child procedure. The delete_child procedure
pointer is of type XtWidgetProc.

typedef void (*XtWidgetProc)(Widget);

w Passes the child being deleted.

Most widgets inherit the delete_child procedure from their superclass. Composite widgets that
create companion widgets define their own delete_child procedure to remove these companion
widgets.

3.4. Adding and Removing Children from the Managed Set
The Intrinsics provide a set of generic routines to permit the addition of widgets to or the removal
of widgets from a composite widget’s managed set. These generic routines eventually call the
composite widget’s change_managed procedure if the procedure pointer is non-NULL. The
changeManaged procedure pointer is of type XtWidgetProc. The widget argument specifies the
composite widget whose managed child set has been modified.

3.4.1. Managing Children
To add a list of widgets to the geometry-managed (and hence displayable) subset of their Com-
posite parent, use XtManageChildren.

typedef Widget *WidgetList;

void XtManageChildren(children, num_children)
   WidgetList children;
   Cardinal num_children;

   children Specify es a list of child widgets. Each child must be of class RectObj or any sub-
   class thereof.

   num_children Specify es the number of children in the list.

The XtManageChildren function performs the following:
• Issues an error if the children do not all have the same parent or if the parent’s class is not a
  subclass of compositeWidgetClass.
• Returns immediately if the common parent is being destroyed; otherwise, for each unique
  child on the list, XtManageChildren ignores the child if it already is managed or is being
  destroyed, and marks it if not.
If the parent is realized and after all children have been marked, it makes some of the newly managed children viewable:

- Calls the change_managed routine of the widgets’ parent.
- Calls XtRealizeWidget on each previously unmanaged child that is unrealized.
- Maps each previously unmanaged child that has map_when_managed True.

Managing children is independent of the ordering of children and independent of creating and deleting children. The layout routine of the parent should consider children whose managed field is True and should ignore all other children. Note that some composite widgets, especially fixed boxes, call XtManageChild from their insert_child procedure.

If the parent widget is realized, its change_managed procedure is called to notify it that its set of managed children has changed. The parent can reposition and resize any of its children. It moves each child as needed by calling XtMoveWidget, which first updates the x and y fields and which then calls XMoveWindow.

If the composite widget wishes to change the size or border width of any of its children, it calls XtResizeWidget, which first updates the width, height, and border_width fields and then calls XConfigureWindow. Simultaneous repositioning and resizing may be done with XtConfigureWidget; see Section 6.6.

To add a single child to its parent widget’s set of managed children, use XtManageChild.

```c
void XtManageChild(child)
    Widget child;
```

child Specifies the child. Must be of class RectObj or any subclass thereof.

The XtManageChild function constructs a WidgetList of length 1 and calls XtManageChildren.

To create and manage a child widget in a single procedure, use XtCreateManagedWidget or XtVaCreateManagedWidget.

```c
Widget XtCreateManagedWidget(name, widget_class, parent, args, num_args)
    String name;
    WidgetClass widget_class;
    Widget parent;
    ArgList args;
    Cardinal num_args;
```

name Specifies the resource instance name for the created widget.

widget_class Specifies the widget class pointer for the created widget. Must be rectObjClass or any subclass thereof.

parent Specifies the parent widget. Must be of class Composite or any subclass thereof.

args Specifies the argument list to override any other resource specifications.

num_args Specifies the number of entries in the argument list.

The XtCreateManagedWidget function is a convenience routine that calls XtCreateWidget and XtManageChild.
Widget XtVaCreateManagedWidget(name, widget_class, parent, ...)

    String name;
    WidgetClass widget_class;
    Widget parent;

name Specifies the resource instance name for the created widget.
widget_class Specifies the widget class pointer for the created widget. Must be rectObjClass or any subclass thereof.
parent Specifies the parent widget. Must be of class Composite or any subclass thereof.
... Specifies the variable argument list to override any other resource specifications.

XtVaCreateManagedWidget is identical in function to XtCreateManagedWidget with the args and num_args parameters replaced by a varargs list, as described in Section 2.5.1.

3.4.2. Unmanaging Children
To remove a list of children from a parent widget’s managed list, use XtUnmanageChildren.

void XtUnmanageChildren(children, num_children)
    WidgetList children;
    Cardinal num_children;

children Specifies a list of child widgets. Each child must be of class RectObj or any subclass thereof.
num_children Specifies the number of children.

The XtUnmanageChildren function performs the following:
• Returns immediately if the common parent is being destroyed.
• Issues an error if the children do not all have the same parent or if the parent is not a subclass of compositeWidgetClass.
• For each unique child on the list, XtUnmanageChildren ignores the child if it is unmanaged; otherwise it performs the following:
  – Marks the child as unmanaged.
  – If the child is realized and the map_when_managed field is True, it is unmapped.
• If the parent is realized and if any children have become unmanaged, calls the changemanaged routine of the widgets’ parent.

XtUnmanageChildren does not destroy the child widgets. Removing widgets from a parent’s managed set is often a temporary banishment, and some time later the client may manage the children again. To destroy widgets entirely, XtDestroyWidget should be called instead; see Section 2.9.

To remove a single child from its parent widget’s managed set, use XtUnmanageChild.
void XtUnmanageChild(child)
    Widget child;

call

The \texttt{XtUnmanageChild} function constructs a widget list of length 1 and calls \texttt{XtUnmanageChildren}.

These functions are low-level routines that are used by generic composite widget building routines. In addition, composite widgets can provide widget-specific, high-level convenience procedures.

### 3.4.3. Bundling Changes to the Managed Set

A client may simultaneously unmanage and manage children with a single call to the Intrinsics. In this same call the client may provide a callback procedure that can modify the geometries of one or more children. The composite widget class defines whether this single client call results in separate invocations of the change\_managed method, one to unmanage and the other to manage, or in just a single invocation.

To simultaneously remove from and add to the geometry-managed set of children of a composite parent, use \texttt{XtChangeManagedSet}.

void XtChangeManagedSet(unmanage\_children, num\_unmanage\_children,
                        do\_change\_proc, client\_data,
                        manage\_children, num\_manage\_children)

    WidgetList unmanage\_children;
    Cardinal num\_unmanage\_children;
    XtDoChangeProc do\_change\_proc;
    XtPointer client\_data;
    WidgetList manage\_children;
    Cardinal num\_manage\_children;

\textit{unmanage\_children} Specifies the list of widget children to initially remove from the managed set.

\textit{num\_unmanage\_children} Specifies the number of entries in the \textit{unmanage\_children} list.

\textit{do\_change\_proc} Specifies a procedure to invoke between unmanaging and managing the children, or NULL.

\textit{client\_data} Specifies client data to be passed to the \textit{do\_change\_proc}.

\textit{manage\_children} Specifies the list of widget children to finally add to the managed set.

\textit{num\_manage\_children} Specifies the number of entries in the \textit{manage\_children} list.

The \texttt{XtChangeManagedSet} function performs the following:

- Returns immediately if \textit{num\_unmanage\_children} and \textit{num\_manage\_children} are both 0.
- Issues a warning and returns if the widgets specified in the \textit{manage\_children} and the \textit{unmanage\_children} lists do not all have the same parent or if that parent is not a subclass of \texttt{compositeWidgetClass}.
- Returns immediately if the common parent is being destroyed.
- If \textit{do\_change\_proc} is not NULL and the parent’s \texttt{CompositeClassExtension allows\_change\_managed\_set} field is \texttt{False}, then \texttt{XtChangeManagedSet} performs the...
following:
- Calls `XtUnmanageChildren (unmanage_children, num_unmanage_children)`.
- Calls the `do_change_proc`.
- Calls `XtManageChildren (manage_children, num_manage_children)`.

- Otherwise, the following is performed:
  - For each child on the `unmanage_children` list; if the child is already unmanaged it is ignored, otherwise it is marked as unmanaged, and if it is realized and its `map_when_managed` field is `True`, it is unmapped.
  - If `do_change_proc` is non-NULL, the procedure is invoked.
  - For each child on the `manage_children` list; if the child is already managed or is being destroyed, it is ignored; otherwise it is marked as managed.
  - If the parent is realized and all children have been marked, the `change_managed` method of the parent is invoked, and subsequently some of the newly managed children are made viewable by calling `XtRealizeWidget` on each previously unmanaged child that is unrealized and mapping each previously unmanaged child that has `map_when_managed` `True`.

If no `CompositeClassExtension` record is found in the parent’s composite class part `extension` field with record type `NULLQUARK` and version greater than 1, and if `XtInheritChangeManaged` was specified in the parent’s class record during class initialization, the value of the `allows_change_managed` set field is inherited from the superclass. The value inherited from `compositeWidgetClass` for the `allows_change_managed` set field is `False`.

It is not an error to include a child in both the `unmanage_children` and the `manage_children` lists.

The effect of such a call is that the child remains managed following the call, but the `do_change_proc` is able to affect the child while it is in an unmanaged state.

The `do_change_proc` is of type `XtDoChangeProc`.

```c
typedef void (*XtDoChangeProc)(Widget, WidgetList, Cardinal*, WidgetList, Cardinal*, XtPointer);
```

- `composite_parent` Passes the composite parent whose managed set is being altered.
- `unmanage_children` Passes the list of children just removed from the managed set.
- `num_unmanage_children` Passes the number of entries in the `unmanage_children` list.
- `manage_children` Passes the list of children about to be added to the managed set.
- `num_manage_children` Passes the number of entries in the `manage_children` list.
- `client_data` Passes the client data passed to `XtChangeManagedSet`.

The `do_change_proc` procedure is used by the caller of `XtChangeManagedSet` to make changes to one or more children at the point when the managed set contains the fewest entries. These changes may involve geometry requests, and in this case the caller of `XtChangeManagedSet` may take advantage of the fact that the Intrinsics internally grant geometry requests made by unmanaged children without invoking the parent’s geometry manager. To achieve this advantage, if the `do_change_proc` procedure changes the geometry of a child or of a descendant of a child, then that child should be included in the `unmanage_children` and `manage_children` lists.
3.4.4. Determining if a Widget Is Managed
To determine the managed state of a given child widget, use `XtIsManaged`.

```c
Boolean XtIsManaged(w)
    Widget w;
    w Specifies the widget. Must be of class Object or any subclass thereof.
```

The `XtIsManaged` function returns `True` if the specified widget is of class RectObj or any subclass thereof and is managed, or `False` otherwise.

3.5. Controlling When Widgets Get Mapped
A widget is normally mapped if it is managed. However, this behavior can be overridden by setting the XtNmappedWhenManaged resource for the widget when it is created or by setting the `map_when_managed` field to `False`.

To change the value of a given widget’s `map_when_managed` field, use `XtSetMappedWhenManaged`.

```c
void XtSetMappedWhenManaged(w, map_when_managed)
    Widget w;
    Boolean map_when_managed;
    w Specifies the widget. Must be of class Core or any subclass thereof.
    map_when_managed Specifies a Boolean value that indicates the new value that is stored into the widget’s `map_when_managed` field.
```

If the widget is realized and managed, and if `map_when_managed` is `True`, `XtSetMappedWhenManaged` maps the window. If the widget is realized and managed, and if `map_when.managed` is `False`, it unmaps the window. `XtSetMappedWhenManaged` is a convenience function that is equivalent to (but slightly faster than) calling `XtSetValues` and setting the new value for the XtNmappedWhenManaged resource then mapping the widget as appropriate. As an alternative to using `XtSetMappedWhenManaged` to control mapping, a client may set `mapped_when_managed` to `False` and use `XtMapWidget` and `XtUnmapWidget` explicitly.

To map a widget explicitly, use `XtMapWidget`.

```c
XtMapWidget(w)
    Widget w;
    w Specifies the widget. Must be of class Core or any subclass thereof.
```

To unmap a widget explicitly, use `XtUnmapWidget`.

```c
XtUnmapWidget(w)
    Widget w;
    w Specifies the widget. Must be of class Core or any subclass thereof.
```
X Toolkit Intrinsics X11 Release 6.7

XtUnmapWidget(w)
   Widget w;

w Specifi es the widget. Must be of class Core or any subclass thereof.

3.6. Constrained Composite Widgets

The Constraint widget class is a subclass of compositeWidgetClass. The name is derived from
the fact that constraint widgets may manage the geometry of their children based on constraints
associated with each child. These constraints can be as simple as the maximum width and height
the parent will allow the child to occupy or can be as complicated as how other children should
change if this child is moved or resized. Constraint widgets let a parent define constraints as
resources that are supplied for their children. For example, if the Constraint parent defines the
maximum sizes for its children, these new size resources are retrieved for each child as if they
were resources that were defined by the child widget’s class. Accordingly, constraint resources
may be included in the argument list or resource file just like any other resource for the child.
Constraint widgets have all the responsibilities of normal composite widgets and, in addition,
must process and act upon the constraint information associated with each of their children.

To make it easy for widgets and the Intrinsics to keep track of the constraints associated with a
child, every widget has a constraints fi eld, which is the address of a parent-specific structure that
contains constraint information about the child. If a child’s parent does not belong to a subclass
of constraintWidgetClass, then the child’s constraints fi eld is NULL.

Subclasses of Constraint can add constraint data to the constraint record defined by their super-
class. To allow this, widget writers should define the constraint records in their private .h fi le by
using the same conventions as used for widget records. For example, a widget class that needs to
maintain a maximum width and height for each child might define its constraint record as fol-
lows:

typedef struct {
    Dimension max_width, max_height;
} MaxConstraintPart;

typedef struct {
    MaxConstraintPart max;
} MaxConstraintRecord, *MaxConstraint;

A subclass of this widget class that also needs to maintain a minimum size would define its con-
straint record as follows:

typedef struct {
    Dimension min_width, min_height;
} MinConstraintPart;

typedef struct {
    MaxConstraintPart max;
    MinConstraintPart min;
} MaxMinConstraintRecord, *MaxMinConstraint;

Constraints are allocated, initialized, deallocated, and otherwise maintained insofar as possible by
the Intrinsics. The Constraint class record part has several entries that facilitate this. All entries
in ConstraintClassPart are fi elds and procedures that are defined and implemented by the par-
ent, but they are called whenever actions are performed on the parent’s children.
The **XtCreateWidget** function uses the `constraint_size` field in the parent’s class record to allocate a constraint record when a child is created. **XtCreateWidget** also uses the constraint resources to fill in resource fields in the constraint record associated with a child. It then calls the constraint initialize procedure so that the parent can compute constraint fields that are derived from constraint resources and can possibly move or resize the child to conform to the given constraints.

When the **XtGetValues** and **XtSetValues** functions are executed on a child, they use the constraint resources to get the values or set the values of constraints associated with that child. **XtSetValues** then calls the constraint set_values procedures so that the parent can recompute derived constraint fields and move or resize the child as appropriate. If a Constraint widget class or any of its superclasses have declared a **ConstraintClassExtension** record in the **ConstraintClassPart** extension fields with a record type of **NULLQUARK** and the `get_values_hook` field in the extension record is non-NULL, **XtGetValues** calls the `get_values_hook` procedure(s) to allow the parent to return derived constraint fields.

The **XtDestroyWidget** function calls the constraint destroy procedure to deallocate any dynamic storage associated with a constraint record. The constraint record itself must not be deallocated by the constraint destroy procedure; **XtDestroyWidget** does this automatically.
Chapter 4

Shell Widgets

Shell widgets hold an application’s top-level widgets to allow them to communicate with the window manager and session manager. Shells have been designed to be as nearly invisible as possible. Clients have to create them, but they should never have to worry about their sizes.

If a shell widget is resized from the outside (typically by a window manager), the shell widget also resizes its managed child widget automatically. Similarly, if the shell’s child widget needs to change size, it can make a geometry request to the shell, and the shell negotiates the size change with the outer environment. Clients should never attempt to change the size of their shells directly.

The five types of public shells are:

**OverrideShell**
- Used for shell windows that completely bypass the window manager (for example, pop-up menu shells).

**TransientShell**
- Used for shell windows that have the WM_TRANSIENT_FOR property set. The effect of this property is dependent upon the window manager being used.

**TopLevelShell**
- Used for normal top-level windows (for example, any additional top-level widgets an application needs).

**ApplicationShell**
- Formerly used for the single main top-level window that the window manager identifies as an application instance and made obsolete by SessionShell.

**SessionShell**
- Used for the single main top-level window that the window manager identifies as an application instance and that interacts with the session manager.

### 4.1. Shell Widget Definitions

Widgets negotiate their size and position with their parent widget, that is, the widget that directly contains them. Widgets at the top of the hierarchy do not have parent widgets. Instead, they must deal with the outside world. To provide for this, each top-level widget is encapsulated in a special widget, called a shell widget.

Shell widgets, whose class is a subclass of the Composite class, encapsulate other widgets and can allow a widget to avoid the geometry clipping imposed by the parent-child window relationship. They also can provide a layer of communication with the window manager.

The eight different types of shells are:

**Shell**
- The base class for shell widgets; provides the fields needed for all types of shells. Shell is a direct subclass of `compositeWidgetClass`.

**OverrideShell**
- A subclass of Shell; used for shell windows that completely bypass the window manager.
WMShell
A subclass of Shell; contains fields needed by the common window manager protocol.

VendorShell
A subclass of WMShell; contains fields used by vendor-specific window managers.

TransientShell
A subclass of VendorShell; used for shell windows that desire the WM_TRANSIENT_FOR property.

TopLevelShell
A subclass of VendorShell; used for normal top-level windows.

ApplicationShell
A subclass of TopLevelShell; may be used for an application’s additional root windows.

SessionShell
A subclass of ApplicationShell; used for an application’s main root window.

Note that the classes Shell, WMShell, and VendorShell are internal and should not be instantiated or subclassed. Only OverrideShell, TransientShell, TopLevelShell, ApplicationShell, and SessionShell are intended for public use.

4.1.1. ShellClassPart Definitions
Only the Shell class has additional class fields, which are all contained in the ShellClassExtensionRec. None of the other Shell classes have any additional class fields:

typedef struct {
    XtPointer extension;
} ShellClassPart, OverrideShellClassPart,
WMShellClassPart, VendorShellClassPart, TransientShellClassPart,
TopLevelShellClassPart, ApplicationShellClassPart, SessionShellClassPart;

The full Shell class record definitions are:

typedef struct _ShellClassRec {
    CoreClassPart core_class;
    CompositeClassPart composite_class;
    ShellClassPart shell_class;
} ShellClassRec;

typedef struct {
    XtPointer next_extension; See Section 1.6.12
    XrmQuark record_type; See Section 1.6.12
    long version; See Section 1.6.12
    Cardinal record_size; See Section 1.6.12
    XtGeometryHandler root_geometry_manager; See below
} ShellClassExtensionRec, *ShellClassExtension;

typedef struct _OverrideShellClassRec {
    CoreClassPart core_class;
    CompositeClassPart composite_class;
    ShellClassPart shell_class;
    OverrideShellClassPart override_shell_class;
} OverrideShellClassRec;
typedef struct _WMShellClassRec {
    CoreClassPart      core_class;
    CompositeClassPart composite_class;
    ShellClassPart     shell_class;
    WMShellClassPart   wm_shell_class;
} WMShellClassRec;

typedef struct _VendorShellClassRec {
    CoreClassPart      core_class;
    CompositeClassPart composite_class;
    ShellClassPart     shell_class;
    WMShellClassPart   wm_shell_class;
    VendorShellClassPart vendor_shell_class;
} VendorShellClassRec;

typedef struct _TransientShellClassRec {
    CoreClassPart      core_class;
    CompositeClassPart composite_class;
    ShellClassPart     shell_class;
    WMShellClassPart   wm_shell_class;
    VendorShellClassPart vendor_shell_class;
    TransientShellClassPart transient_shell_class;
} TransientShellClassRec;

typedef struct _TopLevelShellClassRec {
    CoreClassPart      core_class;
    CompositeClassPart composite_class;
    ShellClassPart     shell_class;
    WMShellClassPart   wm_shell_class;
    VendorShellClassPart vendor_shell_class;
    TopLevelShellClassPart top_level_shell_class;
} TopLevelShellClassRec;

typedef struct _ApplicationShellClassRec {
    CoreClassPart      core_class;
    CompositeClassPart composite_class;
    ShellClassPart     shell_class;
    WMShellClassPart   wm_shell_class;
    VendorShellClassPart vendor_shell_class;
    TopLevelShellClassPart top_level_shell_class;
    ApplicationShellClassPart application_shell_class;
} ApplicationShellClassRec;

typedef struct _SessionShellClassRec {
    CoreClassPart      core_class;
    CompositeClassPart composite_class;
    ShellClassPart     shell_class;
    WMShellClassPart   wm_shell_class;
    VendorShellClassPart vendor_shell_class;
    TopLevelShellClassPart top_level_shell_class;
    ApplicationShellClassPart application_shell_class;
    SessionShellClassPart session_shell_class;
} SessionShellClassRec;
The single occurrences of the class records and pointers for creating instances of shells are:

```c
extern ShellClassRec shellClassRec;
extern OverrideShellClassRec overrideShellClassRec;
extern WMShellClassRec wmShellClassRec;
extern VendorShellClassRec vendorShellClassRec;
extern TransientShellClassRec transientShellClassRec;
extern TopLevelShellClassRec topLevelShellClassRec;
extern ApplicationShellClassRec applicationShellClassRec;
extern SessionShellClassRec sessionShellClassRec;

extern WidgetClass shellWidgetClass;
extern WidgetClass overrideShellWidgetClass;
extern WidgetClass wmShellWidgetClass;
extern WidgetClass vendorShellWidgetClass;
extern WidgetClass transientShellWidgetClass;
extern WidgetClass topLevelShellWidgetClass;
extern WidgetClass applicationShellWidgetClass;
extern WidgetClass sessionShellWidgetClass;
```

The following opaque types and opaque variables are defined for generic operations on widgets whose class is a subclass of Shell.

<table>
<thead>
<tr>
<th>Types</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>ShellWidget</td>
<td>shellWidgetClass</td>
</tr>
<tr>
<td>OverrideShellWidget</td>
<td>overrideShellWidgetClass</td>
</tr>
<tr>
<td>WMShellWidget</td>
<td>wmShellWidgetClass</td>
</tr>
<tr>
<td>VendorShellWidget</td>
<td>vendorShellWidgetClass</td>
</tr>
<tr>
<td>TransientShellWidget</td>
<td>transientShellWidgetClass</td>
</tr>
<tr>
<td>TopLevelShellWidget</td>
<td>topLevelShellWidgetClass</td>
</tr>
<tr>
<td>ApplicationShellWidget</td>
<td>applicationShellWidgetClass</td>
</tr>
<tr>
<td>SessionShellWidget</td>
<td>sessionShellWidgetClass</td>
</tr>
<tr>
<td>ShellWidgetClass</td>
<td></td>
</tr>
<tr>
<td>OverrideShellWidgetClass</td>
<td></td>
</tr>
<tr>
<td>WMShellWidgetClass</td>
<td></td>
</tr>
<tr>
<td>VendorShellWidgetClass</td>
<td></td>
</tr>
<tr>
<td>TransientShellWidgetClass</td>
<td></td>
</tr>
<tr>
<td>TopLevelShellWidgetClass</td>
<td></td>
</tr>
<tr>
<td>ApplicationShellWidgetClass</td>
<td></td>
</tr>
<tr>
<td>SessionShellWidgetClass</td>
<td></td>
</tr>
</tbody>
</table>

The declarations for all Intrinsics-defined shells except VendorShell appear in `Shell.h` and `ShellP.h`. VendorShell has separate public and private `.h` files which are included by `Shell.h` and `ShellP.h`.

`Shell.h` uses incomplete structure definitions to ensure that the compiler catches attempts to access private data in any of the Shell instance or class data structures.

The symbolic constant for the `ShellClassExtension` version identifier is `XtShellExtensionVersion` (see Section 1.6.12).
The root_geometry_manager procedure acts as the parent geometry manager for geometry requests made by shell widgets. When a shell widget calls either XtMakeGeometryRequest or XtMakeResizeRequest, the root_geometry_manager procedure is invoked to negotiate the new geometry with the window manager. If the window manager permits the new geometry, the root_geometry_manager procedure should return XtGeometryYes; if the window manager denies the geometry request or does not change the window geometry within some timeout interval (equal to wm_timeout in the case of WMShells), the root_geometry_manager procedure should return XtGeometryNo. If the window manager makes some alternative geometry change, the root_geometry_manager procedure may return either XtGeometryNo and handle the new geometry as a resize or XtGeometryAlmost in anticipation that the shell will accept the compromise. If the compromise is not accepted, the new size must then be handled as a resize. Subclasses of Shell that wish to provide their own root_geometry_manager procedures are strongly encouraged to use enveloping to invoke their superclass’s root_geometry_manager procedure under most situations, as the window manager interaction may be very complex.

If no ShellClassPart extension record is declared with record_type equal to NULLQUARK, then XtInheritRootGeometryManager is assumed.

### 4.1.2. ShellPart Definition

The various shell widgets have the following additional instance fields defined in their widget records:

```c
typedef struct {
    String geometry;
    XtCreatePopupChildProc create_popup_child_proc;
    XtGrabKind grab_kind;
    Boolean spring_loaded;
    Boolean popped_up;
    Boolean allow_shell_resize;
    Boolean client_specified;
    Boolean save_under;
    Boolean override_redirect;
    XtCallbackList popup_callback;
    XtCallbackList popdown_callback;
    Visual * visual;
} ShellPart;
```

```c
typedef struct {
    int empty;
} OverrideShellPart;
```

```c
typedef struct {
    String title;
    int wm_timeout;
    Boolean wait_for_wm;
    Boolean transient;
    Boolean urgency;
    Widget client_leader;
    String window_role;
    struct _OldXSizeHints {
        long flags;
        int x, y;
        int width, height;
    } xsizehints;
} ShellClassPart;
```
```c
int min_width, min_height;
int max_width, max_height;
int width_inc, height_inc;
struct {
    int x;
    int y;
} min_aspect, max_aspect;
} size_hints;
XWMHints wm_hints;
int base_width, base_height, win_gravity;
Atom title_encoding;
} WMShellPart;

typedef struct {
    int vendor_specific;
} VendorShellPart;

typedef struct {
    Widget transient_for;
} TransientShellPart;

typedef struct {
    String icon_name;
    Boolean iconic;
    Atom icon_name_encoding;
} TopLevelShellPart;

typedef struct {
    char * class;
    XrmClass xrm_class;
    int argc;
    char ** argv;
} ApplicationShellPart;

typedef struct {
    SmcConn connection;
    String session_id;
    String * restart_command;
    String * clone_command;
    String * discard_command;
    String * resign_command;
    String * shutdown_command;
    String * environment;
    String current_dir;
    String program_path;
    unsigned char restart_style;
    Boolean join_session;
    XtCallbackList save_callbacks;
    XtCallbackList interact_callbacks;
    XtCallbackList cancel_callbacks;
    XtCallbackList save_complete_callbacks;
    XtCallbackList die_callbacks;
    XtCallbackList error_callbacks;
} SessionShellPart;
```
The full shell widget instance record definitions are:

typedef struct {
   CorePart core;
   CompositePart composite;
   ShellPart shell;
} ShellRec, *ShellWidget;

typedef struct {
   CorePart core;
   CompositePart composite;
   ShellPart shell;
   OverrideShellPart override;
} OverrideShellRec, *OverrideShellWidget;

typedef struct {
   CorePart core;
   CompositePart composite;
   ShellPart shell;
   WMShellPart wm;
} WMShellRec, *WMShellWidget;

typedef struct {
   CorePart core;
   CompositePart composite;
   ShellPart shell;
   WMShellPart wm;
   VendorShellPart vendor;
} VendorShellRec, *VendorShellWidget;

typedef struct {
   CorePart core;
   CompositePart composite;
   ShellPart shell;
   WMShellPart wm;
   VendorShellPart vendor;
   TransientShellPart transient;
} TransientShellRec, *TransientShellWidget;

typedef struct {
   CorePart core;
   CompositePart composite;
   ShellPart shell;
   WMShellPart wm;
   VendorShellPart vendor;
   TopLevelShellPart topLevel;
} TopLevelShellRec, *TopLevelShellWidget;
typedef struct {
    CorePart core;
    CompositePart composite;
    ShellPart shell;
    WMShellPart wm;
    VendorShellPart vendor;
    TopLevelShellPart topLevel;
    ApplicationShellPart application;
} ApplicationShellRec, *ApplicationShellWidget;

typedef struct {
    CorePart core;
    CompositePart composite;
    ShellPart shell;
    WMShellPart wm;
    VendorShellPart vendor;
    TopLevelShellPart topLevel;
    ApplicationShellPart application;
    SessionShellPart session;
} SessionShellRec, *SessionShellWidget;

4.1.3. Shell Resources
The resource names, classes, and representation types specified in the shellClassRec resource list are:

<table>
<thead>
<tr>
<th>Name</th>
<th>Class</th>
<th>Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>XtNallowShellResize</td>
<td>XtCAllowShellResize</td>
<td>XTRBoolean</td>
</tr>
<tr>
<td>XtNcreatePopupChildProc</td>
<td>XtCCreatePopupChildProc</td>
<td>XTRFunction</td>
</tr>
<tr>
<td>XtNgeometry</td>
<td>XtCGeometry</td>
<td>XTRString</td>
</tr>
<tr>
<td>XtNoverrideRedirect</td>
<td>XtCOVERRIDE_REDIRECT</td>
<td>XTRBoolean</td>
</tr>
<tr>
<td>XtNpopupdownCallback</td>
<td>XtCCallback</td>
<td>XTRCallback</td>
</tr>
<tr>
<td>XtNpopupCallback</td>
<td>XtCCallback</td>
<td>XTRCallback</td>
</tr>
<tr>
<td>XtNsavemode</td>
<td>XtCSavemode</td>
<td>XTRBoolean</td>
</tr>
<tr>
<td>XtNvisual</td>
<td>XtCVisual</td>
<td>XTRVisual</td>
</tr>
</tbody>
</table>

OverrideShell declares no additional resources beyond those defined by Shell.

The resource names, classes, and representation types specified in the wmShellClassRec resource list are:

<table>
<thead>
<tr>
<th>Name</th>
<th>Class</th>
<th>Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>XtNbaseHeight</td>
<td>XtCBaseHeight</td>
<td>XTRInt</td>
</tr>
<tr>
<td>XtNbaseWidth</td>
<td>XtCBaseWidth</td>
<td>XTRInt</td>
</tr>
<tr>
<td>XtNclientLeader</td>
<td>XtCClientLeader</td>
<td>XTRWidget</td>
</tr>
<tr>
<td>XtNheightInc</td>
<td>XtCHeightInc</td>
<td>XTRInt</td>
</tr>
<tr>
<td>XtNiconMask</td>
<td>XtCIconMask</td>
<td>XTRBitmap</td>
</tr>
<tr>
<td>XtNiconPixmap</td>
<td>XtCIconPixmap</td>
<td>XTRBitmap</td>
</tr>
</tbody>
</table>
The class resource list for VendorShell is implementation-defined.

The resource names, classes, and representation types that are specified in the transient-ShellClassRec resource list are:

<table>
<thead>
<tr>
<th>Name</th>
<th>Class</th>
<th>Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>XtNtransientFor</td>
<td>XtCTransientFor</td>
<td>XtRWidget</td>
</tr>
</tbody>
</table>

The resource names, classes, and representation types that are specified in the topLevelShellClassRec resource list are:

<table>
<thead>
<tr>
<th>Name</th>
<th>Class</th>
<th>Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>XtNiconName</td>
<td>XtCIconName</td>
<td>XtRString</td>
</tr>
<tr>
<td>XtNiconNameEncoding</td>
<td>XtCIconNameEncoding</td>
<td>XtRAtom</td>
</tr>
<tr>
<td>XtNiconic</td>
<td>XtCIconic</td>
<td>XtRBoolean</td>
</tr>
</tbody>
</table>

The resource names, classes, and representation types that are specified in the application-ShellClassRec resource list are:

<table>
<thead>
<tr>
<th>Name</th>
<th>Class</th>
<th>Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>XtNargc</td>
<td>XtCArgc</td>
<td>XtRInt</td>
</tr>
<tr>
<td>XtNargv</td>
<td>XtCArgv</td>
<td>XtRStringArray</td>
</tr>
</tbody>
</table>
The resource names, classes, and representation types that are specified in the `sessionShellClassRec` resource list are:

<table>
<thead>
<tr>
<th>Name</th>
<th>Class</th>
<th>Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>XtNcancelCallback</td>
<td>XtCCallback</td>
<td>XtRCallback</td>
</tr>
<tr>
<td>XtNcloneCommand</td>
<td>XtCCloneCommand</td>
<td>XtRCommandArgArray</td>
</tr>
<tr>
<td>XtNconnection</td>
<td>XtCConnection</td>
<td>XtRSmCConn</td>
</tr>
<tr>
<td>XtNcurrentDirectory</td>
<td>XtCCurrentDirectory</td>
<td>XtRDirectoryString</td>
</tr>
<tr>
<td>XtNdieCallback</td>
<td>XtCCallback</td>
<td>XtRCallback</td>
</tr>
<tr>
<td>XtNdiscardCommand</td>
<td>XtCDiscardCommand</td>
<td>XtRCommandArgArray</td>
</tr>
<tr>
<td>XtNenvironment</td>
<td>XtCEnvironment</td>
<td>XtREnvironmentArray</td>
</tr>
<tr>
<td>XtNerrorCallback</td>
<td>XtCCallback</td>
<td>XtRCallback</td>
</tr>
<tr>
<td>XtNinteractCallback</td>
<td>XtCCallback</td>
<td>XtRCallback</td>
</tr>
<tr>
<td>XtNjoinSession</td>
<td>XtCJoinSession</td>
<td>XtRBoolean</td>
</tr>
<tr>
<td>XtNprogramPath</td>
<td>XtCProgramPath</td>
<td>XtRString</td>
</tr>
<tr>
<td>XtNresignCommand</td>
<td>XtCResignCommand</td>
<td>XtRCommandArgArray</td>
</tr>
<tr>
<td>XtNrestartCommand</td>
<td>XtCRestartCommand</td>
<td>XtRCommandArgArray</td>
</tr>
<tr>
<td>XtNrestartStyle</td>
<td>XtCRestartStyle</td>
<td>XtRRestartStyle</td>
</tr>
<tr>
<td>XtNsavelCallback</td>
<td>XtCCallback</td>
<td>XtRCallback</td>
</tr>
<tr>
<td>XtNsavecompleteCallback</td>
<td>XtCCallback</td>
<td>XtRCallback</td>
</tr>
<tr>
<td>XtNsessionID</td>
<td>XtCSessionID</td>
<td>XtRString</td>
</tr>
<tr>
<td>XtNshutdownCommand</td>
<td>XtCShutdownCommand</td>
<td>XtRCommandArgArray</td>
</tr>
</tbody>
</table>

### 4.1.4. ShellPart Default Values

The default values for fields common to all classes of public shells (filled in by the Shell resource lists and the Shell initialize procedures) are:

<table>
<thead>
<tr>
<th>Field</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>geometry</td>
<td>NULL</td>
</tr>
<tr>
<td>create_popup_child_proc</td>
<td>NULL</td>
</tr>
<tr>
<td>grab_kind</td>
<td>(none)</td>
</tr>
<tr>
<td>spring_loaded</td>
<td>(none)</td>
</tr>
<tr>
<td>popped_up</td>
<td>False</td>
</tr>
<tr>
<td>allow_shell_resize</td>
<td>False</td>
</tr>
<tr>
<td>client_specified</td>
<td>(internal)</td>
</tr>
<tr>
<td>save_under</td>
<td>True for OverrideShell and TransientShell, False otherwise</td>
</tr>
<tr>
<td>override_redirect</td>
<td>True for OverrideShell, False otherwise</td>
</tr>
<tr>
<td>popup_callback</td>
<td>NULL</td>
</tr>
<tr>
<td>popdown_callback</td>
<td>NULL</td>
</tr>
<tr>
<td>visual</td>
<td>CopyFromParent</td>
</tr>
</tbody>
</table>

The `geometry` field specifies the size and position and is usually given only on a command line or in a defaults file. If the `geometry` field is non-NULL when a widget of class WMShell is realized, the geometry specification is parsed using `XWMGeometry` with a default geometry string constructed from the values of `x`, `y`, `width`, `height`, `width_inc`, and `height_inc` and the size and position flags in the window manager size hints are set. If the geometry specifies an `x` or `y` position, then `USPosition` is set. If the geometry specifies a width or height, then `USSize` is set. Any fields in the geometry specification override the corresponding values in the Core `x`, `y`, `width`, and `height` fields. If `geometry` is NULL or contains only a partial specification, then the Core `x`, `y`, `width`, and
height fields are used and PPosition and PSize are set as appropriate. The geometry string is not copied by any of the Intrinsics Shell classes; a client specifying the string in an arglist or varargs list must ensure that the value remains valid until the shell widget is realized. For further information on the geometry string, see Section 16.4 in Xlib — C Language X Interface.

The create_popup_child_proc procedure is called by the XtPopup procedure and may remain NULL. The grab_kind, spring_loaded, and popped_up fields maintain widget state information as described under XtPopup, XtMenuPopup, XtPopdown, and XtMenuPopdown. The allow_shell_resize field controls whether the widget contained by the shell is allowed to try to resize itself. If allow_shell_resize is False, any geometry requests made by the child will always return XtGeometryNo without interacting with the window manager. Setting save_under True instructs the server to attempt to save the contents of windows obscured by the shell when it is mapped and to restore those contents automatically when the shell is unmapped. It is useful for pop-up menus. Setting override_redirect True determines whether the window manager can intercede when the shell window is mapped. For further information on override_redirect, see Section 3.2 in Xlib — C Language X Interface and Sections 4.1.10 and 4.2.2 in the Inter-Client Communication Conventions Manual. The pop-up and pop-down callbacks are called during XtPopup and XtPopdown. The default value of the visual resource is the symbolic value CopyFromParent. The Intrinsics do not need to query the parent’s visual type when the default value is used; if a client using XtGetValues to examine the visual type receives the value CopyFromParent, it must then use XGetWindowAttributes if it needs the actual visual type.

The default values for Shell fields in WMShell and its subclasses are:

<table>
<thead>
<tr>
<th>Field</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>title</td>
<td>Icon name, if specified, otherwise the application’s name</td>
</tr>
<tr>
<td>wm_timeout</td>
<td>Five seconds, in units of milliseconds</td>
</tr>
<tr>
<td>wait_for_wm</td>
<td>True</td>
</tr>
<tr>
<td>transient</td>
<td>True for TransientShell, False otherwise</td>
</tr>
<tr>
<td>urgency</td>
<td>False</td>
</tr>
<tr>
<td>client_leader</td>
<td>NULL</td>
</tr>
<tr>
<td>window_role</td>
<td>NULL</td>
</tr>
<tr>
<td>min_width</td>
<td>XtUnspecifiedShellInt</td>
</tr>
<tr>
<td>min_height</td>
<td>XtUnspecifiedShellInt</td>
</tr>
<tr>
<td>max_width</td>
<td>XtUnspecifiedShellInt</td>
</tr>
<tr>
<td>max_height</td>
<td>XtUnspecifiedShellInt</td>
</tr>
<tr>
<td>width_inc</td>
<td>XtUnspecifiedShellInt</td>
</tr>
<tr>
<td>height_inc</td>
<td>XtUnspecifiedShellInt</td>
</tr>
<tr>
<td>min_aspect_x</td>
<td>XtUnspecifiedShellInt</td>
</tr>
<tr>
<td>min_aspect_y</td>
<td>XtUnspecifiedShellInt</td>
</tr>
<tr>
<td>max_aspect_x</td>
<td>XtUnspecifiedShellInt</td>
</tr>
<tr>
<td>max_aspect_y</td>
<td>XtUnspecifiedShellInt</td>
</tr>
<tr>
<td>input</td>
<td>False</td>
</tr>
<tr>
<td>initial_state</td>
<td>Normal</td>
</tr>
<tr>
<td>icon_pixmap</td>
<td>None</td>
</tr>
<tr>
<td>icon_window</td>
<td>None</td>
</tr>
<tr>
<td>icon_x</td>
<td>XtUnspecifiedShellInt</td>
</tr>
<tr>
<td>icon_y</td>
<td>XtUnspecifiedShellInt</td>
</tr>
<tr>
<td>icon_mask</td>
<td>None</td>
</tr>
<tr>
<td>window_group</td>
<td>XtUnspecifiedShellInt</td>
</tr>
<tr>
<td>base_width</td>
<td>XtUnspecifiedShellInt</td>
</tr>
<tr>
<td>base_height</td>
<td>XtUnspecifiedShellInt</td>
</tr>
</tbody>
</table>
The title and title_encoding fields are stored in the WM_NAME property on the shell’s window by the WMShell realize procedure. If the title_encoding field is None, the title string is assumed to be in the encoding of the current locale and the encoding of the WM_NAME property is set to XStdICCTextStyle. If a language procedure has not been set the default value of title_encoding is XA_STRING, otherwise the default value is None. The wm_timeout field specifies, in milliseconds, the amount of time a shell is to wait for confirmation of a geometry request to the window manager. If none comes back within that time, the shell assumes the window manager is not functioning properly and sets wait_for_wm to False (later events may reset this value). When wait_for_wm is False, the shell does not wait for a response, but relies on asynchronous notification. If transient is True, the WM_TRANSIENT_FOR property will be stored on the shell window with a value as specified below. The interpretation of this property is specific to the window manager under which the application is run; see the Inter-Client Communication Conventions Manual for more details.

The realize and set_values procedures of WMShell store the WM_CLIENT_LEADER property on the shell window. When client_leader is not NULL and the client leader widget is realized, the property will be created with the value of the window of the client leader widget. When client_leader is NULL and the shell window has a NULL parent, the widget’s window is used as the value of the property. When client_leader is NULL and the shell window has a non-NULL parent, a search is made for the closest shell ancestor with a non-NULL client_leader, and if none is found the shell ancestor with a NULL parent is the result. If the resulting widget is realized, the property is created with the value of the widget’s window.

When the value of window_role is not NULL, the realize and set_values procedures store the WM_WINDOW_ROLE property on the shell window with the value of the resource. All other resources specify fields in the window manager hints and the window manager size hints. The realize and set_values procedures of WMShell set the corresponding flag bits in the hints if any of the fields contain nondefault values. In addition, if a flag bit is set that refers to a field with the value XtUnspecifiedShellInt, the value of the field is modified as follows:

<table>
<thead>
<tr>
<th>Field</th>
<th>Replacement</th>
</tr>
</thead>
<tbody>
<tr>
<td>base_width, base_height</td>
<td>0</td>
</tr>
<tr>
<td>width_inc, height_inc</td>
<td>1</td>
</tr>
<tr>
<td>max_width, max_height</td>
<td>32767</td>
</tr>
<tr>
<td>min_width, min_height</td>
<td>1</td>
</tr>
<tr>
<td>min_aspect_x, min_aspect_y</td>
<td>-1</td>
</tr>
<tr>
<td>max_aspect_x, max_aspect_y</td>
<td>-1</td>
</tr>
<tr>
<td>icon_x, icon_y</td>
<td>-1</td>
</tr>
<tr>
<td>win_gravity</td>
<td>Value returned by XWMGeometry if called, else NorthWestGravity</td>
</tr>
</tbody>
</table>

If the shell widget has a non-NULL parent, then the realize and set_values procedures replace the value XtUnspecifiedWindow in the window_group field with the window id of the root widget of the widget tree if the root widget is realized. The symbolic constant XtUnspecifiedWindowGroup may be used to indicate that the window_group hint flag bit is not to be set. If transient is True, the shell’s class is not a subclass of TransientShell, and window_group is not XtUnspecifiedWindowGroup, the WMShell realize and set_values procedures then store the WM_TRANSIENT_FOR property with the value of window_group.
Transient shells have the following additional resource:

<table>
<thead>
<tr>
<th>Field</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>transient_for</td>
<td>NULL</td>
</tr>
</tbody>
</table>

The realize and set_values procedures of TransientShell store the `WM_TRANSIENT_FOR` property on the shell window if `transient` is `True`. If `transient_for` is non-NULL and the widget specified by `transient_for` is realized, then its window is used as the value of the `WM_TRANSIENT_FOR` property; otherwise, the value of `window_group` is used.

**TopLevel** shells have the following additional resources:

<table>
<thead>
<tr>
<th>Field</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>icon_name</td>
<td>Shell widget’s name</td>
</tr>
<tr>
<td>iconic</td>
<td>False</td>
</tr>
<tr>
<td>icon_name_encoding</td>
<td>See text</td>
</tr>
</tbody>
</table>

The `icon_name` and `icon_name_encoding` fields are stored in the `WM_ICON_NAME` property on the shell’s window by the TopLevelShell realize procedure. If the `icon_name_encoding` field is `None`, the `icon_name` string is assumed to be in the encoding of the current locale and the encoding of the `WM_ICON_NAME` property is set to `XStdICCTextStyle`. If a language procedure has not been set, the default value of `icon_name_encoding` is `XA_STRING`, otherwise the default value is `None`. The `iconic` field may be used by a client to request that the window manager iconify or deiconify the shell; the TopLevelShell set_values procedure will send the appropriate `WM_CHANGE_STATE` message (as specified by the `Inter-Client Communication Conventions Manual`) if this resource is changed from `False` to `True` and will call `XtPopup` specifying `grab_kind` as `XtGrabNone` if `iconic` is changed from `True` to `False`. The `XtNiconic` resource is also an alternative way to set the `XtNinitialState` resource to indicate that a shell should be initially displayed as an icon; the TopLevelShell initialize procedure will set `initial_state` to `Iconic-State` if `iconic` is `True`.

Application shells have the following additional resources:

<table>
<thead>
<tr>
<th>Field</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>argc</td>
<td>0</td>
</tr>
<tr>
<td>argv</td>
<td>NULL</td>
</tr>
</tbody>
</table>

The `argc` and `argv` fields are used to initialize the standard property `WM_COMMAND`. See the `Inter-Client Communication Conventions Manual` for more information.

The default values for the SessionShell instance fields, which are filled in from the resource lists and by the initialize procedure, are:

<table>
<thead>
<tr>
<th>Field</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>cancel_callbacks</td>
<td>NULL</td>
</tr>
<tr>
<td>clone_command</td>
<td>See text</td>
</tr>
<tr>
<td>connection</td>
<td>NULL</td>
</tr>
<tr>
<td>current_dir</td>
<td>NULL</td>
</tr>
<tr>
<td>die_callbacks</td>
<td>NULL</td>
</tr>
</tbody>
</table>
discard_command: NULL
environment: NULL
error_callbacks: NULL
interact_callbacks: NULL
join_session: True
program_path: See text
resign_command: NULL
restart_command: See text
restart_style: SmRestartIfRunning
save_callbacks: NULL
save_complete_callbacks: NULL
session_id: NULL
shutdown_command: NULL

The connection field contains the session connection object or NULL if a session connection is not being managed by this widget.

The session_id is an identification assigned to the session participant by the session manager. The session_id will be passed to the session manager as the client identifier of the previous session. When a connection is established with the session manager, the client id assigned by the session manager is stored in the session_id field. When not NULL, the session_id of the Session shell widget that is at the root of the widget tree of the client leader widget will be used to create the SM_CLIENT_ID property on the client leader's window.

If join_session is False, the widget will not attempt to establish a connection to the session manager at shell creation time. See Sections 4.2.1 and 4.2.4 for more information on the functionality of this resource.

The restart_command, clone_command, discard_command, resign_command, shutdown_command, environment, current_dir, program_path, and restart_style fields contain standard session properties.

When a session connection is established or newly managed by the shell, the shell initialize and set_values methods check the values of the restart_command, clone_command, and program_path resources. At that time, if restart_command is NULL, the value of the argv resource will be copied to restart_command. Whether or not restart_command was NULL, if “-xtsessionID” “<session id>” does not already appear in the restart_command, it will be added by the initialize and set_values methods at the beginning of the command arguments; if the “-xsessionID” argument already appears with an incorrect session id in the following argument, that argument will be replaced with the current session id.

After this, the shell initialize and set_values procedures check the clone_command. If clone_command is NULL, restart_command will be copied to clone_command, except the “-xsessionID” and following argument will not be copied.

Finally, the shell initialize and set_values procedures check the program_path. If program_path is NULL, the first element of restart_command is copied to program_path.

The possible values of restart_style are SmRestartIfRunning, SmRestartAnyway, SmRestartImmediately, and SmRestartNever. A resource converter is registered for this resource; for the strings that it recognizes, see Section 9.6.1.

The resource type EnvironmentArray is a NULL-terminated array of pointers to strings; each string has the format "name=value". The ‘=’ character may not appear in the name, and the string is terminated by a null character.
4.2. Session Participation

Applications can participate in a user’s session, exchanging messages with the session manager as described in the X Session Management Protocol and the X Session Management Library.

When a widget of sessionShellWidgetClass or a subclass is created, the widget provides support for the application as a session participant and continues to provide support until the widget is destroyed.

4.2.1. Joining a Session

When a Session shell is created, if connection is NULL, and if join_session is True, and if argv or restart_command is not NULL, and if in POSIX environments the SESSION_MANAGER environment variable is defined, the shell will attempt to establish a new connection with the session manager.

To transfer management of an existing session connection from an application to the shell at widget creation time, pass the existing session connection ID as the connection resource value when creating the Session shell, and if the other creation-time conditions on session participation are met, the widget will maintain the connection with the session manager. The application must ensure that only one Session shell manages the connection.

In the Session shell set_values procedure, if join_session changes from False to True and connection is NULL and when in POSIX environments the SESSION_MANAGER environment variable is defined, the shell will attempt to open a connection to the session manager. If connection changes from NULL to non-NULL, the Session shell will take over management of that session connection and will set join_session to True. If join_session changes from False to True and connection is not NULL, the Session shell will take over management of the session connection.

When a successful connection has been established, connection contains the session connection ID for the session participant. When the shell begins to manage the connection, it will call XtAppAddInput to register the handler which watches for protocol messages from the session manager. When the attempt to connect fails, a warning message is issued and connection is set to NULL.

While the connection is being managed, if a SaveYourself, SaveYourselfPhase2, Interact, ShutdownCancelled, SaveComplete, or Die message is received from the session manager, the Session shell will call out to application callback procedures registered on the respective callback list of the Session shell and will send SaveYourselfPhase2Request, InteractRequest, InteractDone, SaveYourselfDone, and ConnectionClosed messages as appropriate. Initially, all of the client’s session properties are undefined. When any of the session property resource values are defined or change, the Session shell initialize and set_values procedures will update the client’s session property value by a SetProperties or a DeleteProperties message, as appropriate. The session ProcessID and UserID properties are always set by the shell when it is possible to determine the value of these properties.

4.2.2. Saving Application State

The session manager instigates an application checkpoint by sending a SaveYourself request. Applications are responsible for saving their state in response to the request.

When the SaveYourself request arrives, the procedures registered on the Session shell’s save callback list are called. If the application does not register any save callback procedures on the save callback list, the shell will report to the session manager that the application failed to save its state. Each procedure on the save callback list receives a token in the call_data parameter.
The checkpoint token in the \textit{call_data} parameter is of type \texttt{XtCheckpointToken}.

```c
typedef struct {
    int save_type;
    int interact_style;
    Boolean shutdown;
    Boolean fast;
    Boolean cancel_shutdown
    int phase;
    int interact_dialog_type; /* return */
    Boolean request_cancel; /* return */
    Boolean request_next_phase; /* return */
    Boolean save_success; /* return */
} XtCheckpointTokenRec, *XtCheckpointToken;
```

The \textit{save_type}, \textit{interact_style}, \textit{shutdown}, and \textit{fast} fields of the token contain the parameters of the \texttt{SaveYourself} message. The possible values of \textit{save_type} are \texttt{SmSaveLocal}, \texttt{SmSaveGlobal}, and \texttt{SmSaveBoth}; these indicate the type of information to be saved. The possible values of \textit{interact_style} are \texttt{SmInteractStyleNone}, \texttt{SmInteractStyleErrors}, and \texttt{SmInteractStyleAny}; these indicate whether user interaction would be permitted and, if so, what kind of interaction. If \textit{shutdown} is \texttt{True}, the checkpoint is being performed in preparation for the end of the session. If \textit{fast} is \texttt{True}, the client should perform the checkpoint as quickly as possible. If \textit{cancel_shutdown} is \texttt{True}, a \texttt{ShutdownCancelled} message has been received for the current save operation. (See Section 4.4.4.) The \textit{phase} is used by manager clients, such as a window manager, to distinguish between the first and second phase of a save operation. The \textit{phase} will be either 1 or 2. The remaining fields in the checkpoint token structure are provided for the application to communicate with the shell.

Upon entry to the first application save callback procedure, the return fields in the token have the following initial values: \textit{interact_dialog_type} is \texttt{SmDialogNormal}; \textit{request_cancel} is \texttt{False}; \textit{request_next_phase} is \texttt{False}; and \textit{save_success} is \texttt{True}. When a token is returned with any of the four return fields containing a noninitial value, and when the field is applicable, subsequent tokens passed to the application during the current save operation will always contain the noninitial value.

The purpose of the token’s \textit{save_success} field is to indicate the outcome of the entire operation to the session manager and ultimately, to the user. Returning \texttt{False} indicates some portion of the application state could not be successfully saved. If any token is returned to the shell with \textit{save_success False}, tokens subsequently received by the application for the current save operation will show \textit{save_success} as \texttt{False}. When the shell sends the final status of the checkpoint to the session manager, it will indicate failure to save application state if any token was returned with \textit{save_success False}.

Session participants that manage and save the state of other clients should structure their save or interact callbacks to set \textit{request_next_phase} to \texttt{True} when phase is 1, which will cause the shell to send the \texttt{SaveYourselfPhase2Request} when the first phase is complete. When the \texttt{SaveYourselfPhase2} message is received, the shell will invoke the save callbacks a second time with \textit{phase} equal to 2. Manager clients should save the state of other clients when the callbacks are invoked the second time and \textit{phase} equal to 2.

The application may request additional tokens while a checkpoint is under way, and these additional tokens must be returned by an explicit call.
To request an additional token for a save callback response that has a deferred outcome, use `XtSessionGetToken`.

```c
XtCheckpointToken XtSessionGetToken(widget)
    Widget widget;

    widget Specifi es the Session shell widget which manages session participation.
```

The `XtSessionGetToken` function will return NULL if no checkpoint operation is currently underway.

To indicate the completion of checkpoint processing including user interaction, the application must signal the Session shell by returning all tokens. (See Sections 4.2.2.2 and 4.2.2.4). To return a token, use `XtSessionReturnToken`.

```c
void XtSessionReturnToken(token)
    XtCheckpointToken token;

    token Specifi es a token that was received as the call_data by a procedure on the interact callback list or a token that was received by a call to XtSessionGetToken.
```

Tokens passed as call_data to save callbacks are implicitly returned when the save callback procedure returns. A save callback procedure should not call `XtSessionReturnToken` on the token passed in its call_data.

### 4.2.2.1. Requesting Interaction

When the token `interact_style` allows user interaction, the application may interact with the user during the checkpoint, but must wait for permission to interact. Applications request permission to interact with the user during the checkpointing operation by registering a procedure on the Session shell’s interact callback list. When all save callback procedures have returned, and each time a token that was granted by a call to `XtSessionGetToken` is returned, the Session shell examines the interact callback list. If interaction is permitted and the interact callback list is not empty, the shell will send an `InteractRequest` to the session manager when an interact request is not already outstanding for the application.

The type of interaction dialog that will be requested is specified by the `interact_dialog_type` field in the checkpoint token. The possible values for `interact_dialog_type` are `SmDialogError` and `SmDialogNormal`. If a token is returned with `interact_dialog_type` containing `SmDialogError`, the interact request and any subsequent interact requests will be for an error dialog; otherwise, the request will be for a normal dialog with the user.

When a token is returned with `save_success` **False** or `interact_dialog_type` `SmDialogError`, tokens subsequently passed to callbacks during the same active `SaveYourself` response will reflect these changed values, indicating that an error condition has occurred during the checkpoint.

The `request_cancel` field is a return value for interact callbacks only. Upon return from a procedure on the save callback list, the value of the token’s `request_cancel` field is not examined by the shell. This is also true of tokens received through a call to `XtSessionGetToken`. 
4.2.2.2. Interacting with the User during a Checkpoint
When the session manager grants the application’s request for user interaction, the Session shell receives an Interact message. The procedures registered on the interact callback list are executed, but not as if executing a typical callback list. These procedures are individually executed in sequence, with a checkpoint token functioning as the sequencing mechanism. Each step in the sequence begins by removing a procedure from the interact callback list and executing it with a token passed in the call_data. The interact callback will typically pop up a dialog box and return. When the user interaction and associated application checkpointing has completed, the application must return the token by calling XtSessionReturnToken. Returning the token completes the current step and triggers the next step in the sequence.

During interaction the client may request cancellation of a shutdown. When a token passed as call_data to an interact procedure is returned, if shutdown is True and cancel_shutdown is False, request_cancel indicates whether the application requests that the pending shutdown be cancelled. If request_cancel is True, the field will also be True in any tokens subsequently granted during the checkpoint operation. When a token is returned requesting cancellation of the session shutdown, pending interact procedures will still be called by the Session shell. When all interact procedures have been removed from the interact callback list, executed, and the final interact token returned to the shell, an InteractDone message is sent to the session manager, indicating whether a pending session shutdown is requested to be cancelled.

4.2.2.3. Responding to a Shutdown Cancellation
Callbacks registered on the cancel callback list are invoked when the Session shell processes a ShutdownCancelled message from the session manager. This may occur during the processing of save callbacks, while waiting for interact permission, during user interaction, or after the save operation is complete and the application is expecting a SaveComplete or a Die message. The call_data for these callbacks is NULL.

When the shell notices that a pending shutdown has been cancelled, the token cancel_shutdown field will be True in tokens subsequently given to the application.

Receiving notice of a shutdown cancellation does not cancel the pending execution of save callbacks or interact callbacks. After the cancel callbacks execute, if interact_style is not SmInteractStyleNone and the interact list is not empty, the procedures on the interact callback list will be executed and passed a token with interact_style SmInteractStyleNone. The application should not interact with the user, and the Session shell will not send an InteractDone message.

4.2.2.4. Completing a Save
When there is no user interaction, the shell regards the application as having finished saving state when all callback procedures on the save callback list have returned, and any additional tokens passed out by XtSessionGetToken have been returned by corresponding calls to XtSessionReturnToken. If the save operation involved user interaction, the above completion conditions apply, and in addition, all requests for interaction have been granted or cancelled, and all tokens passed to interact callbacks have been returned through calls to XtSessionReturnToken. If the save operation involved a manager client that requested the second phase, the above conditions apply to both the first and second phase of the save operation.

When the application has finished saving state, the Session shell will report the result to the session manager by sending the SaveYourselfDone message. If the session is continuing, the shell will receive the SaveComplete message when all applications have completed saving state. This message indicates that applications may again allow changes to their state. The shell will execute the save_complete callbacks. The call_data for these callbacks is NULL.
4.2.3. Responding to a Shutdown

Callbacks registered on the die callback list are invoked when the session manager sends a Die message. The callbacks on this list should do whatever is appropriate to quit the application. Before executing procedures on the die callback list, the Session shell will close the connection to the session manager and will remove the handler that watches for protocol messages. The call_data for these callbacks is NULL.

4.2.4. Resigning from a Session

When the Session shell widget is destroyed, the destroy method will close the connection to the session manager by sending a ConnectionClosed protocol message and will remove the input callback that was watching for session protocol messages.

When XtSetValues is used to set join_session to False, the set_values method of the Session shell will close the connection to the session manager if one exists by sending a ConnectionClosed message, and connection will be set to NULL.

Applications that exit in response to user actions and that do not wait for phase 2 destroy to complete on the Session shell should set join_session to False before exiting.

When XtSetValues is used to set connection to NULL, the Session shell will stop managing the connection, if one exists. However, that session connection will not be closed.

Applications that wish to ensure continuation of a session connection beyond the destruction of the shell should first retrieve the connection resource value, then set the connection resource to NULL, and then they may safely destroy the widget without losing control of the session connection.

The error callback list will be called if an unrecoverable communications error occurs while the shell is managing the connection. The shell will close the connection, set connection to NULL, remove the input callback, and call the procedures registered on the error callback list. The call_data for these callbacks is NULL.
Chapter 5

Pop-Up Widgets

Pop-up widgets are used to create windows outside of the window hierarchy defined by the widget tree. Each pop-up child has a window that is a descendant of the root window, so that the pop-up window is not clipped by the pop-up widget’s parent window. Therefore, pop-ups are created and attached differently to their widget parent than normal widget children.

A parent of a pop-up widget does not actively manage its pop-up children; in fact, it usually does not operate upon them in any way. The `popup_list` field in the `CorePart` structure contains the list of its pop-up children. This pop-up list exists mainly to provide the proper place in the widget hierarchy for the pop-up to get resources and to provide a place for `XtDestroyWidget` to look for all extant children.

A composite widget can have both normal and pop-up children. A pop-up can be popped up from almost anywhere, not just by its parent. The term `child` always refers to a normal, geometry-managed widget on the composite widget’s list of children, and the term `pop-up child` always refers to a widget on the pop-up list.

5.1. Pop-Up Widget Types

There are three kinds of pop-up widgets:

- **Modeless pop-ups**
  A modeless pop-up (for example, a dialog box that does not prevent continued interaction with the rest of the application) can usually be manipulated by the window manager and looks like any other application window from the user’s point of view. The application main window itself is a special case of a modeless pop-up.

- **Modal pop-ups**
  A modal pop-up (for example, a dialog box that requires user input to continue) can sometimes be manipulated by the window manager, and except for events that occur in the dialog box, it disables user-event distribution to the rest of the application.

- **Spring-loaded pop-ups**
  A spring-loaded pop-up (for example, a menu) can seldom be manipulated by the window manager, and except for events that occur in the pop-up or its descendants, it disables user-event distribution to all other applications.

Modal pop-ups and spring-loaded pop-ups are very similar and should be coded as if they were the same. In fact, the same widget (for example, a `ButtonBox` or `Menu` widget) can be used both as a modal pop-up and as a spring-loaded pop-up within the same application. The main difference is that spring-loaded pop-ups are brought up with the pointer and, because of the grab that the pointer button causes, require different processing by the Intrinsics. Furthermore, all user input remap events occurring outside the spring-loaded pop-up (e.g., in a descendant) are also delivered to the spring-loaded pop-up after they have been dispatched to the appropriate descendant, so that, for example, button-up can take down a spring-loaded pop-up no matter where the button-up occurs.

Any kind of pop-up, in turn, can pop up other widgets. Modal and spring-loaded pop-ups can constrain user events to the most recent such pop-up or allow user events to be dispatched to any of the modal or spring-loaded pop-ups currently mapped.

Regardless of their type, all pop-up widget classes are responsible for communicating with the X window manager and therefore are subclasses of one of the Shell widget classes.
5.2. Creating a Pop-Up Shell

For a widget to be popped up, it must be the child of a pop-up shell widget. None of the Intrinsics-supplied shells will simultaneously manage more than one child. Both the shell and child taken together are referred to as the pop-up. When you need to use a pop-up, you always refer to the pop-up by the pop-up shell, not the child.

To create a pop-up shell, use XtCreatePopupShell.

```
Widget XtCreatePopupShell(name, widget_class, parent, args, num_args)
```

- `name`: Specifies the instance name for the created shell widget.
- `widget_class`: Specifies the widget class pointer for the created shell widget.
- `parent`: Specifies the parent widget. Must be of class Core or any subclass thereof.
- `args`: Specifies the argument list to override any other resource specifications.
- `num_args`: Specifies the number of entries in the argument list.

The XtCreatePopupShell function ensures that the specified class is a subclass of Shell and, rather than using insert_child to attach the widget to the parent’s children list, attaches the shell to the parent’s popup_list directly.

The screen resource for this widget is determined by first scanning args for the XtNscreen argument. If no XtNscreen argument is found, the resource database associated with the parent’s screen is queried for the resource name.screen, class Class.Screen where Class is the class_name field from the CoreClassPart of the specified widget_class. If this query fails, the parent’s screen is used. Once the screen is determined, the resource database associated with that screen is used to retrieve all remaining resources for the widget not specified in args.

A spring-loaded pop-up invoked from a translation table via XtMenuPopup must already exist at the time that the translation is invoked, so the translation manager can find the shell by name. Pop-ups invoked in other ways can be created when the pop-up actually is needed. This delayed creation of the shell is particularly useful when you pop up an unspecified number of pop-ups. You can look to see if an appropriate unused shell (that is, not currently popped up) exists and create a new shell if needed.

To create a pop-up shell using varargs lists, use XtVaCreatePopupShell.
Widget XtVaCreatePopupShell(name, widget_class, parent, ...)

  String name;
  WidgetClass widget_class;
  Widget parent;

name Specifi es the instance name for the created shell widget.
widget_class Specifi es the widget class pointer for the created shell widget.
parent Specifi es the parent widget. Must be of class Core or any subclass thereof.
...

XtVaCreatePopupShell is identical in function to XtCreatePopupShell with the args and num_args parameters replaced by a varargs list as described in Section 2.5.1.

5.3. Creating Pop-Up Children

Once a pop-up shell is created, the single child of the pop-up shell can be created either statically or dynamically.

At startup, an application can create the child of the pop-up shell, which is appropriate for pop-up children composed of a fixed set of widgets. The application can change the state of the subparts of the pop-up child as the application state changes. For example, if an application creates a static menu, it can call XtSetSensitive (or, in general, XtSetValues) on any of the buttons that make up the menu. Creating the pop-up child early means that pop-up time is minimized, especially if the application calls XtRealizeWidget on the pop-up shell at startup. When the menu is needed, all the widgets that make up the menu already exist and need only be mapped. The menu should pop up as quickly as the X server can respond.

Alternatively, an application can postpone the creation of the child until it is needed, which minimizes application startup time and allows the pop-up child to reconfigure itself each time it is popped up. In this case, the pop-up child creation routine might poll the application to find out if it should change the sensitivity of any of its subparts.

Pop-up child creation does not map the pop-up, even if you create the child and call XtRealizeWidget on the pop-up shell.

All shells have pop-up and pop-down callbacks, which provide the opportunity either to make last-minute changes to a pop-up child before it is popped up or to change it after it is popped down. Note that excessive use of pop-up callbacks can make popping up occur more slowly.

5.4. Mapping a Pop-Up Widget

Pop-ups can be popped up through several mechanisms:

- A call to XtPopup or XtPopupSpringLoaded.
- One of the supplied callback procedures XtCallbackNone, XtCallbackNonexclusive, or XtCallbackExclusive.
- The standard translation action XtMenuPopup.

Some of these routines take an argument of type XtGrabKind, which is defined as

typedef enum {XtGrabNone, XtGrabNonexclusive, XtGrabExclusive} XtGrabKind;

The create_popup_child_proc procedure pointer in the shell widget instance record is of type \texttt{XtCreatePopupChildProc}.

\begin{verbatim}
typedef void (*XtCreatePopupChildProc)(Widget);
  Widget w;
  w       Specifies the shell widget being popped up.
\end{verbatim}

To map a pop-up from within an application, use \texttt{XtPopup}.

\begin{verbatim}
void XtPopup(popup_shell, grab_kind)
  Widget popup_shell;
  XtGrabKind grab_kind;

  popup_shell       Specifies the shell widget.
  grab_kind         Specifies the way in which user events should be constrained.
\end{verbatim}

The \texttt{XtPopup} function performs the following:
\begin{itemize}
  \item Calls \texttt{XtCheckSubclass} to ensure \texttt{popup_shell}’s class is a subclass of \texttt{shellWidgetClass}.
  \item Raises the window and returns if the shell’s \texttt{popped_up} field is already \texttt{True}.
  \item Calls the callback procedures on the shell’s \texttt{popup_callback} list, specifying a pointer to the value of \texttt{grab_kind} as the \texttt{call_data} argument.
  \item Sets the shell \texttt{popped_up} field to \texttt{True}, the shell \texttt{spring_loaded} field to \texttt{False}, and the shell \texttt{grab_kind} field from \texttt{grab_kind}.
  \item If the shell’s \texttt{create_popup_child_proc} field is non-NULL, \texttt{XtPopup} calls it with \texttt{popup_shell} as the parameter.
  \item If \texttt{grab_kind} is either \texttt{XtGrabNonexclusive} or \texttt{XtGrabExclusive}, it calls
      \begin{verbatim}
        XtAddGrab(popup_shell, (grab_kind == XtGrabExclusive), False)
      \end{verbatim}
  \item Calls \texttt{XtRealizeWidget} with \texttt{popup_shell} specified.
  \item Calls \texttt{XMapRaised} with the window of \texttt{popup_shell}.
\end{itemize}

To map a spring-loaded pop-up from within an application, use \texttt{XtPopupSpringLoaded}.

\begin{verbatim}
void XtPopupSpringLoaded(popup_shell)
  Widget popup_shell;

  popup_shell       Specifies the shell widget to be popped up.
\end{verbatim}

The \texttt{XtPopupSpringLoaded} function performs exactly as \texttt{XtPopup} except that it sets the shell \texttt{spring_loaded} field to \texttt{True} and always calls \texttt{XtAddGrab} with \texttt{exclusive} \texttt{True} and \texttt{spring-loaded} \texttt{True}.

To map a pop-up from a given widget’s callback list, you also can register one of the \texttt{XtCallBackNone}, \texttt{XtCallbackNonexclusive}, or \texttt{XtCallbackExclusive} convenience routines as callbacks, using the pop-up shell widget as the client data.
void XtCallbackNone(w, client_data, call_data)
    Widget w;
    XtPointer client_data;
    XtPointer call_data;

    w    Specifies the widget.
    client_data    Specifies the pop-up shell.
    call_data    Specifies the callback data argument, which is not used by this procedure.

void XtCallbackNonexclusive(w, client_data, call_data)
    Widget w;
    XtPointer client_data;
    XtPointer call_data;

    w    Specifies the widget.
    client_data    Specifies the pop-up shell.
    call_data    Specifies the callback data argument, which is not used by this procedure.

void XtCallbackExclusive(w, client_data, call_data)
    Widget w;
    XtPointer client_data;
    XtPointer call_data;

    w    Specifies the widget.
    client_data    Specifies the pop-up shell.
    call_data    Specifies the callback data argument, which is not used by this procedure.

The XtCallbackNone, XtCallbackNonexclusive, and XtCallbackExclusive functions call XtPopup with the shell specified by the client_data argument and grab_kind set as the name specified. XtCallbackNone, XtCallbackNonexclusive, and XtCallbackExclusive specify XtGrabNone, XtGrabNonexclusive, and XtGrabExclusive, respectively. Each function then sets the widget that executed the callback list to be insensitive by calling XtSetSensitive. Using these functions in callbacks is not required. In particular, an application must provide customized code for callbacks that create pop-up shells dynamically or that must do more than desensitizing the button.

Within a translation table, to pop up a menu when a key or pointer button is pressed or when the pointer is moved into a widget, use XtMenuPopup, or its synonym, MenuPopup. From a translation writer's point of view, the definition for this translation action is

void XtMenuPopup(shell_name)
    String shell_name;

    shell_name    Specifies the name of the shell widget to pop up.

XtMenuPopup is known to the translation manager, which registers the corresponding built-in action procedure XtMenuPopupAction using XtRegisterGrabAction specifying owner_events True, event_mask ButtonPressMask | ButtonReleaseMask, and pointer_mode and keyboard_mode GrabModeAsync.
If `XtMenuPopup` is invoked on `ButtonPress`, it calls `XtPopupSpringLoaded` on the specified shell widget. If `XtMenuPopup` is invoked on `KeyPress` or `EnterWindow`, it calls `XtPopup` on the specified shell widget with `grab_kind` set to `XtGrabNonexclusive`. Otherwise, the translation manager generates a warning message and ignores the action.

`XtMenuPopup` tries to find the shell by searching the widget tree starting at the widget in which it is invoked. If it finds a shell with the specified name in the pop-up children of that widget, it pops up the shell with the appropriate parameters. Otherwise, it moves up the parent chain to find a pop-up child with the specified name. If `XtMenuPopup` gets to the application top-level shell widget and has not found a matching shell, it generates a warning and returns immediately.

5.5. Unmapping a Pop-Up Widget

Pop-ups can be popped down through several mechanisms:

- A call to `XtPopdown`
- The supplied callback procedure `XtCallbackPopdown`
- The standard translation action `XtMenuPopdown`

To unmap a pop-up from within an application, use `XtPopdown`.

```c
void XtPopdown(popup_shell)
    Widget popup_shell;
```

`popup_shell` specifies the shell widget to pop down.

The `XtPopdown` function performs the following:

- Calls `XtCheckSubclass` to ensure `popup_shell`’s class is a subclass of `shellWidgetClass`.
- Checks that the `popped_up` field of `popup_shell` is `True`; otherwise, it returns immediately.
- Unmaps `popup_shell`’s window and, if `override_redirect` is `False`, sends a synthetic `UnmapNotify` event as specified by the Inter-Client Communication Conventions Manual.
- If `popup_shell`’s `grab_kind` is either `XtGrabNonexclusive` or `XtGrabExclusive`, it calls `XtRemoveGrab`.
- Sets `popup_shell`’s `popped_up` field to `False`.
- Calls the callback procedures on the shell’s `popdown_callback` list, specifying a pointer to the value of the shell’s `grab_kind` field as the `call_data` argument.

To pop down a pop-up from a callback list, you may use the callback `XtCallbackPopdown`.

```c
void XtCallbackPopdown(w, client_data, call_data)
    Widget w;
    XtPointer client_data;
    XtPointer call_data;

    w        Specifies the widget.
    client_data Specifies a pointer to the `XtPopdownID` structure.
    call_data Specifies the callback data argument, which is not used by this procedure.
```

The `XtCallbackPopdown` function casts the `client_data` parameter to a pointer of type `XtPopdownID`.
typedef struct {
    Widget shell_widget;
    Widget enable_widget;
} XtPopdownIDRec, *XtPopdownID;

The *shell_widget* is the pop-up shell to pop down, and the *enable_widget* is usually the widget that was used to pop it up in one of the pop-up callback convenience procedures.

XtCallbackPopdown calls XtPopdown with the specified *shell_widget* and then calls XtSetSensitive to resensitize *enable_widget*.

Within a translation table, to pop down a spring-loaded menu when a key or pointer button is released or when the pointer is moved into a widget, use XtMenuPopdown or its synonym, MenuPopdown. From a translation writer’s point of view, the definition for this translation action is

```c
global XtMenuPopdown(shell_name)
    String shell_name;
```

*shell_name* specifies the name of the shell widget to pop down.

If a shell name is not given, XtMenuPopdown calls XtPopdown with the widget for which the translation is specified. If *shell_name* is specified in the translation table, XtMenuPopdown tries to find the shell by looking up the widget tree starting at the widget in which it is invoked. If it finds a shell with the specified name in the pop-up children of that widget, it pops down the shell; otherwise, it moves up the parent chain to find a pop-up child with the specified name. If XtMenuPopdown gets to the application top-level shell widget and cannot find a matching shell, it generates a warning and returns immediately.
Chapter 6

Geometry Management

A widget does not directly control its size and location; rather, its parent is responsible for controlling them. Although the position of children is usually left up to their parent, the widgets themselves often have the best idea of their optimal sizes and, possibly, preferred locations.

To resolve physical layout conflicts between sibling widgets and between a widget and its parent, the Intrinsics provide the geometry management mechanism. Almost all composite widgets have a geometry manager specified in the `geometry_manager` field in the widget class record that is responsible for the size, position, and stacking order of the widget’s children. The only exception is fixed boxes, which create their children themselves and can ensure that their children will never make a geometry request.

6.1. Initiating Geometry Changes

Parents, children, and clients each initiate geometry changes differently. Because a parent has absolute control of its children’s geometry, it changes the geometry directly by calling `XtMoveWidget`, `XtResizeWidget`, or `XtConfigureWidget`. A child must ask its parent for a geometry change by calling `XtMakeGeometryRequest` or `XtMakeResizeRequest`. An application or other client code initiates a geometry change by calling `XtSetValues` on the appropriate geometry fields, thereby giving the widget the opportunity to modify or reject the client request before it gets propagated to the parent and the opportunity to respond appropriately to the parent’s reply.

When a widget that needs to change its size, position, border width, or stacking depth asks its parent’s geometry manager to make the desired changes, the geometry manager can allow the request, disallow the request, or suggest a compromise.

When the geometry manager is asked to change the geometry of a child, the geometry manager may also rearrange and resize any or all of the other children that it controls. The geometry manager can move children around freely using `XtMoveWidget`. When it resizes a child (that is, changes the width, height, or border width) other than the one making the request, it should do so by calling `XtResizeWidget`. The requesting child may be given special treatment; see Section 6.5. It can simultaneously move and resize a child with a single call to `XtConfigureWidget`.

Often, geometry managers find that they can satisfy a request only if they can reconfigure a widget that they are not in control of; in particular, the composite widget may want to change its own size. In this case, the geometry manager makes a request to its parent’s geometry manager. Geometry requests can cascade this way to arbitrary depth.

Because such cascaded arbitration of widget geometry can involve extended negotiation, windows are not actually allocated to widgets at application startup until all widgets are satisfied with their geometry; see Sections 2.5 and 2.6.

Notes

1. The Intrinsics treatment of stacking requests is deficient in several areas. Stacking requests for unrealized widgets are granted but will have no effect. In addition, there is no way to do an `XtSetValues` that will generate a stacking geometry request.

2. After a successful geometry request (one that returned `XtGeometryYes`), a widget does not know whether its resize procedure has been called. Widgets should have resize procedures that can be called more than once without ill effects.
6.2. General Geometry Manager Requests

When making a geometry request, the child specifies an `XtWidgetGeometry` structure.

```c
typedef unsigned long XtGeometryMask;

typedef struct {
    XtGeometryMask request_mode;
    Position x, y;
    Dimension width, height;
    Dimension border_width;
    Widget sibling;
    int stack_mode;
} XtWidgetGeometry;
```

To make a general geometry manager request from a widget, use `XtMakeGeometryRequest`.

```c
XtGeometryResult XtMakeGeometryRequest(w, request, reply_return)
    Widget w;
    XtWidgetGeometry *request;
    XtWidgetGeometry *reply_return;

w               Specifies the widget making the request. Must be of class RectObj or any subclass thereof.
request         Specifies the desired widget geometry (size, position, border width, and stacking order).
reply_return    Returns the allowed widget size, or may be NULL if the requesting widget is not interested in handling `XtGeometryAlmost`.
```

Depending on the condition, `XtMakeGeometryRequest` performs the following:

- If the widget is unmanaged or the widget’s parent is not realized, it makes the changes and returns `XtGeometryYes`.
- If the parent’s class is not a subclass of `compositeWidgetClass` or the parent’s `geometry_manager` field is NULL, it issues an error.
- If the widget’s `being_destroyed` field is `True`, it returns `XtGeometryNo`.
- If the widget `x`, `y`, `width`, `height`, and `border_width` fields are all equal to the requested values, it returns `XtGeometryYes`; otherwise, it calls the parent’s `geometry_manager` procedure with the given parameters.
- If the parent’s geometry manager returns `XtGeometryYes` and if `XtCWQueryOnly` is not set in `request->request_mode` and if the widget is realized, `XtMakeGeometryRequest` calls the `XConfigureWindow` Xlib function to reconfigure the widget’s window (set its size, location, and stacking order as appropriate).
- If the geometry manager returns `XtGeometryDone`, the change has been approved and actually has been done. In this case, `XtMakeGeometryRequest` does no configuring and returns `XtGeometryYes`. `XtMakeGeometryRequest` never returns `XtGeometryDone`.
- Otherwise, `XtMakeGeometryRequest` just returns the resulting value from the parent’s geometry manager.

Children of primitive widgets are always unmanaged; therefore, `XtMakeGeometryRequest` always returns `XtGeometryYes` when called by a child of a primitive widget.
The return codes from geometry managers are

typedef enum {
    XtGeometryYes,
    XtGeometryNo,
    XtGeometryAlmost,
    XtGeometryDone
} XtGeometryResult;

The request_mode definitions are from <X11/X.h>.

#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)
#define XtCWQueryOnly (1<<7)

The Intrinsics also support the following value.

#define Above 0
#define Below 1
#define TopIf 2
#define BottomIf 3
#define Opposite 4
#define XtSMDontChange 5

XtCWQueryOnly indicates that the corresponding geometry request is only a query as to what
would happen if this geometry request were made and that no widgets should actually be
changed.

XtMakeGeometryRequest, like the XConfigureWindow Xlib function, uses request_mode to
determine which fields in the XtWidgetGeometry structure the caller wants to specify.

The stack_mode definitions are from <X11/X.h>:

The Intrinsics also support the following value.

For definition and behavior of Above, Below, TopIf, BottomIf, and Opposite, see Section 3.7
in Xlib — C Language X Interface. XtSMDontChange indicates that the widget wants its current
stacking order preserved.
6.3. Resize Requests

To make a simple resize request from a widget, you can use `XtMakeResizeRequest` as an alternative to `XtMakeGeometryRequest`.

```c
XtGeometryResult XtMakeResizeRequest(Widget w, Dimension width, Dimension height, Dimension *width_return, Dimension *height_return);
```

- `w`: Specifies the widget making the request. Must be of class `RectObj` or any subclass thereof.
- `width` and `height`: Specify the desired widget width and height.
- `width_return` and `height_return`: Return the allowed widget width and height.

The `XtMakeResizeRequest` function, a simple interface to `XtMakeGeometryRequest`, creates an `XtWidgetGeometry` structure and specifies that width and height should change by setting `request_mode` to `CWWidth` | `CWHeight`. The geometry manager is free to modify any of the other window attributes (position or stacking order) to satisfy the resize request. If the return value is `XtGeometryAlmost`, `width_return` and `height_return` contain a compromise width and height. If these are acceptable, the widget should immediately call `XtMakeResizeRequest` again and request that the compromise width and height be applied. If the widget is not interested in `XtGeometryAlmost` replies, it can pass NULL for `width_return` and `height_return`.

6.4. Potential Geometry Changes

Sometimes a geometry manager cannot respond to a geometry request from a child without first making a geometry request to the widget’s own parent (the original requestor’s grandparent). If the request to the grandparent would allow the parent to satisfy the original request, the geometry manager can make the intermediate geometry request as if it were the originator. On the other hand, if the geometry manager already has determined that the original request cannot be completely satisfied (for example, if it always denies position changes), it needs to tell the grandparent to respond to the intermediate request without actually changing the geometry because it does not know if the child will accept the compromise. To accomplish this, the geometry manager uses `XtCWQueryOnly` in the intermediate request.

When `XtCWQueryOnly` is used, the geometry manager needs to cache enough information to exactly reconstruct the intermediate request. If the grandparent’s response to the intermediate query was `XtGeometryAlmost`, the geometry manager needs to cache the entire reply geometry in the event the child accepts the parent’s compromise.

If the grandparent’s response was `XtGeometryAlmost`, it may also be necessary to cache the entire reply geometry from the grandparent when `XtCWQueryOnly` is not used. If the geometry manager is still able to satisfy the original request, it may immediately accept the grandparent’s compromise and then act on the child’s request. If the grandparent’s compromise geometry is insufficient to allow the child’s request and if the geometry manager is willing to offer a different compromise to the child, the grandparent’s compromise should not be accepted until the child has accepted the new compromise.

Note that a compromise geometry returned with `XtGeometryAlmost` is guaranteed only for the next call to the same widget; therefore, a cache of size 1 is sufficient.
6.5. Child Geometry Management: The geometry_manager Procedure

The geometry_manager procedure pointer in a composite widget class is of type XtGeometry-Handler.

typedef XtGeometryResult (*XtGeometryHandler)(Widget, XtWidgetGeometry*, XtWidgetGeometry*);

Widget w;
XtWidgetGeometry *request;
XtWidgetGeometry *geometry_return;

w  Passes the widget making the request.
request  Passes the new geometry the child desires.
geometry_return  Passes a geometry structure in which the geometry manager may store a compromise.

A class can inherit its superclass’s geometry manager during class initialization.

A bit set to zero in the request’s request_mode field means that the child widget does not care about the value of the corresponding field, so the geometry manager can change this field as it wishes. A bit set to 1 means that the child wants that geometry element set to the value in the corresponding field.

If the geometry manager can satisfy all changes requested and if XtCWQueryOnly is not specified, it updates the widget’s x, y, width, height, and border_width fields appropriately. Then, it returns XtGeometryYes, and the values pointed to by the geometry_return argument are undefined. The widget’s window is moved and resized automatically by XtMakeGeometryRequest.

Homogeneous composite widgets often find it convenient to treat the widget making the request the same as any other widget, including reconfiguring it using XtConfigureWidget or XtResizeWidget as part of its layout process, unless XtCWQueryOnly is specified. If it does this, it should return XtGeometryDone to inform XtMakeGeometryRequest that it does not need to do the configuration itself.

Note

To remain compatible with layout techniques used in older widgets (before XtGeometryDone was added to the Intrinsics), a geometry manager should avoid using XtResizeWidget or XtConfigureWidget on the child making the request because the layout process of the child may be in an intermediate state in which it is not prepared to handle a call to its resize procedure. A self-contained widget set may choose this alternative geometry management scheme, however, provided that it clearly warns widget developers of the compatibility consequences.

Although XtMakeGeometryRequest resizes the widget’s window (if the geometry manager returns XtGeometryYes), it does not call the widget class’s resize procedure. The requesting widget must perform whatever resizing calculations are needed explicitly.

If the geometry manager disallows the request, the widget cannot change its geometry. The values pointed to by geometry_return are undefined, and the geometry manager returns XtGeometryNo.

Sometimes the geometry manager cannot satisfy the request exactly but may be able to satisfy a similar request. That is, it could satisfy only a subset of the requests (for example, size but not position) or a lesser request (for example, it cannot make the child as big as the request but it can make the child bigger than its current size). In such cases, the geometry manager fills in the structure pointed to by geometry_return with the actual changes it is willing to make, including an appropriate request_mode mask, and returns XtGeometryAlmost. If a bit in geometry_return->request_mode is zero, the geometry manager agrees not to change the corresponding
value if $geometry\_return$ is used immediately in a new request. If a bit is 1, the geometry manager does change that element to the corresponding value in $geometry\_return$. More bits may be set in $geometry\_return\rightarrow request\_mode$ than in the original request if the geometry manager intends to change other fields should the child accept the compromise.

When $XtGeometryAlmost$ is returned, the widget must decide if the compromise suggested in $geometry\_return$ is acceptable. If it is, the widget must not change its geometry directly; rather, it must make another call to $XtMakeGeometryRequest$.

If the next geometry request from this child uses the $geometry\_return$ values filled in by the geometry manager with an $XtGeometryAlmost$ return and if there have been no intervening geometry requests on either its parent or any of its other children, the geometry manager must grant the request, if possible. That is, if the child asks immediately with the returned geometry, it should get an answer of $XtGeometryYes$. However, dynamic behavior in the user’s window manager may affect the final outcome.

To return $XtGeometryYes$, the geometry manager frequently rearranges the position of other managed children by calling $XtMoveWidget$. However, a few geometry managers may sometimes change the size of other managed children by calling $XtResizeWidget$ or $XtConfigureWidget$. If $XtCWQueryOnly$ is specified, the geometry manager must return data describing how it would react to this geometry request without actually moving or resizing any widgets.

Geometry managers must not assume that the $request$ and $geometry\_return$ arguments point to independent storage. The caller is permitted to use the same field for both, and the geometry manager must allocate its own temporary storage, if necessary.

### 6.6. Widget Placement and Sizing

To move a sibling widget of the child making the geometry request, the parent uses $XtMoveWidget$.

```c
void XtMoveWidget(w, x, y)
    Widget w;
    Position x;
    Position y;

    w Description the widget. Must be of class RectObj or any subclass thereof.
    x
    y Specify the new widget x and y coordinates.
```

The $XtMoveWidget$ function returns immediately if the specified geometry fields are the same as the old values. Otherwise, $XtMoveWidget$ writes the new $x$ and $y$ values into the object and, if the object is a widget and is realized, issues an Xlib $XMoveWindow$ call on the widget’s window.

To resize a sibling widget of the child making the geometry request, the parent uses $XtResizeWidget$. 
void XtResizeWidget(w, width, height, border_width)
    Widget w;
    Dimension width;
    Dimension height;
    Dimension border_width;

w Specifies the widget. Must be of class RectObj or any subclass thereof.
width
height
border_width Specify the new widget size.

The XtResizeWidget function returns immediately if the specified geometry fields are the same as the old values. Otherwise, XtResizeWidget writes the new width, height, and border_width values into the object and, if the object is a widget and is realized, issues an XConfigureWindow call on the widget’s window.

If the new width or height is different from the old values, XtResizeWidget calls the object’s resize procedure to notify it of the size change.

To move and resize the sibling widget of the child making the geometry request, the parent uses XtConfigureWidget.

void XtConfigureWidget(w, x, y, width, height, border_width)
    Widget w;
    Position x;
    Position y;
    Dimension width;
    Dimension height;
    Dimension border_width;

w Specifies the widget. Must be of class RectObj or any subclass thereof.
x y Specify the new widget x and y coordinates.
width
height
border_width Specify the new widget size.

The XtConfigureWidget function returns immediately if the specified new geometry fields are all equal to the current values. Otherwise, XtConfigureWidget writes the new x, y, width, height, and border_width values into the object and, if the object is a widget and is realized, makes an Xlib XConfigureWindow call on the widget’s window.

If the new width or height is different from its old value, XtConfigureWidget calls the object’s resize procedure to notify it of the size change; otherwise, it simply returns.

To resize a child widget that already has the new values of its width, height, and border width, the parent uses XtResizeWindow.
void XtResizeWindow(w)
    Widget w;

    w Specifies the widget. Must be of class Core or any subclass thereof.

The XtResizeWindow function calls the XConfigureWindow Xlib function to make the window of the specified widget match its width, height, and border width. This request is done unconditionally because there is no inexpensive way to tell if these values match the current values. Note that the widget’s resize procedure is not called.

There are very few times to use XtResizeWindow; instead, the parent should use XtResizeWidget.

6.7. Preferred Geometry

Some parents may be willing to adjust their layouts to accommodate the preferred geometries of their children. They can use XtQueryGeometry to obtain the preferred geometry and, as they see fit, can use or ignore any portion of the response.

To query a child widget’s preferred geometry, use XtQueryGeometry.

XtGeometryResult XtQueryGeometry(w, intended, preferred_return)
    Widget w;
    XtWidgetGeometry *intended;
    XtWidgetGeometry *preferred_return;

    w Specifies the widget. Must be of class RectObj or any subclass thereof.
    intended Specifies the new geometry the parent plans to give to the child, or NULL.
    preferred_return Returns the child widget’s preferred geometry.

To discover a child’s preferred geometry, the child’s parent stores the new geometry in the corresponding fields of the intended structure, sets the corresponding bits in intended.request_mode, and calls XtQueryGeometry. The parent should set only those fields that are important to it so that the child can determine whether it may be able to attempt changes to other fields.

XtQueryGeometry clears all bits in the preferred_return->request_mode field and checks the query_geometry field of the specified widget’s class record. If query_geometry is not NULL, XtQueryGeometry calls the query_geometry procedure and passes as arguments the specified widget, intended, and preferred_return structures. If the intended argument is NULL, XtQueryGeometry replaces it with a pointer to an XtWidgetGeometry structure with request_mode equal to zero before calling the query_geometry procedure.

Note

If XtQueryGeometry is called from within a geometry_manager procedure for the widget that issued XtMakeGeometryRequest or XtMakeResizeRequest, the results are not guaranteed to be consistent with the requested changes. The change request passed to the geometry manager takes precedence over the preferred geometry.

The query_geometry procedure pointer is of type XtGeometryHandler.
typedef XtGeometryResult (*XtGeometryHandler)(Widget, XtWidgetGeometry*, XtWidgetGeometry*);
    Widget w;
    XtWidgetGeometry *request;
    XtWidgetGeometry *preferred_return;

    w     Passes the child widget whose preferred geometry is required.
    request Passes the geometry changes that the parent plans to make.
    preferred_return Passes a structure in which the child returns its preferred geometry.

The query_geometry procedure is expected to examine the bits set in request->request_mode,
evaluate the preferred geometry of the widget, and store the result in preferred_return (setting the
bits in preferred_return->request_mode corresponding to those geometry fields that it cares
about). If the proposed geometry change is acceptable without modification, the query_geometry
procedure should return XtGeometryYes. If at least one field in preferred_return with a bit set
in preferred_return->request_mode is different from the corresponding field in request or if a bit
was set in preferred_return->request_mode that was not set in the request, the query_geometry
procedure should return XtGeometryAlmost. If the preferred geometry is identical to the cur-
rent geometry, the query_geometry procedure should return XtGeometryNo.

Note
The query_geometry procedure may assume that no XtMakeResizeRequest or
XtMakeGeometryRequest is in progress for the specified widget; that is, it is not
required to construct a reply consistent with the requested geometry if such a request
were actually outstanding.

After calling the query_geometry procedure or if the query_geometry field is NULL, XtQuery-
Geometry examines all the unset bits in preferred_return->request_mode and sets the corre-
sponding fields in preferred_return to the current values from the widget instance. If CWStack-
Mode is not set, the stack_mode field is set to XtSMDontChange. XtQueryGeometry returns
the value returned by the query_geometry procedure or XtGeometryYes if the query_geometry
field is NULL.

Therefore, the caller can interpret a return of XtGeometryYes as not needing to evaluate the con-
tents of the reply and, more important, not needing to modify its layout plans. A return of XtGeome-
tryAlmost means either that both the parent and the child expressed interest in at least one
common field and the child’s preference does not match the parent’s intentions or that the child
expressed interest in a field that the parent might need to consider. A return value of XtGeome-
tryNo means that both the parent and the child expressed interest in a field and that the child sug-
gests that the field’s current value in the widget instance is its preferred value. In addition,
whether or not the caller ignores the return value or the reply mask, it is guaranteed that the preferred_return structure contains complete geometry information for the child.

Parents are expected to call XtQueryGeometry in their layout routine and wherever else the
information is significant after change_managed has been called. The first time it is invoked, the
changed_managed procedure may assume that the child’s current geometry is its preferred geometry.
Thus, the child is still responsible for storing values into its own geometry during its initial-
ize procedure.

6.8. Size Change Management: The resize Procedure
A child can be resized by its parent at any time. Widgets usually need to know when they have
changed size so that they can lay out their displayed data again to match the new size. When a
parent resizes a child, it calls XtResizeWidget, which updates the geometry fields in the widget,
configures the window if the widget is realized, and calls the child’s resize procedure to notify the child. The resize procedure pointer is of type `XtWidgetProc`.

If a class need not recalculate anything when a widget is resized, it can specify NULL for the `resize` field in its class record. This is an unusual case and should occur only for widgets with very trivial display semantics. The resize procedure takes a widget as its only argument. The `x`, `y`, `width`, `height`, and `border_width` fields of the widget contain the new values. The resize procedure should recalculate the layout of internal data as needed. (For example, a centered Label in a window that changes size should recalculate the starting position of the text.) The widget must obey resize as a command and must not treat it as a request. A widget must not issue an `XtMakeGeometryRequest` or `XtMakeResizeRequest` call from its resize procedure.
Chapter 7

Event Management

While Xlib allows the reading and processing of events anywhere in an application, widgets in the X Toolkit neither directly read events nor grab the server or pointer. Widgets register procedures that are to be called when an event or class of events occurs in that widget.

A typical application consists of startup code followed by an event loop that reads events and dispatches them by calling the procedures that widgets have registered. The default event loop provided by the Intrinsics is `XtAppMainLoop`.

The event manager is a collection of functions to perform the following tasks:

- Add or remove event sources other than X server events (in particular, timer interrupts, file input, or POSIX signals).
- Query the status of event sources.
- Add or remove procedures to be called when an event occurs for a particular widget.
- Enable and disable the dispatching of user-initiated events (keyboard and pointer events) for a particular widget.
- Constrain the dispatching of events to a cascade of pop-up widgets.
- Register procedures to be called when specific events arrive.
- Register procedures to be called when the Intrinsics will block.
- Enable safe operation in a multi-threaded environment.

Most widgets do not need to call any of the event handler functions explicitly. The normal interface to X events is through the higher-level translation manager, which maps sequences of X events, with modifiers, into procedure calls. Applications rarely use any of the event manager routines besides `XtAppMainLoop`.

7.1. Adding and Deleting Additional Event Sources

While most applications are driven only by X events, some applications need to incorporate other sources of input into the Intrinsics event-handling mechanism. The event manager provides routines to integrate notification of timer events and file data pending into this mechanism.

The next section describes functions that provide input gathering from files. The application registers the files with the Intrinsics read routine. When input is pending on one of the files, the registered callback procedures are invoked.

7.1.1. Adding and Removing Input Sources

To register a new file as an input source for a given application context, use `XtAppAddInput`. 
XtInputId XtAppAddInput(app_context, source, condition, proc, client_data)
    XtAppContext app_context;
    int source;
    XtPointer condition;
    XtInputCallbackProc proc;
    XtPointer client_data;

app_context  Specifies the application context that identifies the application.
source       Specifies the source file descriptor on a POSIX-based system or other operating-
             system-dependent device specification.
condition    Specifies the mask that indicates a read, write, or exception condition or some
             other operating-system-dependent condition.
proc         Specifies the procedure to be called when the condition is found.
client_data  Specifies an argument passed to the specified procedure when it is called.

The XtAppAddInput function registers with the Intrinsics read routine a new source of events,
which is usually file input but can also be file output. Note that file should be loosely interpreted
to mean any sink or source of data. XtAppAddInput also specifies the conditions under which
the source can generate events. When an event is pending on this source, the callback procedure
is called.

The legal values for the condition argument are operating-system-dependent. On a POSIX-based
system, source is a file number and the condition is some union of the following:

XtInputReadMask  Specifies that proc is to be called when source has data to be read.
XtInputWriteMask Specifies that proc is to be called when source is ready for writing.
XtInputExceptMask Specifies that proc is to be called when source has exception data.

Callback procedure pointers used to handle file events are of type XtInputCallbackProc.

typedef void (*XtInputCallbackProc)(XtPointer, int*, XtInputId*);
    XtPointer client_data;
    int *source;
    XtInputId *id;

client_data  Passes the client data argument that was registered for this procedure in XtApp-
             AddInput.
source       Passes the source file descriptor generating the event.
id           Passes the id returned from the corresponding XtAddInput call.

See Section 7.12 for information regarding the use of XtAppAddInput in multiple threads.

To discontinue a source of input, use XtRemoveInput.

void XtRemoveInput(id)
    XtInputId id;

id           Specifies the id returned from the corresponding XtAppAddInput call.

The XtRemoveInput function causes the Intrinsics read routine to stop watching for events from
the file source specified by id.
See Section 7.12 for information regarding the use of `XtRemoveInput` in multiple threads.

### 7.1.2. Adding and Removing Blocking Notifications

Occasionally it is desirable for an application to receive notification when the Intrinsics event manager detects no pending input from file sources and no pending input from X server event sources and is about to block in an operating system call.

To register a hook that is called immediately prior to event blocking, use `XtAppAddBlockHook`.

```c
XtBlockHookId XtAppAddBlockHook(app_context, proc, client_data)
    XtAppContext app_context;
    XtBlockHookProc proc;
    XtPointer client_data;

    app_context Specifi es the application context that identifi es the application.
    proc Specifi es the procedure to be called before blocking.
    client_data Specifi es an argument passed to the specifi ed procedure when it is called.
```

The `XtAppAddBlockHook` function registers the specified procedure and returns an identifier for it. The hook procedure `proc` is called at any time in the future when the Intrinsics are about to block pending some input.

The procedure pointers used to provide notification of event blocking are of type `XtBlockHookProc`.

```c
typedef void (*XtBlockHookProc)(XtPointer);
    XtPointer client_data;

    client_data Passes the client data argument that was registered for this procedure in `XtAppAddBlockHook`.
```

To discontinue the use of a procedure for blocking notification, use `XtRemoveBlockHook`.

```c
void XtRemoveBlockHook(id)
    XtBlockHookId id;

    id Specifi es the identifi er returned from the corresponding call to `XtAppAddBlockHook`.
```

The `XtRemoveBlockHook` function removes the specified procedure from the list of procedures that are called by the Intrinsics read routine before blocking on event sources.

### 7.1.3. Adding and Removing Timeouts

The timeout facility notifies the application or the widget through a callback procedure that a specified time interval has elapsed. Timeout values are uniquely identified by an interval id.

To register a timeout callback, use `XtAppAddTimeOut`.

```c
typedef void (*XtTimeOutProc)(XtPointer);
    XtPointer client_data;

    client_data Passes the client data argument that was registered for this procedure in `XtAppAddTimeOut`.
```

The `XtAppAddTimeOut` function registers the specified procedure and returns an identifier for it. The procedure pointers used to provide timeout notification are of type `XtTimeOutProc`.

```c
void XtRemoveTimeOut(id)
    XtTimeOutId id;

    id Specifi es the identifi er returned from the corresponding call to `XtAppAddTimeOut`.
```

The `XtRemoveTimeOut` function removes the specified procedure from the list of procedures that are called by the Intrinsics read routine before blocking on event sources.
X Toolkit Intrinsics

XtIntervalId XtAppAddTimeOut(app_context, interval, proc, client_data)

    XtAppContext app_context;
    unsigned long interval;
    XtTimerCallbackProc proc;
    XtPointer client_data;

    app_context   Specifi es the application context for which the timer is to be set.
    interval      Specifi es the time interval in milliseconds.
    proc          Specifi es the procedure to be called when the time expires.
    client_data   Specifi es an argument passed to the specifi ed procedure when it is called.

The XtAppAddTimeOut function creates a timeout and returns an identifi er for it. The timeout value is set to interval. The callback procedure proc is called when XtAppNextEvent or XtAppProcessEvent is next called after the time interval elapses, and then the timeout is removed.

Callback procedure pointers used with timeouts are of type XtTimerCallbackProc.

typedef void (*XtTimerCallbackProc)(XtPointer, XtIntervalId*);

    XtPointer client_data;
    XtIntervalId *timer;

    client_data  Passes the client data argument that was registered for this procedure in XtAppAddTimeOut.
    timer        Passes the id returned from the corresponding XtAppAddTimeOut call.

See Section 7.12 for information regarding the use of XtAppAddTimeOut in multiple threads.

To clear a timeout value, use XtRemoveTimeOut.

    void XtRemoveTimeOut(timer)

    XtIntervalId timer;

    timer       Specifi es the id for the timeout request to be cleared.

The XtRemoveTimeOut function removes the pending timeout. Note that timeouts are automatically removed once they trigger.

Please refer to Section 7.12 for information regarding the use of XtRemoveTimeOut in multiple threads.

7.1.4. Adding and Removing Signal Callbacks

The signal facility notifi es the application or the widget through a callback procedure that a signal or other external asynchronous event has occurred. The registered callback procedures are uniquely identifi ed by a signal id.

Prior to establishing a signal handler, the application or widget should call XtAppAddSignal and store the resulting identifi er in a place accessible to the signal handler. When a signal arrives, the signal handler should call XtNoticeSignal to notify the Intrinsics that a signal has occurred. To register a signal callback use XtAppAddSignal.
X Toolkit Intrinsics

XtSignalId XtAppAddSignal(app_context, proc, client_data)
   XtAppContext app_context;
   XtSignalCallbackProc proc;
   XtPointer client_data;

   app_context  Specifie the application context that identifies the application.
   proc  Specifie the procedure to be called when the signal is noticed.
   client_data  Specifie an argument passed to the specified procedure when it is called.

The callback procedure pointers used to handle signal events are of type XtSignalCallbackProc.

typedef void (*XtSignalCallbackProc)(XtPointer, XtSignalId*);
   XtPointer client_data;
   XtSignalId *id;

   client_data  Passes the client data argument that was registered for this procedure in XtAppAddSignal.
   id  Passes the id returned from the corresponding XtAppAddSignal call.

To notify the Intrinsics that a signal has occurred, use XtNoticeSignal.

void XtNoticeSignal(id)
   XtSignalId id;

   id  Specifie the id returned from the corresponding XtAppAddSignal call.

On a POSIX-based system, XtNoticeSignal is the only Intrinsics function that can safely be called from a signal handler. If XtNoticeSignal is invoked multiple times before the Intrinsics are able to invoke the registered callback, the callback is only called once. Logically, the Intrinsics maintain “pending” flag for each registered callback. This flag is initially False and is set to True by XtNoticeSignal. When XtAppNextEvent or XtAppProcessEvent (with a mask including XtIMSIGNAL) is called, all registered callbacks with “pending” True are invoked and the flags are reset to False.

If the signal handler wants to track how many times the signal has been raised, it can keep its own private counter. Typically the handler would not do any other work; the callback does the actual processing for the signal. The Intrinsics never block signals from being raised, so if a given signal can be raised multiple times before the Intrinsics can invoke the callback for that signal, the callback must be designed to deal with this. In another case, a signal might be raised just after the Intrinsics sets the pending flag to False but before the callback can get control, in which case the pending flag will still be True after the callback returns, and the Intrinsics will invoke the callback again, even though all of the signal raises have been handled. The callback must also be prepared to handle this case.

To remove a registered signal callback, call XtRemoveSignal.
void XtRemoveSignal(id)
    XtSignalId id;

id          Specifies the id returned by the corresponding call to XtAppAddSignal.

The client should typically disable the source of the signal before calling XtRemoveSignal. If
the signal could have been raised again before the source was disabled and the client wants to
process it, then after disabling the source but before calling XtRemoveSignal the client can test
for signals with XtAppPending and process them by calling XtAppProcessEvent with the mask
XtIMSignal.

7.2. Constraining Events to a Cascade of Widgets

Modal widgets are widgets that, except for the input directed to them, lock out user input to the
application.

When a modal menu or modal dialog box is popped up using XtPopup, user events (keyboard
and pointer events) that occur outside the modal widget should be delivered to the modal widget
or ignored. In no case will user events be delivered to a widget outside the modal widget.

Menus can pop up submenus, and dialog boxes can pop up further dialog boxes to create a pop-up
cascade. In this case, user events may be delivered to one of several modal widgets in the cas-
cade.

Display-related events should be delivered outside the modal cascade so that exposure events and
the like keep the application’s display up-to-date. Any event that occurs within the cascade is
delivered as usual. The user events delivered to the most recent spring-loaded shell in the cascade
when they occur outside the cascade are called remap events and are KeyPress, KeyRelease,
ButtonPress, and ButtonRelease. The user events ignored when they occur outside the cascade
are MotionNotify and EnterNotify. All other events are delivered normally. In particular, note
that this is one way in which widgets can receive LeaveNotify events without first receiving
EnterNotify events; they should be prepared to deal with this, typically by ignoring any
unmatched LeaveNotify events.

XtPopup uses the XtAddGrab and XtRemoveGrab functions to constrain user events to a
modal cascade and subsequently to remove a grab when the modal widget is popped down.

To constrain or redirect user input to a modal widget, use XtAddGrab.

void XtAddGrab(w, exclusive, spring_loaded)
    Widget w;
    Boolean exclusive;
    Boolean spring_loaded;

w          Specifies the widget to add to the modal cascade. Must be of class Core or any
            subclass thereof.
exclusive    Specifies whether user events should be dispatched exclusively to this widget or
            also to previous widgets in the cascade.
spring_loaded Specifies whether this widget was popped up because the user pressed a pointer
            button.

The XtAddGrab function appends the widget to the modal cascade and checks that exclusive is
True if spring_loaded is True. If this condition is not met, XtAddGrab generates a warning
message.
The modal cascade is used by `XtDispatchEvent` when it tries to dispatch a user event. When at least one modal widget is in the widget cascade, `XtDispatchEvent` first determines if the event should be delivered. It starts at the most recent cascade entry and follows the cascade up to and including the most recent cascade entry added with the `exclusive` parameter `True`.

This subset of the modal cascade along with all descendants of these widgets comprise the active subset. User events that occur outside the widgets in this subset are ignored or remapped. Modal menus with submenus generally add a submenu widget to the cascade with `exclusive` `False`. Modal dialog boxes that need to restrict user input to the most deeply nested dialog box add a subdialog widget to the cascade with `exclusive` `True`. User events that occur within the active subset are delivered to the appropriate widget, which is usually a child or further descendant of the modal widget.

Regardless of where in the application they occur, remap events are always delivered to the most recent widget in the active subset of the cascade registered with `spring_loaded` `True`, if any such widget exists. If the event occurred in the active subset of the cascade but outside the spring-loaded widget, it is delivered normally before being delivered also to the spring-loaded widget. Regardless of where it is dispatched, the Intrinsics do not modify the contents of the event.

To remove the redirection of user input to a modal widget, use `XtRemoveGrab`.

```c
void XtRemoveGrab(w)
    Widget w;

    w        Specifies the widget to remove from the modal cascade.
```

The `XtRemoveGrab` function removes widgets from the modal cascade starting at the most recent widget up to and including the specified widget. It issues a warning if the specified widget is not on the modal cascade.

### 7.2.1. Requesting Key and Button Grabs

The Intrinsics provide a set of key and button grab interfaces that are parallel to those provided by Xlib and that allow the Intrinsics to modify event dispatching when necessary. X Toolkit applications and widgets that need to passively grab keys or buttons or actively grab the keyboard or pointer should use the following Intrinsics routines rather than the corresponding Xlib routines.

To passively grab a single key of the keyboard, use `XtGrabKey`.

```c
```
void XtGrabKey(widget, keycode, modifi ers, owner_events, pointer_mode, keyboard_mode)
  Widget widget;
  KeyCode keycode;
  Modifi ers modifi ers;
  Boolean owner_events;
  int pointer_mode, keyboard_mode;

widget Specifi es the widget in whose window the key is to be grabbed. Must be of class
  Core or any subclass thereof.

keycode
modifi ers
owner_events
pointer_mode
keyboard_mode Specify arguments to XGrabKey; see Section 12.2 in Xlib — C Language X In-
  terface.

XtGrabKey calls XGrabKey specifying the widget’s window as the grab window if the widget
  is realized. The remaining arguments are exactly as for XGrabKey. If the widget is not realized,
  or is later unrealized, the call to XGrabKey is performed (again) when the widget is realized and
  its window becomes mapped. In the future, if XtDispatchEvent is called with a KeyPress event
  matching the specified keycode and modifi ers (which may be AnyKey or AnyModifier, respec-
  tively) for the widget’s window, the Intrinsics will call XtUngrabKeyboard with the timestamp
  from the KeyPress event if either of the following conditions is true:
  • There is a modal cascade and the widget is not in the active subset of the cascade and the
    keyboard was not previously grabbed, or
  • XFilterEvent returns True.

To cancel a passive key grab, use XtUngrabKey.

void XtUngrabKey(widget, keycode, modifi ers)
  Widget widget;
  KeyCode keycode;
  Modifi ers modifi ers;

widget Specifi es the widget in whose window the key was grabbed.

keycode
modifi ers Specify arguments to XUngrabKey; see Section 12.2 in Xlib — C Language X In-
  terface.

The XtUngrabKey procedure calls XUngrabKey specifying the widget’s window as the ungrab
  window if the widget is realized. The remaining arguments are exactly as for XUngrabKey. If
  the widget is not realized, XtUngrabKey removes a deferred XtGrabKey request, if any, for the
  specified widget, keycode, and modifi ers.

To actively grab the keyboard, use XtGrabKeyboard.
int XtGrabKeyboard(widget, owner_events, pointer_mode, keyboard_mode, time)
    Widget widget;
    Boolean owner_events;
    int pointer_mode, keyboard_mode;
    Time time;

    widget Specifi es the widget for whose window the keyboard is to be grabbed. Must be of class Core or any subclass thereof.

    owner_events
    pointer_mode
    keyboard_mode
time Specifi y arguments to XGrabKeyboard; see Section 12.2 in Xlib — C Language X Interface.

If the specifi ed widget is realized, XtGrabKeyboard calls XGrabKeyboard specifying the widget’s window as the grab window. The remaining arguments and return value are exactly as for XGrabKeyboard. If the widget is not realized, XtGrabKeyboard immediately returns Grab-NotViewable. No future automatic ungrab is implied by XtGrabKeyboard.

To cancel an active keyboard grab, use XtUngrabKeyboard.

void XtUngrabKeyboard(widget, time)
    Widget widget;
    Time time;

    widget Specifi es the widget that has the active keyboard grab.

    time Specifi es the additional argument to XUngrabKeyboard; see Section 12.2 in Xlib — C Language X Interface.

XtUngrabKeyboard calls XUngrabKeyboard with the specifi ed time.

To passively grab a single pointer button, use XtGrabButton.
void XtGrabButton(widget, button, modifiers, owner_events, event_mask, pointer_mode, keyboard_mode, confine_to, cursor)

Widget widget;
int button;
Modifiers modifiers;
Boolean owner_events;
unsigned int event_mask;
int pointer_mode, keyboard_mode;
Window confine_to;
Cursor cursor;

widget Specify the widget in whose window the button is to be grabbed. Must be of class Core or any subclass thereof.

button modifiers owner_events event_mask pointer_mode keyboard_mode confine_to cursor Specify arguments to XGrabButton; see Section 12.1 in Xlib — C Language X Interface.

XtGrabButton calls XGrabButton specifying the widget’s window as the grab window if the widget is realized. The remaining arguments are exactly as for XGrabButton. If the widget is not realized, or is later unrealized, the call to XtGrabButton is performed (again) when the widget is realized and its window becomes mapped. In the future, if XtDispatchEvent is called with a ButtonPress event matching the specified button and modifiers (which may be AnyButton or AnyModifier, respectively) for the widget’s window, the Intrinsics will call XtUngrabPointer with the timestamp from the ButtonPress event if either of the following conditions is true:

- There is a modal cascade and the widget is not in the active subset of the cascade and the pointer was not previously grabbed, or
- XFilterEvent returns True.

To cancel a passive button grab, use XtUngrabButton.

void XtUngrabButton(widget, button, modifiers)

Widget widget;
unsigned int button;
Modifiers modifiers;

widget Specify the widget in whose window the button was grabbed.

button modifiers Specify arguments to XUngrabButton; see Section 12.1 in Xlib — C Language X Interface.

The XtUngrabButton procedure calls XUngrabButton specifying the widget’s window as the ungrab window if the widget is realized. The remaining arguments are exactly as for XUngrabButton. If the widget is not realized, XtUngrabButton removes a deferred XtGrabButton request, if any, for the specified widget, button, and modifiers.
To actively grab the pointer, use **XtGrabPointer**.

```c
int XtGrabPointer(widget, owner_events, event_mask, pointer_mode, keyboard_mode,
                   confine_to, cursor, time)
```

- **widget**: Specifi es the widget for whose window the pointer is to be grabbed. Must be of class Core or any subclass thereof.

- **owner_events**, **event_mask**, **pointer_mode**, **keyboard_mode**, **confixe_to**, **cursor**, **time**: Specify arguments to **XGrabPointer**; see Section 12.1 in *Xlib — C Language X Interface*.

If the specified widget is realized, **XtGrabPointer** calls **XGrabPointer**, specifying the widget’s window as the grab window. The remaining arguments and return value are exactly as for **XGrabPointer**. If the widget is not realized, **XtGrabPointer** immediately returns **Grab-NotViewable**. No future automatic ungrab is implied by **XtGrabPointer**.

To cancel an active pointer grab, use **XtUngrabPointer**.

```c
void XtUngrabPointer(widget, time)
```

- **widget**: Specifi es the widget that has the active pointer grab.

- **time**: Specifi es the time argument to **XUngrabPointer**; see Section 12.1 in *Xlib — C Language X Interface*.

**XtUngrabPointer** calls **XUngrabPointer** with the specified time.

### 7.3. Focusing Events on a Child

To redirect keyboard input to a normal descendant of a widget without calling **XSetInputFocus**, use **XtSetKeyboardFocus**.
void XtSetKeyboardFocus(subtree descendant)
    Widget subtree, descendant;

subtree Specifies the subtree of the hierarchy for which the keyboard focus is to be set. Must be of class Core or any subclass thereof.

descendant Specifies either the normal (non-pop-up) descendant of subtree to which keyboard events are logically directed, or None. It is not an error to specify None when no input focus was previously set. Must be of class Object or any subclass thereof.

XtSetKeyboardFocus causes XtDispatchEvent to remap keyboard events occurring within the specified subtree and dispatch them to the specified descendant widget or to an ancestor. If the descendant’s class is not a subclass of Core, the descendant is replaced by its closest windowed ancestor.

When there is no modal cascade, keyboard events can be dispatched to a widget in one of five ways. Assume the server delivered the event to the window for widget E (because of X input focus, key or keyboard grabs, or pointer position).

- If neither E nor any of E’s ancestors have redirected the keyboard focus, or if the event activated a grab for E as specified by a call to XtGrabKey with any value of owner_events, or if the keyboard is actively grabbed by E with owner_events False via XtGrabKeyboard or XtGrabKey on a previous key press, the event is dispatched to E.
- Beginning with the ancestor of E closest to the root that has redirected the keyboard focus or E if no such ancestor exists, if the target of that focus redirection has in turn redirected the keyboard focus, recursively follow this focus chain to find a widget F that has not redirected focus.
  - If E is the final focus target widget F or a descendant of F, the event is dispatched to E.
  - If E is not F, an ancestor of F, or a descendant of F, and the event activated a grab for E as specified by a call to XtGrabKey for E, XtUngrabKeyboard is called.
  - If E is an ancestor of F, and the event is a key press, and either
    + E has grabbed the key with XtGrabKey and owner_events False, or
    + E has grabbed the key with XtGrabKey and owner_events True, and the coordinates of the event are outside the rectangle specified by E’s geometry, then the event is dispatched to E.
  - Otherwise, define A as the closest common ancestor of E and F:
    + If there is an active keyboard grab for any widget via either XtGrabKeyboard or XtGrabKey on a previous key press, or if no widget between F and A (noninclusively) has grabbed the key and modifier combination with XtGrabKey and any value of owner_events, the event is dispatched to F.
    + Else, the event is dispatched to the ancestor of F closest to A that has grabbed the key and modifier combination with XtGrabKey.

When there is a modal cascade, the final destination widget as identified above is in the active subset of the cascade, the event is dispatched; otherwise the event is remapped to a spring-loaded shell or discarded. Regardless of where it is dispatched, the Intrinsics do not modify the contents of the event.

When subtree or one of its descendants acquires the X input focus or the pointer moves into the subtree such that keyboard events would now be delivered to the subtree, a FocusIn event is generated for the descendant if FocusChange events have been selected by the descendant. Similarly, when subtree loses the X input focus or the keyboard focus for one of its ancestors, a FocusOut event is generated for descendant if FocusChange events have been selected by the
A widget tree may also actively manage the X server input focus. To do so, a widget class specifies an accept_focus procedure. The accept_focus procedure pointer is of type `XtAcceptFocusProc`.

```c
typedef Boolean (*XtAcceptFocusProc)(Widget, Time*);
```

- `w` Specifi es the widget.
- `time` Specifi es the X time of the event causing the accept focus.

Widgets that need the input focus can call `XSetInputFocus` explicitly, pursuant to the restrictions of the `Inter-Client Communication Conventions Manual`. To allow outside agents, such as the parent, to cause a widget to take the input focus, every widget exports an accept_focus procedure. The widget returns a value indicating whether it actually took the focus or not, so that the parent can give the focus to another widget. Widgets that need to know when they lose the input focus must use the Xlib focus notification mechanism explicitly (typically by specifying translations for `FocusIn` and `FocusOut` events). Widgets classes that never want the input focus should set the accept_focus field to NULL.

To call a widget’s accept_focus procedure, use `XtCallAcceptFocus`.

```c
Boolean XtCallAcceptFocus(Widget, time)
    Widget w;
    Time *time;
```

- `w` Specifi es the widget. Must be of class Core or any subclass thereof.
- `time` Specifi es the X time of the event that is causing the focus change.

The `XtCallAcceptFocus` function calls the specified widget’s accept_focus procedure, passing it the specified widget and time, and returns what the accept_focus procedure returns. If accept_focus is NULL, `XtCallAcceptFocus` returns `False`.

### 7.3.1. Events for Drawables That Are Not a Widget’s Window

Sometimes an application must handle events for drawables that are not associated with widgets in its widget tree. Examples include handling `GraphicsExpose` and `NoExpose` events on Pixmaps, and handling `PropertyNotify` events on the root window.

To register a drawable with the Intrinsics event dispatching, use `XtRegisterDrawable`.
void XtRegisterDrawable(display, drawable, widget)
    Display *display;
    Drawable drawable;
    Widget widget;

display Speciﬁes the drawable’s display.
drawable Speciﬁes the drawable to register.
wedge Speciﬁes the widget to register the drawable for.

XtRegisterDrawable associates the speciﬁed drawable with the speciﬁed widget so that future
calls to XtWindowToWidget with the drawable will return the widget. The default event dis-
patcher will dispatch future events that arrive for the drawable to the widget in the same manner
as events that contain the widget’s window.

If the drawable is already registered with another widget, or if the drawable is the window of a
widget in the client’s widget tree, the results of calling XtRegisterDrawable are undeﬁned.

To unregister a drawable with the Intrinsics event dispatching, use XtUnregisterDrawable.

void XtUnregisterDrawable(display, drawable)
    Display *display;
    Drawable drawable;

display Speciﬁes the drawable’s display.
drawable Speciﬁes the drawable to unregister.

XtUnregisterDrawable removes an association created with XtRegisterDrawable. If the draw-
able is the window of a widget in the client’s widget tree the results of calling XtUnregister-
Drawable are undeﬁned.

7.4. Querying Event Sources

The event manager provides several functions to examine and read events (including ﬁle and
timer events) that are in the queue. The next three functions are Intrinsics equivalents of the
XPending, XPeekEvent, and XNextEvent Xlib calls.

To determine if there are any events on the input queue for a given application, use XtAppPend-
ing.

XtInputMask XtAppPending(app_context)
    XtAppContext app_context;

app_context Speciﬁes the application context that identiﬁes the application to check.

The XtAppPending function returns a nonzero value if there are events pending from the X
server, timer pending, other input sources pending, or signal sources pending. The value returned
is a bit mask that is the OR of XtIMXEvent, XtIMTimer, XtIMAlternateInput, and XtIM-
Signal (see XtAppProcessEvent). If there are no events pending, XtAppPending ﬂushes
the output buffers of each Display in the application context and returns zero.
To return the event from the head of a given application’s input queue without removing input from the queue, use `XtAppPeekEvent`.

```c
Boolean XtAppPeekEvent(app_context, event_return)
    XtAppContext app_context;
    XEvent *event_return;

app_context    Specifies the application context that identifies the application.
event_return    Returns the event information to the specified event structure.
```

If there is an X event in the queue, `XtAppPeekEvent` copies it into `event_return` and returns `True`. If no X input is on the queue, `XtAppPeekEvent` flushes the output buffers of each Display in the application context and blocks until some input is available (possibly calling some timeout callbacks in the interim). If the next available input is an X event, `XtAppPeekEvent` fills `event_return` and returns `True`. Otherwise, the input is for an input source registered with `XtAppAddInput`, and `XtAppPeekEvent` returns `False`.

To remove and return the event from the head of a given application’s `X` event queue, use `XtAppNextEvent`.

```c
void XtAppNextEvent(app_context, event_return)
    XtAppContext app_context;
    XEvent *event_return;

app_context    Specifies the application context that identifies the application.
event_return    Returns the event information to the specified event structure.
```

If the X event queue is empty, `XtAppNextEvent` flushes the X output buffers of each Display in the application context and waits for an X event while looking at the other input sources and timeout values and calling any callback procedures triggered by them. This wait time can be used for background processing; see Section 7.8.

### 7.5. Dispatching Events

The Intrinsics provide functions that dispatch events to widgets or other application code. Every client interested in X events on a widget uses `XtAddEventHandler` to register which events it is interested in and a procedure (event handler) to be called when the event happens in that window. The translation manager automatically registers event handlers for widgets that use translation tables; see Chapter 10.

Applications that need direct control of the processing of different types of input should use `XtAppProcessEvent`.

---

The sample implementations provide `XtAppPeekEvent` as described. Timeout callbacks are called while blocking for input. If some input for an input source is available, `XtAppPeekEvent` will return `True` without returning an event.
void XtAppProcessEvent(app_context, mask)
    XtAppContext app_context;
    XtInputMask mask;

app_context Specifies the application context that identifies the application for which to process input.

mask Specifies what types of events to process. The mask is the bitwise inclusive OR of any combination of XtIMXEvent, XtIMTimer, XtIMAAlternateInput, and XtIMSignal. As a convenience, Intrinsic.h defines the symbolic name XtIMAll to be the bitwise inclusive OR of these four event types.

The XtAppProcessEvent function processes one timer, input source, signal source, or X event. If there is no event or input of the appropriate type to process, then XtAppProcessEvent blocks until there is. If there is more than one type of input available to process, it is undefined which will get processed. Usually, this procedure is not called by client applications; see XtAppMain-Loop. XtAppProcessEvent processes timer events by calling any appropriate timer callbacks, input sources by calling any appropriate input callbacks, signal source by calling any appropriate signal callbacks, and X events by calling XtDispatchEvent.

When an X event is received, it is passed to XtDispatchEvent, which calls the appropriate event handlers and passes them the widget, the event, and client-specific data registered with each procedure. If no handlers for that event are registered, the event is ignored and the dispatcher simply returns.

To dispatch an event returned by XtAppNextEvent, retrieved directly from the Xlib queue, or synthetically constructed, to any registered event filters or event handlers, call XtDispatchEvent.

Boolean XtDispatchEvent(event)
    XEvent *event;

event Specifies a pointer to the event structure to be dispatched to the appropriate event handlers.

The XtDispatchEvent function first calls XFilterEvent with the event and the window of the widget to which the Intrinsics intend to dispatch the event, or the event window if the Intrinsics would not dispatch the event to any handlers. If XFilterEvent returns True and the event activated a server grab as identified by a previous call to XtGrabKey or XtGrabButton, XtDispatchEvent calls XtUngrabKeyboard or XtUngrabPointer with the timestamp from the event and immediately returns True. If XFilterEvent returns True and a grab was not activated, XtDispatchEvent just immediately returns True. Otherwise, XtDispatchEvent sends the event to the event handler functions that have been previously registered with the dispatch routine. XtDispatchEvent returns True if XFilterEvent returned True, or if the event was dispatched to some handler, and False if it found no handler to which to dispatch the event. XtDispatchEvent records the last timestamp in any event that contains a timestamp (see XtLast-TimestampProcessed), regardless of whether it was filtered or dispatched. If a modal cascade is active with spring_loaded True, and if the event is a remap event as defined by XtAddGrab, XtDispatchEvent may dispatch the event a second time. If it does so, XtDispatchEvent will call XFilterEvent again with the window of the spring-loaded widget prior to the second dispatch, and if XFilterEvent returns True, the second dispatch will not be performed.
7.6. The Application Input Loop
To process all input from a given application in a continuous loop, use the convenience procedure \texttt{XtAppMainLoop}.

\begin{verbatim}
void XtAppMainLoop(app_context)
    XtAppContext app_context;

app_context Specifies the application context that identifies the application.
\end{verbatim}

The \texttt{XtAppMainLoop} function first reads the next incoming X event by calling \texttt{XtAppNextEvent} and then dispatches the event to the appropriate registered procedure by calling \texttt{XtDispatchEvent}. This constitutes the main loop of X Toolkit applications. There is nothing special about \texttt{XtAppMainLoop}; it simply calls \texttt{XtAppNextEvent} and then \texttt{XtDispatchEvent} in a conditional loop. At the bottom of the loop, it checks to see if the specified application context’s destroy flag is set. If the flag is set, the loop breaks. The whole loop is enclosed between a matching \texttt{XtAppLock} and \texttt{XtAppUnlock}.

Applications can provide their own version of this loop, which tests some global termination flag or tests that the number of top-level widgets is larger than zero before circling back to the call to \texttt{XtAppNextEvent}.

7.7. Setting and Checking the Sensitivity State of a Widget
Many widgets have a mode in which they assume a different appearance (for example, are grayed out or stippled), do not respond to user events, and become dormant. When dormant, a widget is considered to be insensitive. If a widget is insensitive, the event manager does not dispatch any events to the widget with an event type of \texttt{KeyPress}, \texttt{KeyRelease}, \texttt{ButtonPress}, \texttt{ButtonRelease}, \texttt{MotionNotify}, \texttt{EnterNotify}, \texttt{LeaveNotify}, \texttt{FocusIn}, or \texttt{FocusOut}.

A widget can be insensitive because its \texttt{Sensitive} field is \texttt{False} or because one of its ancestors is insensitive and thus the widget’s \texttt{ancestor_sensitive} field also is \texttt{False}. A widget can but does not need to distinguish these two cases visually.

\textbf{Note}
Pop-up shells will have \texttt{ancestor_sensitive False} if the parent was insensitive when the shell was created. Since \texttt{XtSetSensitive} on the parent will not modify the resource of the pop-up child, clients are advised to include a resource specification of the form “**TransientShell.ancestorSensitive: True**” in the application defaults resource file or to otherwise ensure that the parent is sensitive when creating pop-up shells.

To set the sensitivity state of a widget, use \texttt{XtSetSensitive}.

\begin{verbatim}
void XtSetSensitive(w, sensitive)
    Widget w;
    Boolean sensitive;

w Specifies the widget. Must be of class RectObj or any subclass thereof.

sensitive Specifies whether the widget should receive keyboard, pointer, and focus events.
\end{verbatim}

The \texttt{XtSetSensitive} function first calls \texttt{XtSetValues} on the current widget with an argument list
specifying the XtNsensitive resource and the new value. If sensitive is False and the widget’s class is a subclass of Composite, XtSetSensitive recursively propagates the new value down the child tree by calling XtSetValues on each child to set ancestor_sensitive to False. If sensitive is True and the widget’s class is a subclass of Composite and the widget’s ancestor_sensitive field is True, XtSetSensitive sets the ancestor_sensitive of each child to True and then recursively calls XtSetValues on each normal descendant that is now sensitive to set ancestor_sensitive to True.

XtSetSensitive calls XtSetValues to change the sensitive and ancestor_sensitive fields of each affected widget. Therefore, when one of these changes, the widget’s set_values procedure should take whatever display actions are needed (for example, graying out or stippling the widget).

XtSetSensitive maintains the invariant that, if the parent has either sensitive or ancestor_sensitive False, then all children have ancestor_sensitive False.

To check the current sensitivity state of a widget, use XtIsSensitive.

```c
Boolean XtIsSensitive(w)
    Widget w;
    w Specifies the object. Must be of class Object or any subclass thereof.
```

The XtIsSensitive function returns True or False to indicate whether user input events are being dispatched. If object’s class is a subclass of RectObj and both sensitive and ancestor_sensitive are True, XtIsSensitive returns True; otherwise, it returns False.

### 7.8. Adding Background Work Procedures

The Intrinsics have some limited support for background processing. Because most applications spend most of their time waiting for input, you can register an idle-time work procedure that is called when the toolkit would otherwise block in XtAppNextEvent or XtAppProcessEvent. Work procedure pointers are of type XtWorkProc.

```c
typedef Boolean (*XtWorkProc)(XtPointer);
    XtPointer client_data;
    client_data Passes the client data specified when the work procedure was registered.
```

This procedure should return True when it is done to indicate that it should be removed. If the procedure returns False, it will remain registered and called again when the application is next idle. Work procedures should be very judicious about how much they do. If they run for more than a small part of a second, interactive feel is likely to suffer.

To register a work procedure for a given application, use XtAppAddWorkProc.
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XtWorkProcId XtAppAddWorkProc(app_context, proc, client_data)
  XtAppContext app_context;
  XtWorkProc proc;
  XtPointer client_data;

app_context Specifies the application context that identifies the application.
proc Specifies the procedure to be called when the application is idle.
client_data Specifies the argument passed to the specified procedure when it is called.

The XtAppAddWorkProc function adds the specified work procedure for the application identified by app_context and returns an opaque unique identifier for this work procedure. Multiple work procedures can be registered, and the most recently added one is always the one that is called. However, if a work procedure adds another work procedure, the newly added one has lower priority than the current one.

To remove a work procedure, either return True from the procedure when it is called or use XtRemoveWorkProc outside of the procedure.

void XtRemoveWorkProc(id)
  XtWorkProcId id;

id Specifies which work procedure to remove.

The XtRemoveWorkProc function explicitly removes the specified background work procedure.

7.9. X Event Filters

The event manager provides filters that can be applied to specific X events. The filters, which screen out events that are redundant or are temporarily unwanted, handle pointer motion compression, enter/leave compression, and exposure compression.

7.9.1. Pointer Motion Compression

Widgets can have a hard time keeping up with a rapid stream of pointer motion events. Furthermore, they usually do not care about every motion event. To throw out redundant motion events, the widget class field compress_motion should be True. When a request for an event would return a motion event, the Intrinsics check if there are any other motion events for the same widget immediately following the current one and, if so, skip all but the last of them.

7.9.2. Enter/Leave Compression

To throw out pairs of enter and leave events that have no intervening events, as can happen when the user moves the pointer across a widget without stopping in it, the widget class field compress_enterleave should be True. These enter and leave events are not delivered to the client if they are found together in the input queue.

7.9.3. Exposure Compression

Many widgets prefer to process a series of exposure events as a single expose region rather than as individual rectangles. Widgets with complex displays might use the expose region as a clip list in a graphics context, and widgets with simple displays might ignore the region entirely and
redisplays their whole window or might get the bounding box from the region and redisplay only that rectangle.

In either case, these widgets do not care about getting partial exposure events. The `compress_exposure` field in the widget class structure specifies the type and number of exposure events that are dispatched to the widget’s expose procedure. This field must be initialized to one of the following values:

```c
#define XtExposeNoCompress ((XtEnum)False)
#define XtExposeCompressSeries ((XtEnum)True)
#define XtExposeCompressMultiple <implementation-defined>
#define XtExposeCompressMaximal <implementation-defined>
```

optionally ORed with any combination of the following flags (all with implementation-defined values): `XtExposeGraphicsExpose`, `XtExposeGraphicsExposeMerged`, `XtExposeNoExpose`, and `XtExposeNoRegion`.

If the `compress_exposure` field in the widget class structure does not specify `XtExposeNoCompress`, the event manager calls the widget’s expose procedure only once for a series of exposure events. In this case, all `Expose` or `GraphicsExpose` events are accumulated into a region. When the final event is received, the event manager replaces the rectangle in the event with the bounding box for the region and calls the widget’s expose procedure, passing the modified exposure event and (unless `XtExposeNoRegion` is specified) the region. For more information on regions, see Section 16.5 in *Xlib — C Language X Interface*.

The values have the following interpretation:

- **XtExposeNoCompress**
  No exposure compression is performed; every selected event is individually dispatched to the expose procedure with a `region` argument of NULL.

- **XtExposeCompressSeries**
  Each series of exposure events is coalesced into a single event, which is dispatched when an exposure event with count equal to zero is reached.

- **XtExposeCompressMultiple**
  Consecutive series of exposure events are coalesced into a single event, which is dispatched when an exposure event with count equal to zero is reached and either the event queue is empty or the next event is not an exposure event for the same widget.

- **XtExposeCompressMaximal**
  All expose series currently in the queue for the widget are coalesced into a single event without regard to intervening nonexposure events. If a partial series is in the end of the queue, the Intrinsics will block until the end of the series is received.

The additional flags have the following meaning:

- **XtExposeGraphicsExpose**
  Specifies that `GraphicsExpose` events are also to be dispatched to the expose procedure. `GraphicsExpose` events are compressed, if specified, in the same manner as `Expose`
events.

**XtExposeGraphicsExposeMerged**

Specifies in the case of `XtExposeCompressMultiple` and `XtExposeCompressMaximal` that series of `GraphicsExpose` and `Expose` events are to be compressed together, with the final event type determining the type of the event passed to the expose procedure. If this flag is not set, then only series of the same event type as the event at the head of the queue are coalesced. This flag also implies `XtExposeGraphicsExpose`.

**XtExposeNoExpose**

Specifies that `NoExpose` events are also to be dispatched to the expose procedure. `NoExpose` events are never coalesced with other exposure events or with each other.

**XtExposeNoRegion**

Specifies that the final region argument passed to the expose procedure is NULL. The rectangle in the event will still contain bounding box information for the entire series of compressed exposure events. This option saves processing time when the region is not needed by the widget.

### 7.10. Widget Exposure and Visibility

Every primitive widget and some composite widgets display data on the screen by means of direct Xlib calls. Widgets cannot simply write to the screen and forget what they have done. They must keep enough state to redisplay the window or parts of it if a portion is obscured and then reexposed.

#### 7.10.1. Redisplay of a Widget: The expose Procedure

The expose procedure pointer in a widget class is of type `XtExposeProc`.

```c
typedef void (*XtExposeProc)(Widget, XEvent*, Region);
```

- `Widget w;`  
- `XEvent *event;`  
- `Region region;`

```c
w Specifi es the widget instance requiring redisplay.
```

```c
event Specifi es the exposure event giving the rectangle requiring redisplay.
```

```c
region Specifi es the union of all rectangles in this exposure sequence.
```

The redisplay of a widget upon exposure is the responsibility of the expose procedure in the widget's class record. If a widget has no display semantics, it can specify NULL for the `expose` field. Many composite widgets serve only as containers for their children and have no expose procedure.

**Note**

If the `expose` procedure is NULL, `XtRealizeWidget` fills in a default bit gravity of `NorthWestGravity` before it calls the widget's realize procedure.

If the widget's `compress_expose` class field specifies `XtExposeNoCompress` or `XtExposeNoRegion`, or if the event type is `NoExpose` (see Section 7.9.3), `region` is NULL. If `XtExposeNoCompress` is not specified and the event type is not `NoExpose`, the event is the final event
in the compressed series but \( x, y, \text{width}, \) and \( \text{height} \) contain the bounding box for all the compressed events. The region is created and destroyed by the Intrinsics, but the widget is permitted to modify the region contents.

A small simple widget (for example, Label) can ignore the bounding box information in the event and redisplay the entire window. A more complicated widget (for example, Text) can use the bounding box information to minimize the amount of calculation and redisplay it does. A very complex widget uses the region as a clip list in a GC and ignores the event information. The expose procedure is not chained and is therefore responsible for exposure of all superclass data as well as its own.

However, it often is possible to anticipate the display needs of several levels of subclassing. For example, rather than implement separate display procedures for the widgets Label, Pushbutton, and Toggle, you could write a single display routine in Label that uses display state fields like

- Boolean invert;
- Boolean highlight;
- Dimension highlight_width;

Label would have \( \text{invert} \) and \( \text{highlight} \) always \( \text{False} \) and \( \text{highlight_width} \) zero. Pushbutton would dynamically set \( \text{highlight} \) and \( \text{highlight_width} \), but it would leave \( \text{invert} \) always \( \text{False} \). Finally, Toggle would dynamically set all three. In this case, the expose procedures for Pushbutton and Toggle inherit their superclass's expose procedure; see Section 1.6.10.

### 7.10.2. Widget Visibility

Some widgets may use substantial computing resources to produce the data they will display. However, this effort is wasted if the widget is not actually visible on the screen, that is, if the widget is obscured by another application or is iconified.

The \( \text{visible} \) field in the core widget structure provides a hint to the widget that it need not compute display data. This field is guaranteed to be \( \text{True} \) by the time an exposure event is processed if any part of the widget is visible, but is \( \text{False} \) if the widget is fully obscured.

Widgets can use or ignore the \( \text{visible} \) hint. If they ignore it, they should have \( \text{visible_interest} \) in their widget class record set \( \text{False} \). In such cases, the \( \text{visible} \) field is initialized \( \text{True} \) and never changes. If \( \text{visible_interest} \) is \( \text{True} \), the event manager asks for \( \text{VisibilityNotify} \) events for the widget and sets \( \text{visible} \) to \( \text{True} \) on \( \text{VisibilityUnobscured} \) or \( \text{VisibilityPartiallyObscured} \) events and \( \text{False} \) on \( \text{VisibilityFullyObscured} \) events.

### 7.11. X Event Handlers

Event handlers are procedures called when specified events occur in a widget. Most widgets need not use event handlers explicitly. Instead, they use the Intrinsics translation manager. Event handler procedure pointers are of the type \text{XtEventHandler}.
typedef void (*XtEventHandler)(Widget, XtPointer, XEvent*, Boolean*);

  Widget w;
  XtPointer client_data;
  XEvent *event;
  Boolean *continue_to_dispatch;

  w Specifies the widget for which the event arrived.
  client_data Specifies any client-specific information registered with the event handler.
  event Specifies the triggering event.
  continue_to_dispatch Specifies whether the remaining event handlers registered for the current event should be called.

After receiving an event and before calling any event handlers, the Boolean pointed to by continue_to_dispatch is initialized to True. When an event handler is called, it may decide that further processing of the event is not desirable and may store False in this Boolean, in which case any handlers remaining to be called for the event are ignored.

The circumstances under which the Intrinsics may add event handlers to a widget are currently implementation-dependent. Clients must therefore be aware that storing False into the continue_to_dispatch argument can lead to portability problems.

7.11.1. Event Handlers That Select Events
To register an event handler procedure with the dispatch mechanism, use XtAddEventHandler.

void XtAddEventHandler(w, event_mask, nonmaskable, proc, client_data)
  Widget w;
  EventMask event_mask;
  Boolean nonmaskable;
  XtEventHandler proc;
  XtPointer client_data;

  w Specifies the widget for which this event handler is being registered. Must be of class Core or any subclass thereof.
  event_mask Specifies the event mask for which to call this procedure.
  nonmaskable Specifies whether this procedure should be called on the nonmaskable events (GraphicsExpose, NoExpose, SelectionClear, SelectionRequest, SelectionNotify, ClientMessage, and MappingNotify).
  proc Specifies the procedure to be called.
  client_data Specifies additional data to be passed to the event handler.

The XtAddEventHandler function registers a procedure with the dispatch mechanism that is to be called when an event that matches the mask occurs on the specified widget. Each widget has a single registered event handler list, which will contain any procedure/client_data pair exactly once regardless of the manner in which it is registered. If the procedure is already registered with the same client_data value, the specified mask augments the existing mask. If the widget is realized, XtAddEventHandler calls XSelectInput, if necessary. The order in which this procedure is called relative to other handlers registered for the same event is not defined.
To remove a previously registered event handler, use **XtRemoveEventHandler**.

```c
void XtRemoveEventHandler(w, event_mask, nonmaskable, proc, client_data)
    Widget w;
    EventMask event_mask;
    Boolean nonmaskable;
    XtEventHandler proc;
    XtPointer client_data;

    w Specifies the widget for which this procedure is registered. Must be of class Core or any subclass thereof.
    event_mask Specifies the event mask for which to unregister this procedure.
    nonmaskable Specifies whether this procedure should be removed on the nonmaskable events (GraphicsExpose, NoExpose, SelectionClear, SelectionRequest, SelectionNotify, ClientMessage, and MappingNotify).
    proc Specifies the procedure to be removed.
    client_data Specifies the registered client data.
```

The **XtRemoveEventHandler** function unregisters an event handler registered with **XtAddEventHandler** or **XtInsertEventHandler** for the specified events. The request is ignored if **client_data** does not match the value given when the handler was registered. If the widget is realized and no other event handler requires the event, **XtRemoveEventHandler** calls **XSelectInput**. If the specified procedure has not been registered or if it has been registered with a different value of **client_data**, **XtRemoveEventHandler** returns without reporting an error.

To stop a procedure registered with **XtAddEventHandler** or **XtInsertEventHandler** from receiving all selected events, call **XtRemoveEventHandler** with an **event_mask** of **XtAllEvents** and **nonmaskable** True. The procedure will continue to receive any events that have been specified in calls to **XtAddRawEventHandler** or **XtInsertRawEventHandler**.

To register an event handler procedure that receives events before or after all previously registered event handlers, use **XtInsertEventHandler**.

```c
typedef enum {XtListHead, XtListTail} XtListPosition;

void XtInsertEventHandler(w, event_mask, nonmaskable, proc, client_data, position)
    Widget w;
    EventMask event_mask;
    Boolean nonmaskable;
    XtEventHandler proc;
    XtPointer client_data;
    XtListPosition position;

    w Specifies the widget for which this event handler is being registered. Must be of class Core or any subclass thereof.
    event_mask Specifies the event mask for which to call this procedure.
    nonmaskable Specifies whether this procedure should be called on the nonmaskable events (GraphicsExpose, NoExpose, SelectionClear, SelectionRequest, SelectionNotify, ClientMessage, and MappingNotify).
    proc Specifies the procedure to be called.
```
client_data  Specifi es additional data to be passed to the client’s event handler.
position  Specifi es when the event handler is to be called relative to other previously regis-

**XtInsertEventHandler** is identical to **XtAddEventHandler** with the additional *position* argument. If *position* is **XtListHead**, the event handler is registered so that it is called before any event handlers that were previously registered for the same widget. If *position* is **XtListTail**, the event handler is registered to be called after any previously registered event handlers. If the procedure is already registered with the same *client_data* value, the specified mask augments the existing mask and the procedure is repositioned in the list.

### 7.11.2. Event Handlers That Do Not Select Events

On occasion, clients need to register an event handler procedure with the dispatch mechanism without explicitly causing the X server to select for that event. To do this, use **XtAddRawEventHandler**.

```c
void XtAddRawEventHandler(w, event_mask, nonmaskable, proc, client_data)
Widget w;
EventMask event_mask;
Boolean nonmaskable;
XtEventHandler proc;
XtPointer client_data;
```

- *w*  Specifi es the widget for which this event handler is being registered. Must be of class Core or any subclass thereof.
- *event_mask*  Specifi es the event mask for which to call this procedure.
- *nonmaskable*  Specifi es whether this procedure should be called on the nonmaskable events (**GraphicsExpose**, **NoExpose**, **SelectionClear**, **SelectionRequest**, **SelectionNotify**, **ClientMessage**, and **MappingNotify**).
- *proc*  Specifi es the procedure to be called.
- *client_data*  Specifi es additional data to be passed to the client’s event handler.

The **XtAddRawEventHandler** function is similar to **XtAddEventHandler** except that it does not affect the widget’s event mask and never causes an **XSelectInput** for its events. Note that the widget might already have those mask bits set because of other nonraw event handlers registered on it. If the procedure is already registered with the same *client_data*, the specified mask augments the existing mask. The order in which this procedure is called relative to other handlers registered for the same event is not defined.

To remove a previously registered raw event handler, use **XtRemoveRawEventHandler**.

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void XtRemoveRawEventHandler(w, event_mask, nonmaskable, proc, client_data)

  Widget w;
  EventMask event_mask;
  Boolean nonmaskable;
  XtEventHandler proc;
  XtPointer client_data;

  w Speciﬁes the widget for which this procedure is registered. Must be of class Core or any subclass thereof.
  event_mask Speciﬁes the event mask for which to unregister this procedure.
  nonmaskable Speciﬁes whether this procedure should be removed on the nonmaskable events
                (GraphicsExpose, NoExpose, SelectionClear, SelectionRequest, Selection-
                Notify, ClientMessage, and MappingNotify).
  proc Speciﬁes the procedure to be registered.
  client_data Speciﬁes the registered client data.

The XtRemoveRawEventHandler function unregisters an event handler registered with XtAdd-
_rawEventHandler or XtInsertRawEventHandler for the speciﬁed events without changing
the window event mask. The request is ignored if client_data does not match the value given
when the handler was registered. If the speciﬁed procedure has not been registered or if it has
been registered with a different value of client_data, XtRemoveRawEventHandler returns with-
out reporting an error.

To stop a procedure registered with XtAddRawEventHandler or XtInsertRawEventHandler
from receiving all nonselected events, call XtRemoveRawEventHandler with an event_mask of
XtAllEvents and nonmaskable True. The procedure will continue to receive any events that
have been speciﬁed in calls to XtAddEventHandler or XtInsertEventHandler.

To register an event handler procedure that receives events before or after all previously registered
event handlers without selecting for the events, use XtInsertRawEventHandler.

void XtInsertRawEventHandler(w, event_mask, nonmaskable, proc, client_data, position)

  Widget w;
  EventMask event_mask;
  Boolean nonmaskable;
  XtEventHandler proc;
  XtPointer client_data;
  XtListPosition position;

  w Speciﬁes the widget for which this event handler is being registered. Must be of
class Core or any subclass thereof.
  event_mask Speciﬁes the event mask for which to call this procedure.
  nonmaskable Speciﬁes whether this procedure should be called on the nonmaskable events
                (GraphicsExpose, NoExpose, SelectionClear, SelectionRequest, Selection-
                Notify, ClientMessage, and MappingNotify).
  proc Speciﬁes the procedure to be registered.
  client_data Speciﬁes additional data to be passed to the client’s event handler.
  position Speciﬁes when the event handler is to be called relative to other previously registered
            handlers.
The `XtInsertRawEventHandler` function is similar to `XtInsertEventHandler` except that it does not modify the widget's event mask and never causes an `XSelectInput` for the specified events. If the procedure is already registered with the same `client_data` value, the specified mask augments the existing mask and the procedure is repositioned in the list.

### 7.11.3. Current Event Mask

To retrieve the event mask for a given widget, use `XtBuildEventMask`.

```c
EventMask XtBuildEventMask(Widget w);
```

- `w` specifies the widget. Must be of class Core or any subclass thereof.

The `XtBuildEventMask` function returns the event mask representing the logical OR of all event masks for event handlers registered on the widget with `XtAddEventHandler` and `XtInsertEventHandler` and all event translations, including accelerators, installed on the widget. This is the same event mask stored into the `XSetWindowAttributes` structure by `XtRealizeWindow` and sent to the server when event handlers and translations are installed or removed on the realized widget.

### 7.11.4. Event Handlers for X11 Protocol Extensions

To register an event handler procedure with the Intrinsic dispatch mechanism according to an event type, use `XtInsertEventTypeHandler`.

```c
void XtInsertEventTypeHandler(Widget widget, int event_type, XtPointer select_data, XtEventHandler proc, XtPointer client_data, XtListPosition position);
```

- `widget` specifies the widget for which this event handler is being registered. Must be of class Core or any subclass thereof.
- `event_type` specifies the event type for which to call this event handler.
- `select_data` specifies data used to request events of the specified type from the server, or NULL.
- `proc` specifies the event handler to be called.
- `client_data` specifies additional data to be passed to the event handler.
- `position` specifies when the event handler is to be called relative to other previously registered handlers.

`XtInsertEventTypeHandler` registers a procedure with the dispatch mechanism that is to be called when an event that matches the specified `event_type` is dispatched to the specified `widget`. If `event_type` specifies one of the core X protocol events, then `select_data` must be a pointer to a value of type `EventMask`, indicating the event mask to be used to select for the desired event. This event mask is included in the value returned by `XtBuildEventMask`. If the widget is realized, `XtInsertEventTypeHandler` calls `XSelectInput` if necessary. Specifying NULL for `select_data` is equivalent to specifying a pointer to an event mask containing 0. This is similar to
the `XtInsertRawEventHandler` function.

If `event_type` specifies an extension event type, then the semantics of the data pointed to by `select_data` are defined by the extension selector registered for the specified event type.

In either case the Intrinsics are not required to copy the data pointed to by `select_data`, so the caller must ensure that it remains valid as long as the event handler remains registered with this value of `select_data`.

The `position` argument allows the client to control the order of invocation of event handlers registered for the same event type. If the client does not care about the order, it should normally specify `XtListTail`, which registers this event handler after any previously registered handlers for this event type.

Each widget has a single registered event handler list, which will contain any procedure/client_data pair exactly once if it is registered with `XtInsertEventTypeHandler`, regardless of the manner in which it is registered and regardless of the value(s) of `select_data`. If the procedure is already registered with the same `client_data` value, the specified mask augments the existing mask and the procedure is repositioned in the list.

To remove an event handler registered with `XtInsertEventTypeHandler`, use `XtRemoveEventTypeHandler`.

```c
void XtRemoveEventTypeHandler(widget, event_type, select_data, proc, client_data)
    Widget widget;
    int event_type;
    XtPointer select_data;
    XtEventHandler proc;
    XtPointer client_data;

    widget       Specifies the widget for which the event handler was registered. Must be of class Core or any subclass thereof.
    event_type   Specifies the event type for which the handler was registered.
    select_data  Specifies data used to deselect events of the specified type from the server, or NULL.
    proc         Specifies the event handler to be removed.
    client_data  Specifies the additional client data with which the procedure was registered.
```

The `XtRemoveEventTypeHandler` function unregisters an event handler registered with `XtInsertEventTypeHandler` for the specified event type. The request is ignored if `client_data` does not match the value given when the handler was registered.

If `event_type` specifies one of the core X protocol events, `select_data` must be a pointer to a value of type `EventMask`, indicating mask to be used to deselect for the appropriate event. If the widget is realized, `XtRemoveEventTypeHandler` calls `XSelectInput` if necessary. Specifying NULL for `select_data` is equivalent to specifying a pointer to an event mask containing 0. This is similar to the `XtRemoveRawEventHandler` function.

If `event_type` specifies an extension event type, then the semantics of the data pointed to by `select_data` are defined by the extension selector registered for the specified event type.

To register a procedure to select extension events for a widget, use `XtRegisterExtensionSelector`.
void XtRegisterExtensionSelector(display, min_event_type, max_event_type, proc, 
    client_data)

    Display *display;
    int min_event_type;
    int max_event_type;
    XtExtensionSelectProc proc;
    XtPointer client_data;

display Specifies the display for which the extension selector is to be registered.
min_event_type Specifies the range of event types for the extension.
max_event_type Specifies the extension selector procedure.
proc Specifies additional data to be passed to the extension selector.

The **XtRegisterExtensionSelector** function registers a procedure to arrange for the delivery of extension events to widgets.

If **min_event_type** and **max_event_type** match the parameters to a previous call to **XtRegisterExtensionSelector** for the same display, then **proc** and **client_data** replace the previously registered values. If the range specified by **min_event_type** and **max_event_type** overlaps the range of the parameters to a previous call for the same display in any other way, an error results.

When a widget is realized, after the **core.realize** method is called, the Intrinsics check to see if any event handler specifies an event type within the range of a registered extension selector. If so, the Intrinsics call each such selector. If an event type handler is added or removed, the Intrinsics check to see if the event type falls within the range of a registered extension selector, and if it does, calls the selector. In either case the Intrinsics pass a list of all the widget’s event types that are within the selector’s range. The corresponding select data are also passed. The selector is responsible for enabling the delivery of extension events required by the widget.

An extension selector is of type **XtExtensionSelectProc**.

```c
typedef void (*XtExtensionSelectProc)(Widget, int *, XtPointer *, int, XtPointer);
```

**widget** Specifies the widget that is being realized or is having an event handler added or removed.

**event_types** Specifies a list of event types that the widget has registered event handlers for.

**select_data** Specifies a list of the select_data parameters specified in **XtInsertEventTypeHandler**.

**count** Specifies the number of entries in the **event_types** and **select_data** lists.

**client_data** Specifies the additional client data with which the procedure was registered.

The **event_types** and **select_data** lists will always have the same number of elements, specified by **count**. Each event type/select data pair represents one call to **XtInsertEventTypeHandler**.
To register a procedure to dispatch events of a specific type within XtDispatchEvent, use XtSetEventDispatcher.

XtEventDispatchProc XtSetEventDispatcher(display, event_type, proc)

Display *display;
int event_type;
XtEventDispatchProc proc;

display Specifies the display for which the event dispatcher is to be registered.
event_type Specifies the event type for which the dispatcher should be invoked.
proc Specifies the event dispatcher procedure.

The XtSetEventDispatcher function registers the event dispatcher procedure specified by proc for events with the type event_type. The previously registered dispatcher (or the default dispatcher if there was no previously registered dispatcher) is returned. If proc is NULL, the default procedure is restored for the specified type.

In the future, when XtDispatchEvent is called with an event type of event_type, the specified proc (or the default dispatcher) is invoked to determine a widget to which to dispatch the event. The default dispatcher handles the Intrinsics modal cascade and keyboard focus mechanisms, handles the semantics of compress_enterleave and compress_motion, and discards all extension events.

An event dispatcher procedure pointer is of type XtEventDispatchProc.

typedef Boolean (*XtEventDispatchProc)(XEvent*)
XEvent *event;
event Passes the event to be dispatched.

The event dispatcher procedure should determine whether this event is of a type that should be dispatched to a widget.

If the event should be dispatched to a widget, the event dispatcher procedure should determine the appropriate widget to receive the event, call XFilterEvent with the window of this widget, or None if the event is to be discarded, and if XFilterEvent returns False, dispatch the event to the widget using XtDispatchEventToWidget. The procedure should return True if either XFilterEvent or XtDispatchEventToWidget returned True and False otherwise.

If the event should not be dispatched to a widget, the event dispatcher procedure should attempt to dispatch the event elsewhere as appropriate and return True if it successfully dispatched the event and False otherwise.

Some dispatchers for extension events may wish to forward events according to the Intrinsics' keyboard focus mechanism. To determine which widget is the end result of keyboard event forwarding, use XtGetKeyboardFocusWidget.

Widget XtGetKeyboardFocusWidget(widget)
Widget widget;

widget Specifies the widget to get forwarding information for.

The XtGetKeyboardFocusWidget function returns the widget that would be the end result of keyboard event forwarding for a keyboard event for the specified widget.
To dispatch an event to a specified widget, use \texttt{XtDispatchEventToWidget}.

\begin{verbatim}
Boolean XtDispatchEventToWidget(widget, event)
    Widget widget;
    XEvent *event;

    widget Specifies the widget to which to dispatch the event.
    event Specifies a pointer to the event to be dispatched.
\end{verbatim}

The \texttt{XtDispatchEventToWidget} function scans the list of registered event handlers for the specified widget and calls each handler that has been registered for the specified event type, subject to the \texttt{continue_to_dispatch} value returned by each handler. The Intrinsics behave as if event handlers were registered at the head of the list for \texttt{Expose}, \texttt{NoExpose}, \texttt{GraphicsExpose}, and \texttt{VisibilityNotify} events to invoke the widget’s expose procedure according to the exposure compression rules and to update the widget’s \texttt{visible} field if \texttt{visible_interest} is \texttt{True}. These internal event handlers never set \texttt{continue_to_dispatch} to \texttt{False}.

\texttt{XtDispatchEventToWidget} returns \texttt{True} if any event handler was called and \texttt{False} otherwise.

\section*{7.12. Using the Intrinsics in a Multi-Threaded Environment}

The Intrinsics may be used in environments that offer multiple threads of execution within the context of a single process. A multi-threaded application using the Intrinsics must explicitly initialize the toolkit for mutually exclusive access by calling \texttt{XtToolkitThreadInitialize}.

\subsection*{7.12.1. Initializing a Multi-Threaded Intrinsics Application}

To test and initialize Intrinsics support for mutually exclusive thread access, call \texttt{XtToolkitThreadInitialize}.

\begin{verbatim}
Boolean XtToolkitThreadInitialize()
\end{verbatim}

\texttt{XtToolkitThreadInitialize} returns \texttt{True} if the Intrinsics support mutually exclusive thread access, otherwise it returns \texttt{False}. \texttt{XtToolkitThreadInitialize} must be called before \texttt{XtCreateApplicationContext}, \texttt{XtAppInitialize}, \texttt{XtOpenApplication}, or \texttt{XtSetLanguageProc} is called. \texttt{XtToolkitThreadInitialize} may be called more than once; however, the application writer must ensure that it is not called simultaneously by two or more threads.

\subsection*{7.12.2. Locking X Toolkit Data Structures}

The Intrinsics employs two levels of locking: application context and process. Locking an application context ensures mutually exclusive access by a thread to the state associated with the application context, including all displays and widgets associated with it. Locking a process ensures mutually exclusive access by a thread to Intrinsics process global data.

A client may acquire a lock multiple times and the effect is cumulative. The client must ensure that the lock is released an equal number of times in order for the lock to be acquired by another thread.

Most application writers will have little need to use locking as the Intrinsics performs the necessary locking internally. Resource converters are an exception. They require the application context or process to be locked before the application can safely call them directly, for example:
When the application relies upon `XtConvertAndStore` or a converter to provide the storage for the results of a conversion, the application should acquire the process lock before calling out and hold the lock until the results have been copied.

Application writers who write their own utility functions, such as one which retrieves the `being_destroyed` field from a widget instance, must lock the application context before accessing widget internal data. For example:

```c
#include <X11/CoreP.h>

Boolean BeingDestroyed (widget)
    Widget widget;
{
    Boolean ret;
    XtAppLock(XtWidgetToApplicationContext(widget));
    ret = widget->core.being_destroyed;
    XtAppUnlock(XtWidgetToApplicationContext(widget));
    return ret;
}
```

A client that wishes to atomically call two or more Intrinsics functions must lock the application context. For example:

```c
...
XtAppLock(XtWidgetToApplicationContext(widget));
XtUnmanageChild (widget1);
XtManageChild (widget2);
XtAppUnlock(XtWidgetToApplicationContext(widget));
...```

### 7.12.2.1. Locking the Application Context

To ensure mutual exclusion of application context, display, or widget internal state, use `XtAppLock`.

```c
void XtAppLock(app_context)
    XtApplicationContext app_context;

app_context    Specify the application context to lock.
```

`XtAppLock` blocks until it is able to acquire the lock. Locking the application context also ensures that only the thread holding the lock makes Xlib calls from within Xt. An application that makes its own direct Xlib calls must either lock the application context around every call or enable thread locking in Xlib.

To unlock a locked application context, use `XtAppUnlock`. 

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void XtAppUnlock(app_context)
   XtAppContext app_context;

app_context specifies the application context that was previously locked.

7.12.2.2. Locking the Process
To ensure mutual exclusion of X Toolkit process global data, a widget writer must use XtProcessLock.

void XtProcessLock()

XtProcessLock blocks until it is able to acquire the lock. Widget writers may use XtProcessLock to guarantee mutually exclusive access to widget static data. To unlock a locked process, use XtProcessUnlock.

void XtProcessUnlock()

To lock both an application context and the process at the same time, call XtAppLock first and then XtProcessLock. To release both locks, call XtProcessUnlock first and then XtAppUnlock. The order is important to avoid deadlock.

7.12.3. Event Management in a Multi-Threaded Environment
In a nonthreaded environment an application writer could reasonably assume that it is safe to exit the application from a quit callback. This assumption may no longer hold true in a multi-threaded environment; therefore it is desirable to provide a mechanism to terminate an event-processing loop without necessarily terminating its thread.

To indicate that the event loop should terminate after the current event dispatch has completed, use XtAppSetExitFlag.

void XtAppSetExitFlag(app_context)
   XtAppContext app_context;

app_context specifies the application context.

XtAppMainLoop tests the value of the flag and will return if the flag is True. Application writers who implement their own main loop may test the value of the exit flag with XtAppGetExitFlag.

Boolean XtAppGetExitFlag(app_context)
   XtAppContext app_context;

app_context specifies the application context.

XtAppGetExitFlag will normally return False, indicating that event processing may continue. When XtAppGetExitFlag returns True, the loop must terminate and return to the caller, which
might then destroy the application context.

Application writers should be aware that, if a thread is blocked in `XtAppNextEvent`, `XtAppPeekEvent`, or `XtAppProcessEvent` and another thread in the same application context opens a new display, adds an alternate input, or a timeout, any new source(s) will not normally be "noticed" by the blocked thread. Any new sources are "noticed" the next time one of these functions is called.

The Intrinsics manage access to events on a last-in, first-out basis. If multiple threads in the same application context block in `XtAppNextEvent`, `XtAppPeekEvent`, or `XtAppProcessEvent`, the last thread to call one of these functions is the first thread to return.
Chapter 8

Callbacks

Applications and other widgets often need to register a procedure with a widget that gets called under certain prespecified conditions. For example, when a widget is destroyed, every procedure on the widget’s `destroy_callbacks` list is called to notify clients of the widget’s impending doom.

Every widget has an `XtNdestroyCallbacks` callback list resource. Widgets can define additional callback lists as they see fit. For example, the Pushbutton widget has a callback list to notify clients when the button has been activated.

Except where otherwise noted, it is the intent that all Intrinsics functions may be called at any time, including from within callback procedures, action routines, and event handlers.

8.1. Using Callback Procedure and Callback List Definitions

Callback procedure pointers for use in callback lists are of type `XtCallbackProc`.

```c
typedef void (*XtCallbackProc)(Widget, XtPointer, XtPointer);
```

- `w` Specifies the widget owning the list in which the callback is registered.
- `client_data` Specifies additional data supplied by the client when the procedure was registered.
- `call_data` Specifies any callback-specific data the widget wants to pass to the client. For example, when Scrollbar executes its `XtNthumbChanged` callback list, it passes the new position of the thumb.

The `client_data` argument provides a way for the client registering the callback procedure also to register client-specific data, for example, a pointer to additional information about the widget, a reason for invoking the callback, and so on. The `client_data` value may be NULL if all necessary information is in the widget. The `call_data` argument is a convenience to avoid having simple cases where the client could otherwise always call `XtGetValues` or a widget-specific function to retrieve data from the widget. Widgets should generally avoid putting complex state information in `call_data`. The client can use the more general data retrieval methods, if necessary.

Whenever a client wants to pass a callback list as an argument in an `XtCreateWidget`, `XtSetValues`, or `XtGetValues` call, it should specify the address of a NULL-terminated array of type `XtCallbackList`.

```c
typedef struct {
    XtCallbackProc callback;
    XtPointer closure;
} XtCallbackRec, *XtCallbackList;
```

For example, the callback list for procedures A and B with client data `clientDataA` and `clientDataB`, respectively, is
static XtCallbackRec callbacks[] = {
    {A, (XtPointer) clientDataA},
    {B, (XtPointer) clientDataB},
    {(XtCallbackProc) NULL, (XtPointer) NULL}
};

Although callback lists are passed by address in arglists and varargs lists, the Intrinsics recognize
callback lists through the widget resource list and will copy the contents when necessary. Widget
initialize and set_values procedures should not allocate memory for the callback list contents.
The Intrinsics automatically do this, potentially using a different structure for their internal repre-
sentation.

8.2. Identifying Callback Lists
Whenever a widget contains a callback list for use by clients, it also exports in its public .h file the
resource name of the callback list. Applications and client widgets never access callback list
fields directly. Instead, they always identify the desired callback list by using the exported
resource name. All the callback manipulation functions described in this chapter except XtCall-
CallbackList check to see that the requested callback list is indeed implemented by the widget.
For the Intrinsics to find and correctly handle callback lists, they must be declared with a resource
type of XtRCallback. The internal representation of a callback list is implementation-depen-
dent; widgets may make no assumptions about the value stored in this resource if it is non-NULL.
Except to compare the value to NULL (which is equivalent to XtCallbackStatus XtCallback-
HasNone), access to callback list resources must be made through other Intrinsics procedures.

8.3. Adding Callback Procedures
To add a callback procedure to a widget’s callback list, use XtAddCallback.

```c
void XtAddCallback(w, callback_name, callback, client_data)
    Widget w;
    String callback_name;
    XtCallbackProc callback;
    XtPointer client_data;

    w Specifies the widget. Must be of class Object or any subclass thereof.
    callback_name Specifies the callback list to which the procedure is to be appended.
    callback Specifies the callback procedure.
    client_data Specifies additional data to be passed to the specified procedure when it is in-
                   voked, or NULL.
```

A callback will be invoked as many times as it occurs in the callback list.

To add a list of callback procedures to a given widget’s callback list, use XtAddCallbacks.
**void XtAddCallbacks (w, callback_name, callbacks)**

  Widget w;
  String callback_name;
  XtCallbackList callbacks;

  \( w \) Specifies the widget. Must be of class Object or any subclass thereof.

  \( callback\_name \) Specifies the callback list to which the procedures are to be appended.

  \( callbacks \) Specifies the null-terminated list of callback procedures and corresponding client data.

**8.4. Removing Callback Procedures**

To delete a callback procedure from a widget’s callback list, use **XtRemoveCallback**.

**void XtRemoveCallback (w, callback_name, callback, client_data)**

  Widget w;
  String callback_name;
  XtCallbackProc callback;
  XtPointer client_data;

  \( w \) Specifies the widget. Must be of class Object or any subclass thereof.

  \( callback\_name \) Specifies the callback list from which the procedure is to be deleted.

  \( callback \) Specifies the callback procedure.

  \( client\_data \) Specifies the client data to match with the registered callback entry.

The **XtRemoveCallback** function removes a callback only if both the procedure and the client data match.

To delete a list of callback procedures from a given widget’s callback list, use **XtRemoveCallbacks**.

**void XtRemoveCallbacks (w, callback_name, callbacks)**

  Widget w;
  String callback_name;
  XtCallbackList callbacks;

  \( w \) Specifies the widget. Must be of class Object or any subclass thereof.

  \( callback\_name \) Specifies the callback list from which the procedures are to be deleted.

  \( callbacks \) Specifies the null-terminated list of callback procedures and corresponding client data.

To delete all callback procedures from a given widget’s callback list and free all storage associated with the callback list, use **XtRemoveAllCallbacks**.
### 8.5. Executing Callback Procedures

To execute the procedures in a given widget’s callback list, specifying the callback list by resource name, use `XtCallCallbacks`.

```c
void XtCallCallbacks(w, callback_name, call_data)
  Widget w;
  String callback_name;
  XtPointer call_data;

  w    Specifies the widget. Must be of class Object or any subclass thereof.
  callback_name    Specifies the callback list to be executed.
  call_data    Specifies a callback-list-specific data value to pass to each of the callback procedure in the list, or NULL.
```

`XtCallCallbacks` calls each of the callback procedures in the list named by `callback_name` in the specified widget, passing the client data registered with the procedure and `call_data`.

To execute the procedures in a callback list, specifying the callback list by address, use `XtCallCallbackList`.

```c
void XtCallCallbackList(widget, callbacks, call_data)
  Widget widget;
  XtCallbackList callbacks;
  XtPointer call_data;

  widget    Specifies the widget instance that contains the callback list. Must be of class Object or any subclass thereof.
  callbacks    Specifies the callback list to be executed.
  call_data    Specifies a callback-list-specific data value to pass to each of the callback procedures in the list, or NULL.
```

The `callbacks` parameter must specify the contents of a widget or object resource declared with representation type `XtRCallback`. If `callbacks` is NULL, `XtCallCallbackList` returns immediately; otherwise it calls each of the callback procedures in the list, passing the client data and `call_data`.

### 8.6. Checking the Status of a Callback List

To find out the status of a given widget’s callback list, use `XtHasCallbacks`.

```c
void XtRemoveAllCallbacks(w, callback_name)
  Widget w;
  String callback_name;

  w    Specifies the widget. Must be of class Object or any subclass thereof.
  callback_name    Specifies the callback list to be cleared.
```
typedef enum {XtCallbackNoList, XtCallbackHasNone, XtCallbackHasSome} XtCallbackStatus;

XtCallbackStatus XtHasCallbacks(w, callback_name)
    Widget w;
    String callback_name;
    
    w Specifies the widget. Must be of class Object or any subclass thereof.
    callback_name Specifies the callback list to be checked.

The XtHasCallbacks function first checks to see if the widget has a callback list identified by callback_name. If the callback list does not exist, XtHasCallbacks returns XtCallbackNoList. If the callback list exists but is empty, it returns XtCallbackHasNone. If the callback list exists and has at least one callback registered, it returns XtCallbackHasSome.
Chapter 9

Resource Management

A resource is a field in the widget record with a corresponding resource entry in the resources list of the widget or any of its superclasses. This means that the field is settable by `XtCreateWidget` (by naming the field in the argument list), by an entry in a resource file (by using either the name or class), and by `XtSetValues`. In addition, it is readable by `XtGetValues`. Not all fields in a widget record are resources. Some are for bookkeeping use by the generic routines (like `managed` and `being_destroyed`). Others can be for local bookkeeping, and still others are derived from resources (many graphics contexts and pixmaps).

Widgets typically need to obtain a large set of resources at widget creation time. Some of the resources come from the argument list supplied in the call to `XtCreateWidget`, some from the resource database, and some from the internal defaults specified by the widget. Resources are obtained first from the argument list, then from the resource database for all resources not specified in the argument list, and last, from the internal default, if needed.

9.1. Resource Lists

A resource entry specifies a field in the widget, the textual name and class of the field that argument lists and external resource files use to refer to the field, and a default value that the field should get if no value is specified. The declaration for the `XtResource` structure is

```c
typedef struct {
    String resource_name;
    String resource_class;
    String resource_type;
    Cardinal resource_size;
    Cardinal resource_offset;
    String default_type;
    XtPointer default_addr;
} XtResource, *XtResourceList;
```

When the resource list is specified as the `CoreClassPart`, `ObjectClassPart`, `RectObjClassPart`, or `ConstraintClassPart` resources field, the strings pointed to by `resource_name`, `resource_class`, `resource_type`, and `default_type` must be permanently allocated prior to or during the execution of the class initialization procedure and must not be subsequently deallocated.

The `resource_name` field contains the name used by clients to access the field in the widget. By convention, it starts with a lowercase letter and is spelled exactly like the field name, except all underscores (_) are deleted and the next letter is replaced by its uppercase counterpart. For example, the resource name for `background_pixel` becomes `backgroundPixel`. Resource names beginning with the two-character sequence “xt”, and resource classes beginning with the two-character sequence “Xt” are reserved to the Intrinsics for future standard and implementation-dependent uses. Widget header files typically contain a symbolic name for each resource name. All resource names, classes, and types used by the Intrinsics are named in `<X11/StringDefs.h>`. The Intrinsics’s symbolic resource names begin with “XtN” and are followed by the string name (for example, XtNbackgroundPixel for backgroundPixel).
The resource_class field contains the class string used in resource specification files to identify the field. A resource class provides two functions:
- It isolates an application from different representations that widgets can use for a similar resource.
- It lets you specify values for several actual resources with a single name. A resource class should be chosen to span a group of closely related fields.

For example, a widget can have several pixel resources: background, foreground, border, block cursor, pointer cursor, and so on. Typically, the background defaults to white and everything else to black. The resource class for each of these resources in the resource list should be chosen so that it takes the minimal number of entries in the resource database to make the background ivory and everything else darkblue.

In this case, the background pixel should have a resource class of “Background” and all the other pixel entries a resource class of “Foreground”. Then, the resource file needs only two lines to change all pixels to ivory or darkblue:

```
*Background: ivory
*Foreground: darkblue
```

Similarly, a widget may have several font resources (such as normal and bold), but all fonts should have the class Font. Thus, changing all fonts simply requires only a single line in the default resource file:

```
*Font: 6x13
```

By convention, resource classes are always spelled starting with a capital letter to distinguish them from resource names. Their symbolic names are preceded with “XtC” (for example, XtCBackground).

The resource_type field gives the physical representation type of the resource and also encodes information about the specific usage of the field. By convention, it starts with an uppercase letter and is spelled identically to the type name of the field. The resource type is used when resources are fetched to convert from the resource database format (usually String) or the format of the resource default value (almost anything, but often String) to the desired physical representation (see Section 9.6). The Intrinsics define the following resource types:

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>Structure or Field Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>XtRAcceleratorTable</td>
<td>XtAccelerators</td>
</tr>
<tr>
<td>XtRAtom</td>
<td>Atom</td>
</tr>
<tr>
<td>XtRBitmap</td>
<td>Pixmap, depth=1</td>
</tr>
<tr>
<td>XtRBoolean</td>
<td>Boolean</td>
</tr>
<tr>
<td>XtRBool</td>
<td>Bool</td>
</tr>
<tr>
<td>XtRCallback</td>
<td>XtRCallbackList</td>
</tr>
<tr>
<td>XtRCardinal</td>
<td>Cardinal</td>
</tr>
<tr>
<td>XtRColor</td>
<td>XColor</td>
</tr>
<tr>
<td>XtRColormap</td>
<td>Colormap</td>
</tr>
<tr>
<td>XtRCommandArgArray</td>
<td>String*</td>
</tr>
<tr>
<td>XtRCursor</td>
<td>Cursor</td>
</tr>
<tr>
<td>XtRDimension</td>
<td>Dimension</td>
</tr>
<tr>
<td>XtRDirectoryString</td>
<td>String</td>
</tr>
<tr>
<td>XtRDisplay</td>
<td>Display*</td>
</tr>
<tr>
<td>XtREnum</td>
<td>XtEnum</td>
</tr>
<tr>
<td>XtREnvironmentArray</td>
<td>String*</td>
</tr>
</tbody>
</table>
### Resource Type

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>Structure or Field Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>XtRFile</td>
<td>FILE*</td>
</tr>
<tr>
<td>XtRFloat</td>
<td>float</td>
</tr>
<tr>
<td>XtRFont</td>
<td>Font</td>
</tr>
<tr>
<td>XtRFontSet</td>
<td>XFontSet</td>
</tr>
<tr>
<td>XtRFontStruct</td>
<td>XFontStruct*</td>
</tr>
<tr>
<td>XtRFunction</td>
<td>(*)()</td>
</tr>
<tr>
<td>XtRGeometry</td>
<td>char*, format as defined by XParseGeometry</td>
</tr>
<tr>
<td>XtRGravity</td>
<td>int</td>
</tr>
<tr>
<td>XtRInitialState</td>
<td>int</td>
</tr>
<tr>
<td>XtRInt</td>
<td>int</td>
</tr>
<tr>
<td>XtRLongBoolean</td>
<td>long</td>
</tr>
<tr>
<td>XtRObject</td>
<td>Object</td>
</tr>
<tr>
<td>XtRPixel</td>
<td>Pixel</td>
</tr>
<tr>
<td>XtRPixmap</td>
<td>Pixmap</td>
</tr>
<tr>
<td>XtRPointer</td>
<td>XtPointer</td>
</tr>
<tr>
<td>XtRPosition</td>
<td>Position</td>
</tr>
<tr>
<td>XtRRestartStyle</td>
<td>unsigned char</td>
</tr>
<tr>
<td>XtRScreen</td>
<td>Screen*</td>
</tr>
<tr>
<td>XtRShort</td>
<td>short</td>
</tr>
<tr>
<td>XtRSmcConn</td>
<td>XtPointer</td>
</tr>
<tr>
<td>XtRString</td>
<td>String</td>
</tr>
<tr>
<td>XtRStringArray</td>
<td>String*</td>
</tr>
<tr>
<td>XtRStringTable</td>
<td>String*</td>
</tr>
<tr>
<td>XtRTranslationTable</td>
<td>XtTranslations</td>
</tr>
<tr>
<td>XtRUnsignedChar</td>
<td>unsigned char</td>
</tr>
<tr>
<td>XtRVisual</td>
<td>Visual*</td>
</tr>
<tr>
<td>XtRWidget</td>
<td>Widget</td>
</tr>
<tr>
<td>XtRWidgetClass</td>
<td>WidgetClass</td>
</tr>
<tr>
<td>XtRWidgetList</td>
<td>WidgetList</td>
</tr>
<tr>
<td>XtRWindow</td>
<td>Window</td>
</tr>
</tbody>
</table>

<X11/StringDefs.h> also defines the following resource types as a convenience for widgets, although they do not have any corresponding data type assigned: XtREditMode, XtRJustify, and XtROrientation.

The resource_size field is the size of the physical representation in bytes; you should specify it as sizeof(type) so that the compiler fills in the value. The resource_offset field is the offset in bytes of the field within the widget. You should use the XtOffsetOf macro to retrieve this value. The default_type field is the representation type of the default resource value. If default_type is different from resource_type and the default value is needed, the resource manager invokes a conversion procedure from default_type to resource_type. Whenever possible, the default type should be identical to the resource type in order to minimize widget creation time. However, there are sometimes no values of the type that the program can easily specify. In this case, it should be a value for which the converter is guaranteed to work (for example, XtDefaultForeground for a pixel resource). The default_addr field specifies the address of the default resource value. As a special case, if default_type is XtRString, then the value in the default_addr field is the pointer to the string rather than a pointer to the pointer. The default is used if a resource is not specified in the argument list or in the resource database or if the conversion from the representation type stored in the resource database fails, which can happen for various reasons (for example, a mis-spelled entry in a resource file).
Two special representation types (XtRImmediate and XtRCallProc) are usable only as default resource types. XtRImmediate indicates that the value in the default_addr field is the actual value of the resource rather than the address of the value. The value must be in the correct representation type for the resource, coerced to an XtPointer. No conversion is possible, since there is no source representation type. XtRCallProc indicates that the value in the default_addr field is a procedure pointer. This procedure is automatically invoked with the widget, resource_offset, and a pointer to an XrmValue in which to store the result. XtRCallProc procedure pointers are of type XtResourceDefaultProc.

```c
typedef void (*XtResourceDefaultProc)(Widget, int, XrmValue*);

void XtGetResourceList(WidgetClass class,
                        XtResourceList *resources_return,
                        Cardinal *num_resources_return);
```

- `class` Specifies the widget whose resource value is to be obtained.
- `offset` Specifies the offset of the field in the widget record.
- `value` Specifies the resource value descriptor to return.

The XtResourceDefaultProc procedure should fill in the value->addr field with a pointer to the resource value in its correct representation type.

To get the resource list structure for a particular class, use XtGetResourceList.

If XtGetResourceList is called before the class is initialized, it returns the resource list as specified in the class record. If it is called after the class has been initialized, XtGetResourceList returns a merged resource list that includes the resources for all superclasses. The list returned by XtGetResourceList should be freed using XtFree when it is no longer needed.

To get the constraint resource list structure for a particular widget class, use XtGetConstraintResourceList.
void XtGetConstraintResourceList(class, resources_return, num_resources_return)
    WidgetClass class;
    XtResourceList *resources_return;
    Cardinal *num_resources_return;

class Specifes the object class to be queried. It must be objectClass or any subclass thereof.
resources_return Returns the constraint resource list.
num_resources_return Returns the number of entries in the constraint resource list.

If XtGetConstraintResourceList is called before the widget class is initialized, the resource list as specified in the widget class Constraint part is returned. If XtGetConstraintResourceList is called after the widget class has been initialized, the merged resource list for the class and all Constraint superclasses is returned. If the specified class is not a subclass of constraintWidgetClass, *resources_return is set to NULL and *num_resources_return is set to zero. The list returned by XtGetConstraintResourceList should be freed using XtFree when it is no longer needed.

The routines XtSetValues and XtGetValues also use the resource list to set and get widget state; see Sections 9.7.1 and 9.7.2.

Here is an abbreviated version of a possible resource list for a Label widget:

    /* Resources specific to Label */
    static XtResource resources[] = {
        {XtNforeground, XtCForeground, XtRPixel, sizeof(Pixel),
         XtOffsetOf(LabelRec, label.foreground), XtRString, XtDefaultForeground},
        {XtNfont, XtCFont, XtRFontStruct, sizeof(XFontStruct*),
         XtOffsetOf(LabelRec, label.font), XtRString, XtDefaultFont},
        {XtNlabel, XtCLabel, XtRString, sizeof(String),
         XtOffsetOf(LabelRec, label.label), XtRString, NULL},
    . . .
    }

The complete resource name for a field of a widget instance is the concatenation of the application shell name (from XtAppCreateShell), the instance names of all the widget’s parents up to the top of the widget tree, the instance name of the widget itself, and the resource name of the specified field of the widget. Similarly, the full resource class of a field of a widget instance is the concatenation of the application class (from XtAppCreateShell), the widget class names of all the widget’s parents up to the top of the widget tree, the widget class name of the widget itself, and the resource class of the specified field of the widget.

9.2. Byte Offset Calculations
To determine the byte offset of a field within a structure type, use XtOffsetOf.
Cardinal XtOffsetOf(structure_type, fi eld_name)
   Type structure_type;
   Field fi eld_name;

   structure_type Specifies a type that is declared as a structure.
   fi eld_name Specifies the name of a member within the structure.

The XtOffsetOf macro expands to a constant expression that gives the offset in bytes to the specified structure member from the beginning of the structure. It is normally used to statically initialize resource lists and is more portable than XtOffset, which serves the same function.

To determine the byte offset of a field within a structure pointer type, use XtOffset.

Cardinal XtOffset(pointer_type, fi eld_name)
   Type pointer_type;
   Field fi eld_name;

   pointer_type Specifies a type that is declared as a pointer to a structure.
   fi eld_name Specifies the name of a member within the structure.

The XtOffset macro expands to a constant expression that gives the offset in bytes to the specified structure member from the beginning of the structure. It may be used to statically initialize resource lists. XtOffset is less portable than XtOffsetOf.

9.3. Superclass-to-Subclass Chaining of Resource Lists
The XtCreateWidget function gets resources as a superclass-to-subclass chained operation. That is, the resources specified in the objectClass resource list are fetched, then those in rectObjClass, and so on down to the resources specified for this widget’s class. Within a class, resources are fetched in the order they are declared.

In general, if a widget resource field is declared in a superclass, that field is included in the superclass’s resource list and need not be included in the subclass’s resource list. For example, the Core class contains a resource entry for background_pixel. Consequently, the implementation of Label need not also have a resource entry for background_pixel. However, a subclass, by specifying a resource entry for that field in its own resource list, can override the resource entry for any field declared in a superclass. This is most often done to override the defaults provided in the superclass with new ones. At class initialization time, resource lists for that class are scanned from the superclass down to the class to look for resources with the same offset. A matching resource in a subclass will be reordered to override the superclass entry. If reordering is necessary, a copy of the superclass resource list is made to avoid affecting other subclasses of the superclass.

Also at class initialization time, the Intrinsics produce an internal representation of the resource list to optimize access time when creating widgets. In order to save memory, the Intrinsics may overwrite the storage allocated for the resource list in the class record; therefore, widgets must allocate resource lists in writable storage and must not access the list contents directly after the class_initialize procedure has returned.
9.4. Subresources

A widget does not do anything to retrieve its own resources; instead, XtCreateWidget does this automatically before calling the class initialize procedure.

Some widgets have subparts that are not widgets but for which the widget would like to fetch resources. Such widgets call XtGetSubresources to accomplish this.

```c
void XtGetSubresources(w, base, name, class, resources, num_resources, args, num_args)
    Widget w;
    XtPointer base;
    String name;
    String class;
    XtResourceList resources;
    Cardinal num_resources;
    ArgList args;
    Cardinal num_args;
```

- **w** Specifi es the object used to qualify the subpart resource name and class. Must be of class Object or any subclass thereof.
- **base** Specifi es the base address of the subpart data structure into which the resources will be written.
- **name** Specifi es the name of the subpart.
- **class** Specifi es the class of the subpart.
- **resources** Specifi es the resource list for the subpart.
- **num_resources** Specifi es the number of entries in the resource list.
- **args** Specifi es the argument list to override any other resource specifi cations.
- **num_args** Specifi es the number of entries in the argument list.

The XtGetSubresources function constructs a name and class list from the application name and class, the names and classes of all the object’s ancestors, and the object itself. Then it append s to this list the name and class pair passed in. The resources are fetched from the argument list, the resource database, or the default values in the resource list. Then they are copied into the subpart record. If args is NULL, num_args must be zero. However, if num_args is zero, the argument list is not referenced.

XtGetSubresources may overwrite the specified resource list with an equivalent representation in an internal format, which optimizes access time if the list is used repeatedly. The resource list must be allocated in writable storage, and the caller must not modify the list contents after the call if the same list is to be used again. Resources fetched by XtGetSubresources are reference counted as if they were referenced by the specified object. Subresources might therefore be freed from the conversion cache and destroyed when the object is destroyed, but not before then.

To fetch resources for widget subparts using varargs lists, use XtVaGetSubresources.
void XtVaGetSubresources(w, base, name, class, resources, num_resources, ...)  
Widget w;  
XtPointer base;  
String name;  
String class;  
XtResourceList resources;  
Cardinal num_resources;  

describes the object used to qualify the subpart resource name and class. Must be of class Object or any subclass thereof.

base  
Specifies the base address of the subpart data structure into which the resources will be written.

name  
Specifies the name of the subpart.

class  
Specifies the class of the subpart.

resources  
Specifies the resource list for the subpart.

num_resources  
Specifies the number of entries in the resource list.

...  
Specifies the variable argument list to override any other resource specifications.

XtVaGetSubresources is identical in function to XtGetSubresources with the args and num_args parameters replaced by a varargs list, as described in Section 2.5.1.

9.5. Obtaining Application Resources

To retrieve resources that are not specific to a widget but apply to the overall application, use XtGetApplicationResources.

void XtGetApplicationResources(w, base, resources, num_resources, args, num_args)  
Widget w;  
XtPointer base;  
XtResourceList resources;  
Cardinal num_resources;  
ArgList args;  
Cardinal num_args;  

describes the object that identifies the resource database to search (the database is that associated with the display for this object). Must be of class Object or any subclass thereof.

base  
Specifies the base address into which the resource values will be written.

resources  
Specifies the resource list.

num_resources  
Specifies the number of entries in the resource list.

args  
Specifies the argument list to override any other resource specifications.

num_args  
Specifies the number of entries in the argument list.

The XtGetApplicationResources function first uses the passed object, which is usually an application shell widget, to construct a resource name and class list. The full name and class of the specified object (that is, including its ancestors, if any) is logically added to the front of each resource name and class. Then it retrieves the resources from the argument list, the resource database, or the resource list default values. After adding base to each address, XtGetApplicationResources copies the resources into the addresses obtained by adding base to each offset in the
resource list. If *args* is NULL, *num_args* must be zero. However, if *num_args* is zero, the argument list is not referenced. The portable way to specify application resources is to declare them as members of a structure and pass the address of the structure as the *base* argument.

**XtGetApplicationResources** may overwrite the specified resource list with an equivalent representation in an internal format, which optimizes access time if the list is used repeatedly. The resource list must be allocated in writable storage, and the caller must not modify the list contents after the call if the same list is to be used again. Any per-display resources fetched by **XtGetApplicationResources** will not be freed from the resource cache until the display is closed.

To retrieve resources for the overall application using varargs lists, use **XtVaGetApplicationResources**.

```c
void XtVaGetApplicationResources(w, base, resources, num_resources, ...)
  Widget w;
  XtPointer base;
  XtResourceList resources;
  Cardinal num_resources;

  w  Specifies the object that identifies the resource database to search (the database is that associated with the display for this object). Must be of class Object or any subclass thereof.
  base  Specifies the base address into which the resource values will be written.
  resources  Specifies the resource list for the subpart.
  num_resources  Specifies the number of entries in the resource list.
  ...  Specifies the variable argument list to override any other resource specifications.

XtVaGetApplicationResources** is identical in function to **XtGetApplicationResources** with the *args* and *num_args* parameters replaced by a varargs list, as described in Section 2.5.1.

### 9.6. Resource Conversions

The Intrinsics provide a mechanism for registering representation converters that are automatically invoked by the resource-fetching routines. The Intrinsics additionally provide and register several commonly used converters. This resource conversion mechanism serves several purposes:

- It permits user and application resource files to contain textual representations of nontextual values.
- It allows textual or other representations of default resource values that are dependent on the display, screen, or colormap, and thus must be computed at runtime.
- It caches conversion source and result data. Conversions that require much computation or space (for example, string-to-translation-table) or that require round-trips to the server (for example, string-to-font or string-to-color) are performed only once.

#### 9.6.1. Predefined Resource Converters

The Intrinsics define all the representations used in the Object, RectObj, Core, Composite, Constraint, and Shell widget classes. The Intrinsics register the following resource converters that accept input values of representation type **XtRString**.

<table>
<thead>
<tr>
<th>Target Representation</th>
<th>Converter Name</th>
<th>Additional Args</th>
</tr>
</thead>
</table>

---

150
<table>
<thead>
<tr>
<th>XRAcceleratorTable</th>
<th>XtCvtStringToAcceleratorTable</th>
<th>Display*</th>
</tr>
</thead>
<tbody>
<tr>
<td>XrAtom</td>
<td>XtCvtStringToAtom</td>
<td>Display*</td>
</tr>
<tr>
<td>XrBoolean</td>
<td>XtCvtStringToBoolean</td>
<td>Display*</td>
</tr>
<tr>
<td>XrBool</td>
<td>XtCvtStringToBool</td>
<td>Display*</td>
</tr>
<tr>
<td>XrCommandArgArray</td>
<td>XtCvtStringToCommandArgArray</td>
<td>Display*</td>
</tr>
<tr>
<td>XrCursor</td>
<td>XtCvtStringToCursor</td>
<td>Display*</td>
</tr>
<tr>
<td>XrDimension</td>
<td>XtCvtStringToDimension</td>
<td>Display*</td>
</tr>
<tr>
<td>XrDirectoryString</td>
<td>XtCvtStringToDirectoryString</td>
<td>Display*</td>
</tr>
<tr>
<td>XrDisplay</td>
<td>XtCvtStringToDisplay</td>
<td>Display*</td>
</tr>
<tr>
<td>XrFile</td>
<td>XtCvtStringToFile</td>
<td>Display*</td>
</tr>
<tr>
<td>XrFloat</td>
<td>XtCvtStringToFloat</td>
<td>Display*</td>
</tr>
<tr>
<td>XrFont</td>
<td>XtCvtStringToFont</td>
<td>Display*</td>
</tr>
<tr>
<td>XrFontSet</td>
<td>XtCvtStringToFontSet</td>
<td>Display*</td>
</tr>
<tr>
<td>XrFontStruct</td>
<td>XtCvtStringToFontStruct</td>
<td>Display*</td>
</tr>
<tr>
<td>XrGravity</td>
<td>XtCvtStringToGravity</td>
<td>Display*</td>
</tr>
<tr>
<td>XrInitialState</td>
<td>XtCvtStringToInitialState</td>
<td>Display*</td>
</tr>
<tr>
<td>XrInt</td>
<td>XtCvtStringToInt</td>
<td>Display*</td>
</tr>
<tr>
<td>XrPixel</td>
<td>XtCvtStringToPixel</td>
<td>Display*</td>
</tr>
<tr>
<td>XrPosition</td>
<td>XtCvtStringToPosition</td>
<td>Display*</td>
</tr>
<tr>
<td>XrRestartStyle</td>
<td>XtCvtStringToRestartStyle</td>
<td>Display*</td>
</tr>
<tr>
<td>XrShort</td>
<td>XtCvtStringToShort</td>
<td>Display*</td>
</tr>
<tr>
<td>XrTranslationTable</td>
<td>XtCvtStringToTranslationTable</td>
<td>Display*</td>
</tr>
<tr>
<td>XrUnsignedChar</td>
<td>XtCvtStringToUnsignedChar</td>
<td>Display*</td>
</tr>
<tr>
<td>XrVisual</td>
<td>XtCvtStringToVisual</td>
<td>Display*</td>
</tr>
</tbody>
</table>

The String-to-Pixel conversion has two predefined constants that are guaranteed to work and contrast with each other: `XtDefaultForeground` and `XtDefaultBackground`. They evaluate to the black and white pixel values of the widget’s screen, respectively. If the application resource `reverseVideo` is `True`, they evaluate to the white and black pixel values of the widget’s screen, respectively. Similarly, the String-to-Font and String-to-FontStruct converters recognize the constant `XtDefaultFont` and evaluate in the following manner:

- Query the resource database for the resource whose full name is “xtDefaultFont”, class “XtDefaultFont” (that is, no widget name/class prefixes), and use a type `XrString` value returned as the font name or a type `XrFont` or `XrFontStruct` value directly as the resource value.

- If the resource database does not contain a value for `xtDefaultFont`, class `XtDefaultFont`, or if the returned font name cannot be successfully opened, an implementation-defined font in ISO8859-1 character set encoding is opened. (One possible algorithm is to perform an `XListFonts` using a wildcard font name and use the first font in the list. This wildcard font name should be as broad as possible to maximize the probability of locating a usable font; for example, ".*.*.*-R-.*.*.*-120-.*.*.*-ISO8859-1").

- If no suitable ISO8859-1 font can be found, issue a warning message and return `False`.

The String-to-FontSet converter recognizes the constant `XtDefaultFontSet` and evaluate in the following manner:

- Query the resource database for the resource whose full name is “xtDefaultFontSet”, class “XtDefaultFontSet” (that is, no widget name/class prefixes), and use a type `XrString` value returned as the base font name list or a type `XrFontSet` value directly as the resource value.

- If the resource database does not contain a value for `xtDefaultFontSet`, class `XtDefaultFontSet`, or if a font set cannot be successfully created from this resource, an implementation-defined font set is created. (One possible algorithm is to perform an `XCreateFontSet`
using a wildcard base font name. This wildcard base font name should be as broad as possible to maximize the probability of locating a usable font; for example, "-*-*-*-R-*-*-*-120-*-*-*-*".)

- If no suitable font set can be created, issue a warning message and return False.

If a font set is created but missing_charset_list is not empty, a warning is issued and the partial font set is returned. The Intrinsics register the String-to-FontSet converter with a conversion argument list that extracts the current process locale at the time the converter is invoked. This ensures that the converter is invoked again if the same conversion is required in a different locale.

The String-to-Gravity conversion accepts string values that are the names of window and bit gravities and their numerical equivalents, as defined in Xlib—C Language X Interface: ForgetGravity, UnmapGravity, NorthWestGravity, NorthGravity, NorthEastGravity, WestGravity, CenterGravity, EastGravity, SouthWestGravity, SouthGravity, SouthEastGravity, and StaticGravity. Alphabetic case is not significant in the conversion.

The String-to-CommandArgArray conversion parses a String into an array of strings. White space characters separate elements of the command line. The converter recognizes the backslash character "\" as an escape character to allow the following white space character to be part of the array element.

The String-to-DirectoryString conversion recognizes the string "XtCurrentDirectory" and returns the result of a call to the operating system to get the current directory.

The String-to-RestartStyle conversion accepts the values RestartIfRunning, RestartAnyway, RestartImmediately, and RestartNever as defined by the X Session Management Protocol.

The String-to-InitialState conversion accepts the values NormalState or IconicState as defined by the Inter-Client Communication Conventions Manual.

The String-to-Visual conversion calls XMatchVisualInfo using the screen and depth fields from the core part and returns the first matching Visual on the list. The widget resource list must be certain to specify any resource of type XtRVisual after the depth resource. The allowed string values are the visual class names defined in X Window System Protocol, Section 8; StaticGray, StaticColor, TrueColor, GrayScale, PseudoColor, and DirectColor.

The Intrinsics register the following resource converter that accepts an input value of representation type XtRColor.

<table>
<thead>
<tr>
<th>Target Representation</th>
<th>Converter Name</th>
<th>Additional Args</th>
</tr>
</thead>
<tbody>
<tr>
<td>XtRPixel</td>
<td>XtCvtColorToPixel</td>
<td></td>
</tr>
</tbody>
</table>

The Intrinsics register the following resource converters that accept input values of representation type XtRInt.

<table>
<thead>
<tr>
<th>Target Representation</th>
<th>Converter Name</th>
<th>Additional Args</th>
</tr>
</thead>
<tbody>
<tr>
<td>XtRBoolean</td>
<td>XtCvtIntToBoolean</td>
<td></td>
</tr>
<tr>
<td>XtRBool</td>
<td>XtCvtIntToBool</td>
<td></td>
</tr>
<tr>
<td>XtRColor</td>
<td>XtCvtIntToColor</td>
<td></td>
</tr>
<tr>
<td>XtRDimension</td>
<td>XtCvtIntToDimension</td>
<td>colorConvertArgs</td>
</tr>
<tr>
<td>XtRFloat</td>
<td>XtCvtIntToFloat</td>
<td></td>
</tr>
<tr>
<td>XtRFont</td>
<td>XtCvtIntToFont</td>
<td></td>
</tr>
<tr>
<td>XtRPixel</td>
<td>XtCvtIntToPixel</td>
<td></td>
</tr>
</tbody>
</table>
The Intrinsics register the following resource converter that accepts an input value of representation type `XtRPixel`.

<table>
<thead>
<tr>
<th>Target Representation</th>
<th>Converter Name</th>
<th>Additional Args</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>XtRColor</code></td>
<td><code>XtCvtPixelToColor</code></td>
<td></td>
</tr>
</tbody>
</table>

### 9.6.2. New Resource Converters

Type converters use pointers to `XrmValue` structures (defined in `<X11/Xresource.h>`; see Section 15.4 in *Xlib — C Language X Interface*) for input and output values.

```c
typedef struct {
    unsigned int size;
    XPointer addr;
} XrmValue, *XrmValuePtr;
```

The `addr` field specifies the address of the data, and the `size` field gives the total number of significant bytes in the data. For values of type `String`, `addr` is the address of the first character and `size` includes the NULL-terminating byte.

A resource converter procedure pointer is of type `XtTypeConverter`.
typedef Boolean (*XtTypeConverter)(Display*, XrmValue*, Cardinal*,
    XrmValue*, XrmValue*, XtPointer*);

Display *display;
XrmValue *args;
Cardinal *num_args;
XrmValue *from;
XrmValue *to;
XtPointer *converter_data;

display Specifies the display connection with which this conversion is associated.
args Specifies a list of additional XrmValue arguments to the converter if additional context is needed to perform the conversion, or NULL. For example, the String-to-Font converter needs the widget’s display, and the String-to-Pixel converter needs the widget’s screen and colormap.
num_args Specifies the number of entries in args.
from Specifies the value to convert.
to Specifies a descriptor for a location into which to store the converted value.
converter_data Specifies a location into which the converter may store converter-specific data associated with this conversion.

The display argument is normally used only when generating error messages, to identify the application context (with the function XtDisplayToApplicationContext).
The to argument specifies the size and location into which the converter should store the converted value. If the addr field is NULL, the converter should allocate appropriate storage and store the size and location into the to descriptor. If the type converter allocates the storage, it remains under the ownership of the converter and must not be modified by the caller. The type converter is permitted to use static storage for this purpose, and therefore the caller must immediately copy the data upon return from the converter. If the addr field is not NULL, the converter must check the size field to ensure that sufficient space has been allocated before storing the converted value. If insufficient space is specified, the converter should update the size field with the number of bytes required and return False without modifying the data at the specified location. If sufficient space was allocated by the caller, the converter should update the size field with the number of bytes actually occupied by the converted value. For converted values of type XtRString, the size should include the NULL-terminating byte, if any. The converter may store any value in the location specified in converter_data; this value will be passed to the destructor, if any, when the resource is freed by the Intrinsics.
The converter must return True if the conversion was successful and False otherwise. If the conversion cannot be performed because of an improper source value, a warning message should also be issued with XtAppWarningMsg.

Most type converters just take the data described by the specified from argument and return data by writing into the location specified in the to argument. A few need other information, which is available in args. A type converter can invoke another type converter, which allows differing sources that may convert into a common intermediate result to make maximum use of the type converter cache.

Note that if an address is written into to->addr, it cannot be that of a local variable of the converter because the data will not be valid after the converter returns. Static variables may be used, as in the following example. If the converter modifies the resource database, the changes affect any in-progress widget creation, XtGetApplicationResources, or XtGetSubresources in an implementation-defined manner; however, insertion of new entries or changes to existing entries is allowed and will not directly cause an error.
The following is an example of a converter that takes a string and converts it to a Pixel. Note that the display parameter is used only to generate error messages; the Screen conversion argument is still required to inform the Intrinsics that the converted value is a function of the particular display (and colormap).

```c
#define done(type, value) \
    { \
        if (toVal->addr != NULL) { \
            if (toVal->size < sizeof(type)) { \
                toVal->size = sizeof(type); \
                return False; \
            } \
            *(type*)(toVal->addr) = (value); \
        } \
        else { \
            static type static_val; \
            static_val = (value); \
            toVal->addr = (XPointer)&static_val; \
        } \
        toVal->size = sizeof(type); \
        return True; \
    }

static Boolean CvtStringToPixel(dpy, args, num_args, fromVal, toVal, converter_data)
    Display *dpy;
    XrmValue *args;
    Cardinal *num_args;
    XrmValue *fromVal;
    XrmValue *toVal;
    XtPointer *converter_data;
{
    static XColor screenColor;
    XColor exactColor;
    Screen *screen;
    Colormap colormap;
    Status status;

    if (*num_args != 2)
        XtAppWarningMsg(XtDisplayToApplicationContext(dpy),
            "wrongParameters", "cvtStringToPixel", "XtToolkitError",
            "String to pixel conversion needs screen and colormap arguments",
            (String*)NULL, (Cardinal*)NULL);

    screen = *((Screen**) args[0].addr);
    colormap = *((Colormap *) args[1].addr);

    if (CompareISOLatin1(str, XtDefaultBackground) == 0) {
        *closure_ret = False;
        done(Pixel, WhitePixelOfScreen(screen));
    }
    if (CompareISOLatin1(str, XtDefaultForeground) == 0) {
        *closure_ret = False;
        done(Pixel, BlackPixelOfScreen(screen));
    }
}```
status = XAllocNamedColor(DisplayOfScreen(screen), colormap, (char*)fromVal->addr,
&screenColor, &exactColor);

if (status == 0) {
    String params[1];
    Cardinal num_params = 1;
    params[0] = (String)fromVal->addr;
    XtAppWarningMsg(XtDisplayToApplicationContext(dpy),
        "noColormap", "cvtStringToPixel", "XtToolkitError",
        "Cannot allocate colormap entry for \"%s\", params, &num_params);
    *converter_data = (char *) False;
    return False;
} else {
    *converter_data = (char *) True;
    done(Pixel, &screenColor.pixel);
}

All type converters should define some set of conversion values for which they are guaranteed to
succeed so these can be used in the resource defaults. This issue arises only with conversions,
such as fonts and colors, where there is no string representation that all server implementations
will necessarily recognize. For resources like these, the converter should define a symbolic con-
stant in the same manner as XtDefaultForeground, XtDefaultBackground, and XtDefault-
Font.

To allow the Intrinsics to deallocate resources produced by type converters, a resource destructor
procedure may also be provided.
A resource destructor procedure pointer is of type XtDestructor.

typedef void (*XtDestructor) (XtAppContext, XrmValue*, XtPointer, XrmValue*, Cardinal*);

app Specifies an application context in which the resource is being freed.
to Specifies a descriptor for the resource produced by the type converter.
converter_data Specifies the converter-specific data returned by the type converter.
args Specifies the additional converter arguments as passed to the type converter when
the conversion was performed.
num_args Specifies the number of entries in args.

The destructor procedure is responsible for freeing the resource specified by the to argument,
including any auxiliary storage associated with that resource, but not the memory directly
addressed by the size and location in the to argument or the memory specified by args.

9.6.3. Issuing Conversion Warnings

The XtDisplayStringConversionWarning procedure is a convenience routine for resource type
converters that convert from string values.
void XtDisplayStringConversionWarning(display, from_value, to_type)
    Display *display;
    String from_value, to_type;

display Specifies the display connection with which the conversion is associated.
from_value Specifies the string that could not be converted.
to_type Specifies the target representation type requested.

The XtDisplayStringConversionWarning procedure issues a warning message using XtAppWarningMsg with name “conversionError”, type “string”, class “XtToolkitError”, and the default message “Cannot convert "from_value" to type to_type”.

To issue other types of warning or error messages, the type converter should use XtAppWarningMsg or XtAppErrorMsg.

To retrieve the application context associated with a given display connection, use XtDisplayToApplicationContext.

XtAppContext XtDisplayToApplicationContext( display )
    Display *display;

display Specifes an open and initialized display connection.

The XtDisplayToApplicationContext function returns the application context in which the specified display was initialized. If the display is not known to the Intrinsics, an error message is issued.

9.6.4. Registering a New Resource Converter

When registering a resource converter, the client must specify the manner in which the conversion cache is to be used when there are multiple calls to the converter. Conversion cache control is specified via an XtCacheType argument.

typedef int XtCacheType;

An XtCacheType field may contain one of the following values:

XtCacheNone
    Specifes that the results of a previous conversion may not be reused to satisfy any other resource requests; the specified converter will be called each time the converted value is required.

XtCacheAll
    Specifes that the results of a previous conversion should be reused for any resource request that depends upon the same source value and conversion arguments.

XtCacheByDisplay
Specifies that the results of a previous conversion should be used as for \mbox{XtCacheAll} but the destructor will be called, if specified, if \mbox{XtCloseDisplay} is called for the display connection associated with the converted value, and the value will be removed from the conversion cache.

The qualifier \mbox{XtCacheRefCount} may be ORed with any of the above values. If \mbox{XtCacheRefCount} is specified, calls to \mbox{XtCreateWidget}, \mbox{XtCreateManagedWidget}, \mbox{XtGetApplicationResources}, and \mbox{XtGetSubresources} that use the converted value will be counted. When a widget using the converted value is destroyed, the count is decremented, and, if the count reaches zero, the destructor procedure will be called and the converted value will be removed from the conversion cache.

To register a type converter for all application contexts in a process, use \mbox{XtSetTypeConverter}, and to register a type converter in a single application context, use \mbox{XtAppSetTypeConverter}. 
void XtSetTypeConverter(from_type, to_type, converter, convert_args, num_args, cache_type, destructor)

  String from_type;
  String to_type;
  XtTypeConverter converter;
  XtConvertArgList convert_args;
  Cardinal num_args;
  XtCacheType cache_type;
  XtDestructor destructor;

from_type  Specifies the source type.
to_type  Specifies the destination type.
converter  Specifies the resource type converter procedure.
convert_args  Specifies additional conversion arguments, or NULL.
num_args  Specifies the number of entries in convert_args.
cache_type  Specifies whether or not resources produced by this converter are sharable or display-specific and when they should be freed.
destructor  Specifies a destroy procedure for resources produced by this conversion, or NULL if no additional action is required to deallocate resources produced by the converter.

void XtAppSetTypeConverter(app_context, from_type, to_type, converter, convert_args, num_args, cache_type, destructor)

  XtAppContext app_context;
  String from_type;
  String to_type;
  XtTypeConverter converter;
  XtConvertArgList convert_args;
  Cardinal num_args;
  XtCacheType cache_type;
  XtDestructor destructor;

app_context  Specifies the application context.
from_type  Specifies the source type.
to_type  Specifies the destination type.
converter  Specifies the resource type converter procedure.
convert_args  Specifies additional conversion arguments, or NULL.
num_args  Specifies the number of entries in convert_args.
cache_type  Specifies whether or not resources produced by this converter are sharable or display-specific and when they should be freed.
destructor  Specifies a destroy procedure for resources produced by this conversion, or NULL if no additional action is required to deallocate resources produced by the converter.

XtSetTypeConverter registers the specified type converter and destructor in all application contexts created by the calling process, including any future application contexts that may be created. XtAppSetTypeConverter registers the specified type converter in the single application context specified. If the same from_type and to_type are specified in multiple calls to either function, the most recent overrides the previous ones.
For the few type converters that need additional arguments, the Intrinsics conversion mechanism provides a method of specifying how these arguments should be computed. The enumerated type \texttt{XtAddressMode} and the structure \texttt{XtConvertArgRec} specify how each argument is derived. These are defined in \texttt{<X11/Intrinsic.h>}. 

```c
typedef enum {
    /* address mode parameter representation */
    XtAddress, /* address */
    XtBaseOffset, /* offset */
    XtImmediate, /* constant */
    XtResourceString, /* resource name string */
    XtResourceQuark, /* resource name quark */
    XtWidgetBaseOffset, /* offset */
    XtProcedureArg /* procedure to call */
} XtAddressMode;

typedef struct {
    XtAddressMode address_mode;
    XtPointer address_id;
    Cardinal size;
} XtConvertArgRec, *XtConvertArgList;
```

The \texttt{size} field specifies the length of the data in bytes. The \texttt{address_mode} field specifies how the \texttt{address_id} field should be interpreted. \texttt{XtAddress} causes \texttt{address_id} to be interpreted as the address of the data. \texttt{XtBaseOffset} causes \texttt{address_id} to be interpreted as the offset from the widget base. \texttt{XtImmediate} causes \texttt{address_id} to be interpreted as a constant. \texttt{XtResourceString} causes \texttt{address_id} to be interpreted as the name of a resource that is to be converted into an offset from the widget base. \texttt{XtResourceQuark} causes \texttt{address_id} to be interpreted as the result of an \texttt{XrmStringToQuark} conversion on the name of a resource, which is to be converted into an offset from the widget base. \texttt{XtWidgetBaseOffset} is similar to \texttt{XtBaseOffset} except that it searches for the closest windowed ancestor if the object is not of a subclass of Core (see Chapter 12). \texttt{XtProcedureArg} specifies that \texttt{address_id} is a pointer to a procedure to be invoked to return the conversion argument. If \texttt{XtProcedureArg} is specified, \texttt{address_id} must contain the address of a function of type \texttt{XtConvertArgProc}.

```c
typedef void (*XtConvertArgProc)(Widget, Cardinal*, XrmValue*);
```

When invoked, the \texttt{XtConvertArgProc} procedure must derive a conversion argument and store the address and size of the argument in the location pointed to by \texttt{value}.

In order to permit reentrancy, the \texttt{XtConvertArgProc} should return the address of storage whose lifetime is no shorter than the lifetime of \texttt{object}. If \texttt{object} is NULL, the lifetime of the conversion argument must be no shorter than the lifetime of the resource with which the conversion argument
is associated. The Intrinsics do not guarantee to copy this storage but do guarantee not to refer-
ence it if the resource is removed from the conversion cache.

The following example illustrates how to register the CvtStringToPixel routine given earlier:

```c
static XtConvertArgRec colorConvertArgs[] = {
    {XtWidgetBaseOffset, (XtPointer)XtOffset(Widget, core.screen), sizeof(Screen*)},
    {XtWidgetBaseOffset, (XtPointer)XtOffset(Widget, core.colormap),sizeof(Colormap)}
};

XtSetTypeConverter(XtRString, XtRPixel, CvtStringToPixel,
    colorConvertArgs, XtNumber(colorConvertArgs), XtCacheByDisplay, NULL);
```

The conversion argument descriptors `colorConvertArgs` and `screenConvertArg` are prede®ned
by the Intrinsics. Both take the values from the closest windowed ancestor if the object is not of a
subclass of Core. The `screenConvertArg` descriptor puts the widget’s `screen` fi eld into `args[0]`. The `colorConvertArgs` descriptor puts the widget’s `screen` fi eld into `args[0]`, and the widget’s `colormap` fi eld into `args[1]`.

Conversion routines should not just put a descriptor for the address of the base of the widget into
`args[0]`, and use that in the routine. They should pass in the actual values on which the conver-
sion depends. By keeping the dependencies of the conversion procedure speci®c c, it is more likely
that subsequent conversions will fi nd what they need in the conversion cache. This way the cache
is smaller and has fewer and more widely applicable entries.

If any conversion arguments of type `XtBaseOffset`, `XtResourceString`, `XtResourceQuark`, and
`XtWidgetBaseOffset` are speci®ed for conversions performed by `XtGetApplicationResources`,
`XtGetSubresources`, `XtVaGetApplicationResources`, or `XtVaGetSubresources`, the argu-
ments are computed with respect to the speci®ed widget, not the base address or resource list speci®ed in the call.

If the `XtConvertArgProc` modi®es the resource database, the changes affect any in-progress
widget creation, `XtGetApplicationResources`, or `XtGetSubresources` in an implementation-de®ned manner; however, insertion of new entries or changes to existing entries are allowed and
will not directly cause an error.

### 9.6.5. Resource Converter Invocation

All resource-fetching routines (for example, `XtGetSubresources`, `XtGetApplicationResources`,
and so on) call resource converters if the resource database or varargs list speci®es a value that
has a different representation from the desired representation or if the widget’s default resource
value representation is different from the desired representation.

To invoke explicit resource conversions, use `XtConvertAndStore` or `XtCallConverter`.

```c
typedef XtPointer XtCacheRef;

Boolean XtCallConverter(display, converter, conversion_args, num_args, from, to_in_out, cache_ref_return)
    Display* display;
    XtTypeConverter converter;
    XrmValuePtr conversion_args;
    Cardinal num_args;
    XrmValuePtr from;
    XrmValuePtr to_in_out;
    XtCacheRef *cache_ref_return;
```
display Specifies the display with which the conversion is to be associated.

converter Specifies the conversion procedure to be called.

conversion_args Specifies the additional conversion arguments needed to perform the conversion, or NULL.

num_args Specifies the number of entries in conversion_args.

from Specifies a descriptor for the source value.

to_in_out Returns the converted value.

cache_ref_return Returns a conversion cache id.

The XtCallConverter function looks up the specified type converter in the application context associated with the display and, if the converter was not registered or was registered with cache type XtCacheAll or XtCacheByDisplay, looks in the conversion cache to see if this conversion procedure has been called with the specified conversion arguments. If so, it checks the success status of the prior call, and if the conversion failed, XtCallConverter returns False immediately; otherwise it checks the size specified in the to argument, and, if it is greater than or equal to the size stored in the cache, copies the information stored in the cache into the location specified by to->addr, stores the cache size into to->size, and returns True. If the size specified in the to argument is smaller than the size stored in the cache, XtCallConverter copies the cache size into to->size and returns False. If the converter was registered with cache type XtCacheNone or no value was found in the conversion cache, XtCallConverter calls the converter, and if it was not registered with cache type XtCacheNone, enters the result in the cache. XtCallConverter then returns what the converter returned.

The cache_ref_return field specifies storage allocated by the caller in which an opaque value will be stored. If the type converter has been registered with the XtCacheRefCount modifier and if the value returned in the cache_ref_return is non-NULL, then the caller should store the cache_ref_return value in order to decrement the reference count when the converted value is no longer required. The cache_ref_return argument should be NULL if the caller is unwilling or unable to store the value.

To explicitly decrement the reference counts for resources obtained from XtCallConverter, use XtAppReleaseCacheRefs.

```c
void XtAppReleaseCacheRefs(app_context, refs)
    XtAppContext app_context;
    XtCacheRef *refs;

app_context Specifies the application context.
refs Specifies the list of cache references to be released.
```

XtAppReleaseCacheRefs decrements the reference count for the conversion entries identified by the refs argument. This argument is a pointer to a NULL-terminated list of XtCacheRef values. If any reference count reaches zero, the destructor, if any, will be called and the resource removed from the conversion cache.

As a convenience to clients needing to explicitly decrement reference counts via a callback function, the Intrinsics define two callback procedures, XtCallbackReleaseCacheRef and XtCallbackReleaseCacheRefList.
void XtCallbackReleaseCacheRef(object, client_data, call_data)
  Widget object;
  XtPointer client_data;
  XtPointer call_data;

object  Specifies the object with which the resource is associated.
client_data  Specifies the conversion cache entry to be released.
call_data  Is ignored.

This callback procedure may be added to a callback list to release a previously returned
XtCacheRef value. When adding the callback, the callback client_data argument must be speci-
fi ed as the value of the XtCacheRef data cast to type XtPointer.

void XtCallbackReleaseCacheRefList(object, client_data, call_data)
  Widget object;
  XtPointer client_data;
  XtPointer call_data;

object  Specifies the object with which the resources are associated.
client_data  Specifies the conversion cache entries to be released.
call_data  Is ignored.

This callback procedure may be added to a callback list to release a list of previously returned
XtCacheRef values. When adding the callback, the callback client_data argument must be speci-
fi ed as a pointer to a NULL-terminated list of XtCacheRef values.

To lookup and call a resource converter, copy the resulting value, and free a cached resource
when a widget is destroyed, use XtConvertAndStore.

Boolean XtConvertAndStore(object, from_type, from, to_type, to_in_out)
  Widget object;
  String from_type;
  XrmValuePtr from;
  String to_type;
  XrmValuePtr to_in_out;

object  Specifies the object to use for additional arguments, if any are needed, and the
destroy callback list. Must be of class Object or any subclass thereof.
from_type  Specifies the source type.
from  Specifies the value to be converted.
to_type  Specifies the destination type.
to_in_out  Specifies a descriptor for storage into which the converted value will be returned.

The XtConvertAndStore function looks up the type converter registered to convert from_type to
to_type, computes any additional arguments needed, and then calls XtCallConverter (or XtDi-
rectConvert if an old-style converter was registered with XtAddConverter or XtAppAddCon-
verter; see Appendix C) with the from and to_in_out arguments. The to_in_out argument speci-
fi es the size and location into which the converted value will be stored and is passed directly to
the converter. If the location is specified as NULL, it will be replaced with a pointer to private
storage and the size will be returned in the descriptor. The caller is expected to copy this private
storage immediately and must not modify it in any way. If a non-NULL location is specified, the
caller must allocate sufficient storage to hold the converted value and must also specify the size of
that storage in the descriptor. The size field will be modified on return to indicate the actual size
of the converted data. If the conversion succeeds, XtConvertAndStore returns True; otherwise,
it returns False.

XtConvertAndStore adds XtCallbackReleaseCacheRef to the destroyCallback list of the speciﬁed object if the conversion returns an XtCacheRef value. The resulting resource should not be referenced after the object has been destroyed.

XtCreateWidget performs processing equivalent to XtConvertAndStore when initializing the
object instance. Because there is extra memory overhead required to implement reference counting,
clients may distinguish those objects that are never destroyed before the application exits from
those that may be destroyed and whose resources should be deallocated.

To specify whether reference counting is to be enabled for the resources of a particular object
when the object is created, the client can specify a value for the Boolean resource XtInitialRe-
sourcesPersistent, class XtCInitialResourcesPersistent.

When XtCreateWidget is called, if this resource is not speciﬁed as False in either the arglist or
the resource database, then the resources referenced by this object are not reference-counted,
regardless of how the type converter may have been registered. The effective default value is
True; thus clients that expect to destroy one or more objects and want resources deallocated must
explicitly specify False for XtInitialResourcesPersistent.

The resources are still freed and destructors called when XtCloseDisplay is called if the conver-
sion was registered as XtCacheByDisplay.

9.7. Reading and Writing Widget State

Any resource ﬁeld in a widget can be read or written by a client. On a write operation, the widget
decides what changes it will actually allow and updates all derived ﬁelds appropriately.

9.7.1. Obtaining Widget State

To retrieve the current values of resources associated with a widget instance, use XtGetValues.

```c
void XtGetValues(object, args, num_args)

    Widget object;
    ArgList args;
    Cardinal num_args;

    object Specifies the object whose resource values are to be returned. Must be of class
          Object or any subclass thereof.
    args Specifies the argument list of name/address pairs that contain the resource names
          and the addresses into which the resource values are to be stored. The resource
          names are widget-dependent.
    num_args Specifies the number of entries in the argument list.
```

The XtGetValues function starts with the resources speciﬁed for the Object class and proceeds
down the subclass chain to the class of the object. The value ﬁeld of a passed argument list must
contain the address into which to copy the contents of the corresponding object instance ﬁeld. If
the ﬁeld is a pointer type, the lifetime of the pointed-to data is deﬁned by the object class. For the
Intrinsics-deﬁned resources, the following lifetimes apply:

- Not valid following any operation that modiﬁes the resource:
- XtNchildren resource of composite widgets.
- All resources of representation type XtRCallback.

• Remain valid at least until the widget is destroyed:
  - XtNaccelerators, XtNtranslations.

• Remain valid until the Display is closed:
  - XtNscreens.

It is the caller’s responsibility to allocate and deallocate storage for the copied data according to the size of the resource representation type used within the object.

If the class of the object’s parent is a subclass of constraintWidgetClass, XtGetValues then fetches the values for any constraint resources requested. It starts with the constraint resources specified for constraintWidgetClass and proceeds down the subclass chain to the parent’s constraint resources. If the argument list contains a resource name that is not found in any of the resource lists searched, the value at the corresponding address is not modified. If any get_values_hook procedures in the object’s class or superclass records are non-NULL, they are called in superclass-to-subclass order after all the resource values have been fetched by XtGetValues.

Finally, if the object’s parent is a subclass of constraintWidgetClass, and if any of the parent’s class or superclass records have declared ConstraintClassExtension records in the Constraint class part extension field with a record type of NULLQUARK, and if the get_values_hook field in the extension record is non-NULL, XtGetValues calls the get_values_hook procedures in superclass-to-subclass order. This permits a Constraint parent to provide nonresource data via XtGetValues.

Get_values_hook procedures may modify the data stored at the location addressed by the value field, including (but not limited to) making a copy of data whose resource representation is a pointer. None of the Intrinsics-defined object classes copy data in this manner. Any operation that modifies the queried object resource may invalidate the pointed-to data.

To retrieve the current values of resources associated with a widget instance using varargs lists, use XtVaGetValues.

```c
void XtVaGetValues(object, ...)
    Widget object;

object              Specifies the object whose resource values are to be returned. Must be of class Object or any subclass thereof.
...
Specified the variable argument list for the resources to be returned.
```

XtVaGetValues is identical in function to XtGetValues with the args and num_args parameters replaced by a varargs list, as described in Section 2.5.1. All value entries in the list must specify pointers to storage allocated by the caller to which the resource value will be copied. It is the caller’s responsibility to ensure that sufficient storage is allocated. If XtVaTypedArg is specified, the type argument specifies the representation desired by the caller and the size argument specifies the number of bytes allocated to store the result of the conversion. If the size is insufficient, a warning message is issued and the list entry is skipped.

9.7.1.1. Widget Subpart Resource Data: The get_values_hook Procedure

Widgets that have subparts can return resource values from them through XtGetValues by supplying a get_values_hook procedure. The get_values_hook procedure pointer is of type XtArgsProc.
typedef void (*XtArgsProc)(Widget, ArgList, Cardinal*);

   Widget w;
   ArgList args;
   Cardinal *num_args;

   w     Specifi es the widget whose subpart resource values are to be retrieved.
   args  Specifi es the argument list that was passed to XtGetValues or the transformed
          varargs list passed to XtVaGetValues.
   num_args  Specifi es the number of entries in the argument list.

The widget with subpart resources should call XtGetSubvalues in the get_values_hook proce-
dure and pass in its subresource list and the args and num_args parameters.

9.7.1.2. Widget Subpart State

To retrieve the current values of subpart resource data associated with a widget instance, use
XtGetSubvalues. For a discussion of subpart resources, see Section 9.4.

void XtGetSubvalues(base, resources, num_resources, args, num_args)
   XtPointer base;
   XtResourceList resources;
   Cardinal num_resources;
   ArgList args;
   Cardinal num_args;

   base     Specifi es the base address of the subpart data structure for which the resources
            should be retrieved.
   resources Specifi es the subpart resource list.
   num_resources Specifi es the number of entries in the resource list.
   args     Specifi es the argument list of name/address pairs that contain the resource names
            and the addresses into which the resource values are to be stored.
   num_args Specifi es the number of entries in the argument list.

The XtGetSubvalues function obtains resource values from the structure identifi ed by base. The
value fi eld in each argument entry must contain the address into which to store the corresponding
resource value. It is the caller’s responsibility to allocate and deallocate this storage according to
the size of the resource representation type used within the subpart. If the argument list contains
a resource name that is not found in the resource list, the value at the corresponding address is not
modifi ed.

To retrieve the current values of subpart resources associated with a widget instance using varargs
lists, use XtVaGetSubvalues.
void XtVaGetSubvalues(base, resources, num_resources, ...)  
XtPointer base;  
XtResourceList resources;  
Cardinal num_resources;

`base` Specifie s the base address of the subpart data structure for which the resources 
should be retrieved.

`resources` Specifie s the subpart resource list.

`num_resources` Specifie s the number of entries in the resource list.

... Specifie s a variable argument list of name/address pairs that contain the resource 
names and the addresses into which the resource values are to be stored.

`XtVaGetSubvalues` is identical in function to `XtGetSubvalues` with the `args` and `num_args` 
parameters replaced by a varargs list, as described in Section 2.5.1. `XtVaTypedArg` is not sup-
ported for `XtVaGetSubvalues`. If `XtVaTypedArg` is specifie d in the list, a warning message is 
issued and the entry is then ignored.

9.7.2. Setting Widget State

To modify the current values of resources associated with a widget instance, use `XtSetValues`.

void XtSetValues(object, args, num_args)  
Widget object;  
ArgList args;  
Cardinal num_args;

`object` Specifie s the object whose resources are to be modifie d. Must be of class Object 
or any subclass thereof.

`args` Specifie s the argument list of name/value pairs that contain the resources to be 
modifie d and their new values.

`num_args` Specifie s the number of entries in the argument list.

The `XtSetValues` function starts with the resources specifie d for the Object class fi elds and pro-
ceeds down the subclass chain to the object. At each stage, it replaces the `object` resource fi elds 
with any values specifie d in the argument list. `XtSetValues` then calls the set_values procedures 
for the object in superclass-to-subclass order. If the object has any non-NULL `set_values_hook` 
fi elds, these are called immediately after the corresponding set_values procedure. This procedure 
permits subclasses to set subpart data via `XtSetValues`.

If the class of the object’s parent is a subclass of `constraintWidgetClass`, `XtSetValues` also 
updates the object’s constraints. It starts with the constraint resources specifie d for `constraint-
tWidgetClass` and proceeds down the subclass chain to the parent’s class. At each stage, it 
replaces the constraint resource fi elds with any values specifie d in the argument list. It then calls 
the constraint set_values procedures from `constraintWidgetClass` down to the parent’s class. 
The constraint set_values procedures are called with widget arguments, as for all set_values pro-
cedures, not just the constraint records, so that they can make adjustments to the desired values 
based on full information about the widget. Any arguments specifie d that do not match a resource 
list entry are silently ignored.

If the object is of a subclass of `RectObj`, `XtSetValues` determines if a geometry request is needed 
by comparing the old object to the new object. If any geometry changes are required, `XtSetVal-
ues` restores the original geometry and makes the request on behalf of the widget. If the geometry
manager returns **XtGeometryYes**, **XtSetValues** calls the object’s resize procedure. If the geometry manager returns **XtGeometryDone**, **XtSetValues** continues, as the object’s resize procedure should have been called by the geometry manager. If the geometry manager returns **XtGeometryNo**, **XtSetValues** ignores the geometry request and continues. If the geometry manager returns **XtGeometryAlmost**, **XtSetValues** calls the set_values_almost procedure, which determines what should be done. **XtSetValues** then repeats this process, deciding once more whether the geometry manager should be called.

Finally, if any of the set_values procedures returned **True**, and the widget is realized, **XtSetValues** causes the widget’s expose procedure to be invoked by calling **XClearArea** on the widget’s window.

To modify the current values of resources associated with a widget instance using varargs lists, use **XtVaSetValues**.

```c
void XtVaSetValues(object, ...)  
    Widget object;

object Specified the object whose resources are to be modified. Must be of class Object or any subclass thereof.

... Specified the variable argument list of name/value pairs that contain the resources to be modified and their new values.
```

**XtVaSetValues** is identical in function to **XtSetValues** with the **args** and **num_args** parameters replaced by a varargs list, as described in Section 2.5.1.

### 9.7.2.1. Widget State: The set_values Procedure

The set_values procedure pointer in a widget class is of type **XtSetValuesFunc**.

```c
typedef Boolean (*XtSetValuesFunc)(Widget, Widget, Widget, ArgList, Cardinal*);

    current Specified a copy of the widget as it was before the **XtSetValues** call.

    request Specified a copy of the widget with all values changed as asked for by the **XtSetValues** call before any class set_values procedures have been called.

    new Specified the widget with the new values that are actually allowed.

    args Specified the argument list passed to **XtSetValues** or the transformed argument list passed to **XtVaSetValues**.

    num_args Specified the number of entries in the argument list.
```

The set_values procedure should recompute any field derived from resources that are changed (for example, many GCS depend on foreground and background pixels). If no recomputation is necessary, and if none of the resources specific to a subclass require the window to be redisplayed when their values are changed, you can specify NULL for the set_values field in the class record.

Like the initialize procedure, set_values mostly deals only with the fields defined in the subclass, but it has to resolve conflicts with its superclass, especially conflicts over width and height.
Sometimes a subclass may want to overwrite values filled in by its superclass. In particular, size calculations of a superclass are often incorrect for a subclass, and, in this case, the subclass must modify or recalculate fields declared and computed by its superclass.

As an example, a subclass can visually surround its superclass display. In this case, the width and height calculated by the superclass set_values procedure are too small and need to be incremented by the size of the surround. The subclass needs to know if its superclass’s size was calculated by the superclass or was specified explicitly. All widgets must place themselves into whatever size is explicitly given, but they should compute a reasonable size if no size is requested. How does a subclass know the difference between a specified size and a size computed by a superclass?

The request and new parameters provide the necessary information. The request widget is a copy of the widget, updated as originally requested. The new widget starts with the values in the request, but it has additionally been updated by all superclass set_values procedures called so far. A subclass set_values procedure can compare these two to resolve any potential conflicts. The set_values procedure need not refer to the request widget unless it must resolve conflicts between the current and new widgets. Any changes the widget needs to make, including geometry changes, should be made in the new widget.

In the above example, the subclass with the visual surround can see if the width and height in the request widget are zero. If so, it adds its surround size to the width and height fields in the new widget. If not, it must make do with the size originally specified. In this case, zero is a special value defined by the class to permit the application to invoke this behavior.

The new widget is the actual widget instance record. Therefore, the set_values procedure should do all its work on the new widget; the request widget should never be modified. If the set_values procedure needs to call any routines that operate on a widget, it should specify new as the widget instance.

Before calling the set_values procedures, the Intrinsics modify the resources of the request widget according to the contents of the arglist; if the widget names all its resources in the class resource list, it is never necessary to examine the contents of args.

Finally, the set_values procedure must return a Boolean that indicates whether the widget needs to be redisplayed. Note that a change in the geometry fields alone does not require the set_values procedure to return True; the X server will eventually generate anExpose event, if necessary. After calling all the set_values procedures, XtSetValues forces a redisplay by calling XClearArea if any of the set_values procedures returned True. Therefore, a set_values procedure should not try to do its own redisplaying.

Set_values procedures should not do any work in response to changes in geometry because XtSetValues eventually will perform a geometry request, and that request might be denied. If the widget actually changes size in response to a call to XtSetValues, its resize procedure is called. Widgets should do any geometry-related work in their resize procedure.

Note that it is permissible to call XtSetValues before a widget is realized. Therefore, the set_values procedure must not assume that the widget is realized.

**9.7.2.2. Widget State: The set_values_almost Procedure**

The set_values_almost procedure pointer in the widget class record is of type XtAlmostProc.
typedef void (*XtAlmostProc)(Widget, Widget, XtWidgetGeometry*, XtWidgetGeometry*);

    Widget old;
    Widget new;
    XtWidgetGeometry *request;
    XtWidgetGeometry *reply;

old       Specifies a copy of the object as it was before the XtSetValues call.
new       Specifies the object instance record.
request   Specifies the original geometry request that was sent to the geometry manager
           that caused XtGeometryAlmost to be returned.
reply     Specifies the compromise geometry that was returned by the geometry manager
           with XtGeometryAlmost.

Most classes inherit the set_values_almost procedure from their superclass by specifying XtIn-
heritSetValuesAlmost in the class initialization. The set_values_almost procedure in rectObj-
Class accepts the compromise suggested.

The set_values_almost procedure is called when a client tries to set a widget’s geometry by
means of a call to XtSetValues and the geometry manager cannot satisfy the request but instead
returns XtGeometryNo or XtGeometryAlmost and a compromise geometry. The new object is
the actual instance record. The x, y, width, height, and border_width fields contain the original
values as they were before the XtSetValues call, and all other fields contain the new values. The
request parameter contains the new geometry request that was made to the parent. The reply
parameter contains reply->request_mode equal to zero if the parent returned XtGeometryNo and
contains the parent’s compromise geometry otherwise. The set_values_almost procedure takes
the original geometry and the compromise geometry and determines if the compromise is accept-
able or whether to try a different compromise. It returns its results in the request parameter,
which is then sent back to the geometry manager for another try. To accept the compromise, the
procedure must copy the contents of the reply geometry into the request geometry; to attempt an
alternative geometry, the procedure may modify any part of the request argument; to terminate the
geometry negotiation and retain the original geometry, the procedure must set
request->request_mode to zero. The geometry fields of the old and new instances must not be
modified directly.

9.7.2.3. Widget State: The ConstraintClassPart set_values Procedure

The constraint set_values procedure pointer is of type XtSetValuesFunc. The values passed to
the parent’s constraint set_values procedure are the same as those passed to the child’s class
set_values procedure. A class can specify NULL for the set_values field of the ConstraintPart
if it need not compute anything.

The constraint set_values procedure should recompute any constraint fi elds derived from con-
straint resources that are changed. Furthermore, it may modify other widget fi elds as appropriate.
For example, if a constraint for the maximum height of a widget is changed to a value smaller
than the widget’s current height, the constraint set_values procedure may reset the height fi eld in
the widget.

9.7.2.4. Widget Subpart State

To set the current values of subpart resources associated with a widget instance, use XtSetSub-
values. For a discussion of subpart resources, see Section 9.4.
void XtSetSubvalues(base, resources, num_resources, args, num_args)
  XtPointer base;
  XtResourceList resources;
  Cardinal num_resources;
  ArgList args;
  Cardinal num_args;

base Specifies the base address of the subpart data structure into which the resources should be written.
resources Specifies the subpart resource list.
num_resources Specifies the number of entries in the resource list.
args Specifies the argument list of name/value pairs that contain the resources to be modified and their new values.
num_args Specifies the number of entries in the argument list.

The XtSetSubvalues function updates the resource fields of the structure identified by base. Any specified arguments that do not match an entry in the resource list are silently ignored.

To set the current values of subpart resources associated with a widget instance using varargs lists, use XtVaSetSubvalues.

void XtVaSetSubvalues(base, resources, num_resources, ...)
  XtPointer base;
  XtResourceList resources;
  Cardinal num_resources;

base Specifies the base address of the subpart data structure into which the resources should be written.
resources Specifies the subpart resource list.
num_resources Specifies the number of entries in the resource list.
...

XtVaSetSubvalues is identical in function to XtSetSubvalues with the args and num_args parameters replaced by a varargs list, as described in Section 2.5.1. XtVaTypedArg is not supported for XtVaSetSubvalues. If an entry containing XtVaTypedArg is specified in the list, a warning message is issued and the entry is ignored.

9.7.2.5. Widget Subpart Resource Data: The set_values_hook Procedure

Note

The set_values_hook procedure is obsolete, as the same information is now available to the set_values procedure. The procedure has been retained for those widgets that used it in versions prior to Release 4.

Widgets that have a subpart can set the subpart resource values through XtSetValues by supplying a set_values_hook procedure. The set_values_hook procedure pointer in a widget class is of type XtArgsFunc.
typedef Boolean (*XtArgsFunc)(Widget, Arglist, Cardinal*);
    Widget w;
    Arglist args;
    Cardinal *num_args;

    w       Specifies the widget whose subpart resource values are to be changed.
    args    Specifies the argument list that was passed to *XtSetValues* or the transformed
            varargs list passed to *XtVaSetValues*.
    num_args Specifies the number of entries in the argument list.

The widget with subpart resources may call *XtSetValues* from the set_values_hook procedure
and pass in its subresource list and the *args* and *num_args* parameters.
Chapter 10
Translation Management

Except under unusual circumstances, widgets do not hardwire the mapping of user events into widget behavior by using the event manager. Instead, they provide a default mapping of events into behavior that you can override.

The translation manager provides an interface to specify and manage the mapping of X event sequences into widget-supplied functionality, for example, calling procedure \textit{Abc} when the \textit{y} key is pressed.

The translation manager uses two kinds of tables to perform translations:

- The action tables, which are in the widget class structure, specify the mapping of externally available procedure name strings to the corresponding procedure implemented by the widget class.
- A translation table, which is in the widget class structure, specifies the mapping of event sequences to procedure name strings.

You can override the translation table in the class structure for a specific widget instance by supplying a different translation table for the widget instance. The resources \texttt{XtNtranslations} and \texttt{XtNbaseTranslations} are used to modify the class default translation table; see Section 10.3.

10.1. Action Tables

All widget class records contain an action table, an array of \texttt{XtActionsRec} entries. In addition, an application can register its own action tables with the translation manager so that the translation tables it provides to widget instances can access application functionality directly. The translation action procedure pointer is of type \texttt{XtActionProc}.


define void (*XtActionProc)(Widget, XEvent*, String*, Cardinal*);

\begin{verbatim}
  Widget w;
  XEvent *event;
  String *params;
  Cardinal *num_params;

  w Specifies the widget that caused the action to be called.
  event Specifies the event that caused the action to be called. If the action is called after a sequence of events, then the last event in the sequence is used.
  params Specifies a pointer to the list of strings that were specified in the translation table as arguments to the action, or NULL.
  num_params Specifies the number of entries in params.
\end{verbatim}

define typedef struct _XtActionsRec {
  String string;
  XtActionProc proc;
} XtActionsRec, *XtActionList;

The \texttt{string} field is the name used in translation tables to access the procedure. The \texttt{proc} field is a pointer to a procedure that implements the functionality.
When the action list is specified as the `CoreClassPart` `actions` field, the string pointed to by `string` must be permanently allocated prior to or during the execution of the class initialization procedure and must not be subsequently deallocated.

Action procedures should not assume that the widget in which they are invoked is realized; an accelerator specification can cause an action procedure to be called for a widget that does not yet have a window. Widget writers should also note which of a widget’s callback lists are invoked from action procedures and warn clients not to assume the widget is realized in those callbacks.

For example, a Pushbutton widget has procedures to take the following actions:

- Set the button to indicate it is activated.
- Unset the button back to its normal mode.
- Highlight the button borders.
- Unhighlight the button borders.
- Notify any callbacks that the button has been activated.

The action table for the Pushbutton widget class makes these functions available to translation tables written for Pushbutton or any subclass. The string entry is the name used in translation tables. The procedure entry (usually spelled identically to the string) is the name of the C procedure that implements that function:

```c
XtActionsRec actionTable[] = {
    {"Set", Set},
    {"Unset", Unset},
    {"Highlight", Highlight},
    {"Unhighlight", Unhighlight},
    {"Notify", Notify},
};
```

The Intrinsics reserve all action names and parameters starting with the characters “Xt” for future standard enhancements. Users, applications, and widgets should not declare action names or pass parameters starting with these characters except to invoke specified built-in Intrinsics functions.

### 10.1.1. Action Table Registration

The `actions` and `num_actions` fields of `CoreClassPart` specify the actions implemented by a widget class. These are automatically registered with the Intrinsics when the class is initialized and must be allocated in writable storage prior to `Core class_part` initialization, and never deallocated. To save memory and optimize access, the Intrinsics may overwrite the storage in order to compile the list into an internal representation.

To declare an action table within an application and register it with the translation manager, use `XtAppAddActions`:

```c
void XtAppAddActions(app_context, actions, num_actions)
    XtAppContext app_context;
    XtActionList actions;
    Cardinal num_actions;
    app_context Specifi es the application context.
    actions Specifi es the action table to register.
    num_actions Specifi es the number of entries in this action table.
```

If more than one action is registered with the same name, the most recently registered action is
used. If duplicate actions exist in an action table, the first is used. The Intrinsics register an action table containing `XtMenuPopup` and `XtMenuPopdown` as part of `XtCreateApplication-Context`.

10.1.2. Action Names to Procedure Translations

The translation manager uses a simple algorithm to resolve the name of a procedure specified in a translation table into the actual procedure specified in an action table. When the widget is realized, the translation manager performs a search for the name in the following tables, in order:

- The widget’s class and all superclass action tables, in subclass-to-superclass order.
- The parent’s class and all superclass action tables, in subclass-to-superclass order, then on up the ancestor tree.
- The action tables registered with `XtAppAddActions` and `XtAddActions` from the most recently added table to the oldest table.

As soon as it finds a name, the translation manager stops the search. If it cannot find a name, the translation manager generates a warning message.

10.1.3. Action Hook Registration

An application can specify a procedure that will be called just before every action routine is dispatched by the translation manager. To do so, the application supplies a procedure pointer of type `XtActionHookProc`.

```c
typedef void (*XtActionHookProc)(Widget, XtPointer, String, XEvent*, String*, Cardinal*);
```

- `w` Specifies the widget whose action is about to be dispatched.
- `client_data` Specifies the application-specific closure that was passed to `XtAppAddActionHook`.
- `action_name` Specifies the name of the action to be dispatched.
- `event` Specifies the event argument that will be passed to the action routine.
- `params` Specifies the action parameters that will be passed to the action routine.
- `num_params` Specifies the number of entries in `params`.

Action hooks should not modify any of the data pointed to by the arguments other than the `client_data` argument.

To add an action hook, use `XtAppAddActionHook`.

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**XtActionHookId XtAppAddActionHook(app, proc, client_data)**

- **app**: Specifies the application context.
- **proc**: Specifies the action hook procedure.
- **client_data**: Specifies application-specific data to be passed to the action hook.

*XtAppAddActionHook* adds the specified procedure to the front of a list maintained in the application context. In the future, when an action routine is about to be invoked for any widget in this application context, either through the translation manager or via *XtCallActionProc*, the action hook procedures will be called in reverse order of registration just prior to invoking the action routine.

Action hook procedures are removed automatically and the *XtActionHookId* is destroyed when the application context in which they were added is destroyed.

To remove an action hook procedure without destroying the application context, use *XtRemoveActionHook*.

**void XtRemoveActionHook(id)**

- **id**: Specifies the action hook id returned by *XtAppAddActionHook*.

*XtRemoveActionHook* removes the specified action hook procedure from the list in which it was registered.

### 10.2. Translation Tables

All widget instance records contain a translation table, which is a resource with a default value specified elsewhere in the class record. A translation table specifies what action procedures are invoked for an event or a sequence of events. A translation table is a string containing a list of translations from an event sequence into one or more action procedure calls. The translations are separated from one another by newline characters (ASCII LF). The complete syntax of translation tables is specified in Appendix B.

As an example, the default behavior of Pushbutton is:

- Highlight on enter window.
- Unhighlight on exit window.
- Invert on left button down.
- Call callbacks and reinvert on left button up.

The following illustrates Pushbutton’s default translation table:

```java
static String defaultTranslations =
    "<EnterWindow>: Highlight()\n\n<LeaveWindow>: Unhighlight()\n\n<Btn1Down>: Set()\n\n<Btn1Up>: Notify() Unset()";
```

---

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The `tm_table` field of the `CoreClassPart` should be filled in at class initialization time with the string containing the class’s default translations. If a class wants to inherit its superclass’s translations, it can store the special value `XtInheritTranslations` into `tm_table`. In Core’s class part initialization procedure, the Intrinsics compile this translation table into an efficient internal form. Then, at widget creation time, this default translation table is combined with the `XtNtranslations` and `XtNbaseTranslations` resources; see Section 10.3.

The resource conversion mechanism automatically compiles string translation tables that are specified in the resource database. If a client uses translation tables that are not retrieved via a resource conversion, it must compile them itself using `XtParseTranslationTable`.

The Intrinsics use the compiled form of the translation table to register the necessary events with the event manager. Widgets need do nothing other than specify the action and translation tables for events to be processed by the translation manager.

### 10.2.1. Event Sequences

An event sequence is a comma-separated list of X event descriptions that describes a specific sequence of X events to map to a set of program actions. Each X event description consists of three parts: The X event type, a prefix consisting of the X modifier bits, and an event-specific suffix.

Various abbreviations are supported to make translation tables easier to read. The events must match incoming events in left-to-right order to trigger the action sequence.

### 10.2.2. Action Sequences

Action sequences specify what program or widget actions to take in response to incoming X events. An action sequence consists of space-separated action procedure call specifications. Each action procedure call consists of the name of an action procedure and a parenthesized list of zero or more comma-separated string parameters to pass to that procedure. The actions are invoked in left-to-right order as specified in the action sequence.

### 10.2.3. Multi-Click Time

Translation table entries may specify actions that are taken when two or more identical events occur consecutively within a short time interval, called the multi-click time. The multi-click time value may be specified as an application resource with name “multiClickTime” and class “MultiClickTime” and may also be modified dynamically by the application. The multi-click time is unique for each Display value and is retrieved from the resource database by `XtDisplayInitialize`. If no value is specified, the initial value is 200 milliseconds.

To set the multi-click time dynamically, use `XtSetMultiClickTime`.

```c
void XtSetMultiClickTime(Display *display, int time)
{
    display
        Specifi es the display connection.
    time
        Specifi es the multi-click time in milliseconds.
}
```

`XtSetMultiClickTime` sets the time interval used by the translation manager to determine when multiple events are interpreted as a repeated event. When a repeat count is specified in a translation entry, the interval between the timestamps in each pair of repeated events (e.g., between two `ButtonPress` events) must be less than the multi-click time in order for the translation actions to
be taken.

To read the multi-click time, use \texttt{XtGetMultiClickTime}.

\begin{verbatim}
int XtGetMultiClickTime(int display)
    Display *display;

    display Specifi es the display connection.
\end{verbatim}

\texttt{XtGetMultiClickTime} returns the time in milliseconds that the translation manager uses to determine if multiple events are to be interpreted as a repeated event for purposes of matching a translation entry containing a repeat count.

\section*{10.3. Translation Table Management}

Sometimes an application needs to merge its own translations with a widget’s translations. For example, a window manager provides functions to move a window. The window manager wishes to bind this operation to a specific pointer button in the title bar without the possibility of user override and bind it to other buttons that may be overridden by the user.

To accomplish this, the window manager should first create the title bar and then should merge the two translation tables into the title bar’s translations. One translation table contains the translations that the window manager wants only if the user has not specified a translation for a particular event or event sequence (i.e., those that may be overridden). The other translation table contains the translations that the window manager wants regardless of what the user has specified.

Three Intrinsics functions support this merging:

\begin{description}
\item[XtParseTranslationTable] Compiles a translation table.
\item[XtAugmentTranslations] Merges a compiled translation table into a widget’s compiled translation table, ignoring any new translations that conflict with existing translations.
\item[XtOverrideTranslations] Merges a compiled translation table into a widget’s compiled translation table, replacing any existing translations that conflict with new translations.
\end{description}

To compile a translation table, use \texttt{XtParseTranslationTable}.

\begin{verbatim}
XtTranslations XtParseTranslationTable(String table);
    String table;

    table Specifi es the translation table to compile.
\end{verbatim}

The \texttt{XtParseTranslationTable} function compiles the translation table, provided in the format given in Appendix B, into an opaque internal representation of type \texttt{XtTranslations}. Note that if an empty translation table is required for any purpose, one can be obtained by calling \texttt{XtParseTranslationTable} and passing an empty string.

To merge additional translations into an existing translation table, use \texttt{XtAugmentTranslations}.
void XtAugmentTranslations(w, translations)
    Widget w;
    XtTranslations translations;
    w Specifies the widget into which the new translations are to be merged. Must be of class Core or any subclass thereof.
    translations Specifies the compiled translation table to merge in.

The **XtAugmentTranslations** function merges the new translations into the existing widget translations, ignoring any **#replace**, **#augment**, or **#override** directive that may have been specified in the translation string. The translation table specified by *translations* is not altered by this process. **XtAugmentTranslations** logically appends the string representation of the new translations to the string representation of the widget’s current translations and reparses the result with no warning messages about duplicate left-hand sides, then stores the result back into the widget instance; i.e., if the new translations contain an event or event sequence that already exists in the widget’s translations, the new translation is ignored.

To overwrite existing translations with new translations, use **XtOverrideTranslations**.

void XtOverrideTranslations(w, translations)
    Widget w;
    XtTranslations translations;
    w Specifies the widget into which the new translations are to be merged. Must be of class Core or any subclass thereof.
    translations Specifies the compiled translation table to merge in.

The **XtOverrideTranslations** function merges the new translations into the existing widget translations, ignoring any **#replace**, **#augment**, or **#override** directive that may have been specified in the translation string. The translation table specified by *translations* is not altered by this process. **XtOverrideTranslations** logically appends the string representation of the widget’s current translations to the string representation of the new translations and reparses the result with no warning messages about duplicate left-hand sides, then stores the result back into the widget instance; i.e., if the new translations contain an event or event sequence that already exists in the widget’s translations, the new translation overrides the widget’s translation.

To replace a widget’s translations completely, use **XtSetValue** on the XtNtranslations resource and specify a compiled translation table as the value.

To make it possible for users to easily modify translation tables in their resource files, the string-to-translation-table resource type converter allows the string to specify whether the table should replace, augment, or override any existing translation table in the widget. To specify this, a pound sign (#) is given as the first character of the table followed by one of the keywords “replace”, “augment”, or “override” to indicate whether to replace, augment, or override the existing table. The replace or merge operation is performed during the Core instance initialization. Each merge operation produces a new translation resource value; if the original tables were shared by other widgets, they are unaffected. If no directive is specified, “#replace” is assumed.

At instance initialization the XtNtranslations resource is first fetched. Then, if it was not specified or did not contain “#replace”, the resource database is searched for the resource XtNbaseTranslations. If XtNbaseTranslations is found, it is merged into the widget class translation table. Then the widget translations field is merged into the result or into the class translation table if XtNbaseTranslations was not found. This final table is then stored into the widget translations.
fi eld. If the XtNtranslations resource specified “#replace”, no merge is done. If neither
XtNbaseTranslations or XtNtranslations are specified, the class translation table is copied into the
widget instance.

To completely remove existing translations, use XtUninstallTranslations.

```c
void XtUninstallTranslations(
    Widget w);
```

`w` specifies the widget from which the translations are to be removed. Must be of
class Core or any subclass thereof.

The XtUninstallTranslations function causes the entire translation table for the widget to be
removed.

### 10.4. Using Accelerators

It is often desirable to be able to bind events in one widget to actions in another. In particular, it
is often useful to be able to invoke menu actions from the keyboard. The Intrinsics provide a
facility, called accelerators, that lets you accomplish this. An accelerator table is a translation ta-
ble that is bound with its actions in the context of a particular widget, the source widget. The
accelerator table can then be installed on one or more destination widgets. When an event
sequence in the destination widget would cause an accelerator action to be taken, and if the
source widget is sensitive, the actions are executed as though triggered by the same event
sequence in the accelerator source widget. The event is passed to the action procedure without
modification. The action procedures used within accelerators must not assume that the source
widget is realized nor that any fields of the event are in reference to the source widget’s window if
the widget is realized.

Each widget instance contains that widget’s exported accelerator table as a resource. Each class
of widget exports a method that takes a displayable string representation of the accelerators so
that widgets can display their current accelerators. The representation is the accelerator table in
canonical translation table form (see Appendix B). The display_accelerator procedure pointer is
of type XtStringProc.

```c
typedef void (*XtStringProc)(Widget, String);
    Widget w;
    String string;

w    specifies the source widget that supplied the accelerators.
string specifies the string representation of the accelerators for this widget.
```

Accelerators can be specified in resource files, and the string representation is the same as for a
translation table. However, the interpretation of the #augment and #override directives applies
to what will happen when the accelerator is installed; that is, whether or not the accelerator trans-
lations will override the translations in the destination widget. The default is #augment, which
means that the accelerator translations have lower priority than the destination translations. The
#replace directive is ignored for accelerator tables.

To parse an accelerator table, use XtParseAcceleratorTable.
XtAccelerators XtParseAcceleratorTable(source)
    String source;

source       Specifies the accelerator table to compile.

The XtParseAcceleratorTable function compiles the accelerator table into an opaque internal representation. The client should set the XtNaccelerators resource of each widget that is to be activated by these translations to the returned value.

To install accelerators from a widget on another widget, use XtInstallAccelerators.

void XtInstallAccelerators(destination, source)
    Widget destination;
    Widget source;

destination       Specifies the widget on which the accelerators are to be installed. Must be of class Core or any subclass thereof.
source        Specifies the widget from which the accelerators are to come. Must be of class Core or any subclass thereof.

The XtInstallAccelerators function installs the accelerators resource value from source onto destination by merging the source accelerators into the destination translations. If the source display_accelerator field is non-NULL, XtInstallAccelerators calls it with the source widget and a string representation of the accelerator table, which indicates that its accelerators have been installed and that it should display them appropriately. The string representation of the accelerator table is its canonical translation table representation.

As a convenience for installing all accelerators from a widget and all its descendants onto one destination, use XtInstallAllAccelerators.

void XtInstallAllAccelerators(destination, source)
    Widget destination;
    Widget source;

destination       Specifies the widget on which the accelerators are to be installed. Must be of class Core or any subclass thereof.
source        Specifies the root widget of the widget tree from which the accelerators are to come. Must be of class Core or any subclass thereof.

The XtInstallAllAccelerators function recursively descends the widget tree rooted at source and installs the accelerators resource value of each widget encountered onto destination. A common use is to call XtInstallAllAccelerators and pass the application main window as the source.

10.5. KeyCode-to-KeySym Conversions
The translation manager provides support for automatically translating KeyCodes in incoming key events into KeySyms. KeyCode-to-KeySym translator procedure pointers are of type XtKeyProc.
typedef void (*XtKeyProc)(Display*, KeyCode, Modifiers, Modifiers*, KeySym*);

Display *display;
KeyCode keycode;
Modifiers modifiers;
Modifiers *modifiers_return;
KeySym *keysym_return;

(display) Specifies the display that the KeyCode is from.
(keycode) Specifies the KeyCode to translate.
(modifiers) Specifies the modifiers to the KeyCode.
(modifiers_return) Specifies a location in which to store a mask that indicates the subset of all modifiers that are examined by the key translator for the specified keycode.
(keysym_return) Specifies a location in which to store the resulting KeySym.

This procedure takes a KeyCode and modifiers and produces a KeySym. For any given key translator function and keyboard encoding, modifiers_return will be a constant per KeyCode that indicates the subset of all modifiers that are examined by the key translator for that KeyCode.

The KeyCode-to-KeySym translator procedure must be implemented such that multiple calls with the same display, keycode, and modifiers return the same result until either a new case converter, an XtCaseProc, is installed or a MappingNotify event is received.

The Intrinsics maintain tables internally to map KeyCodes to KeySyms for each open display. Translator procedures and other clients may share a single copy of this table to perform the same mapping.

To return a pointer to the KeySym-to-KeyCode mapping table for a particular display, use XtGetKeysymTable.

KeySym *XtGetKeysymTable(display, min_keycode_return, keysyms_per_keycode_return)

(display) Specifies the display whose table is required.
(min_keycode_return) Returns the minimum KeyCode valid for the display.
(keysyms_per_keycode_return) Returns the number of KeySyms stored for each KeyCode.

XtGetKeysymTable returns a pointer to the Intrinsics’ copy of the server’s KeyCode-to-KeySym table. This table must not be modified. There are keysyms_per_keycode_return KeySyms associated with each KeyCode, located in the table with indices starting at index

\[(\text{test_keycode} - \text{min_keycode_return}) \times \text{keysyms_per_keycode_return}\]

for KeyCode test_keycode. Any entries that have no KeySyms associated with them contain the value NoSymbol. Clients should not cache the KeySym table but should call XtGetKeysymTable each time the value is needed, as the table may change prior to dispatching each event.

For more information on this table, see Section 12.7 in Xlib — C Language X Interface.
To register a key translator, use **XtSetKeyTranslator**.

```c
void XtSetKeyTranslator(display, proc)
    Display *display;
    XtKeyProc proc;

display      Specifies the display from which to translate the events.
proc         Specifies the procedure to perform key translations.
```

The **XtSetKeyTranslator** function sets the specified procedure as the current key translator. The default translator is **XtTranslateKey**, an **XtKeyProc** that uses the Shift, Lock, numlock, and group modifiers with the interpretations defined in *X Window System Protocol*, Section 5. It is provided so that new translators can call it to get default KeyCode-to-KeySym translations and so that the default translator can be reinstalled.

To invoke the currently registered KeyCode-to-KeySym translator, use **XtTranslateKeycode**.

```c
void XtTranslateKeycode(display, keycode, modifiers, modifiers_return, keysym_return)
    Display *display;
    KeyCode keycode;
    Modifiers *modifiers;
    Modifiers *modifiers_return;
    KeySym *keysym_return;

display      Specifies the display from which the KeyCode is from.
keycode      Specifies the KeyCode to translate.
modifiers    Specifies the modifiers to the KeyCode.
modifiers_return  Returns a mask that indicates the modifiers actually used to generate the
                   KeySym.
keysym_return Returns the resulting KeySym.
```

The **XtTranslateKeycode** function passes the specified arguments directly to the currently registered KeyCode-to-KeySym translator.

To handle capitalization of nonstandard KeySymS, the Intrinsics allow clients to register case conversion routines. Case converter procedure pointers are of type **XtCaseProc**.

```c
typedef void (*XtCaseProc)(Display*, KeySym, KeySym*, KeySym*);
    Display *display;
    KeySym keysym;
    KeySym *lower_return;
    KeySym *upper_return;

display      Specifies the display connection for which the conversion is required.
keysym       Specifies the KeySym to convert.
lower_return Specifies a location into which to store the lowercase equivalent for the KeySym.
upper_return Specifies a location into which to store the uppercase equivalent for the KeySym.
```

If there is no case distinction, this procedure should store the KeySym into both return values.
To register a case converter, use **XtRegisterCaseConverter**.

```c
void XtRegisterCaseConverter(display, proc, start, stop)
{
    Display *display;
    XtCaseProc proc;
    KeySym start;
    KeySym stop;

    display Specifies the display from which the key events are to come.
    proc  Specifies the XtCaseProc to do the conversions.
    start Specifies the first KeySym for which this converter is valid.
    stop  Specifies the last KeySym for which this converter is valid.
}
```

The **XtRegisterCaseConverter** registers the specified case converter. The *start* and *stop* arguments provide the inclusive range of KeySyms for which this converter is to be called. The new converter overrides any previous converters for KeySyms in that range. No interface exists to remove converters; you need to register an identity converter. When a new converter is registered, the Intrinsics refresh the keyboard state if necessary. The default converter understands case conversion for all Latin KeySyms defined in *X Window System Protocol, Appendix A*.

To determine uppercase and lowercase equivalents for a KeySym, use **XtConvertCase**.

```c
void XtConvertCase(display, keysym, lower_return, upper_return)
{
    Display *display;
    KeySym keysym;
    KeySym *lower_return;
    KeySym *upper_return;

    display Specifies the display that the KeySym came from.
    keysym  Specifies the KeySym to convert.
    lower_return Returns the lowercase equivalent of the KeySym.
    upper_return Returns the uppercase equivalent of the KeySym.
}
```

The **XtConvertCase** function calls the appropriate converter and returns the results. A user-supplied **XtKeyProc** may need to use this function.

### 10.6. Obtaining a KeySym in an Action Procedure

When an action procedure is invoked on a **KeyPress** or **KeyRelease** event, it often has a need to retrieve the KeySym and modifiers corresponding to the event that caused it to be invoked. In order to avoid repeating the processing that was just performed by the Intrinsics to match the translation entry, the KeySym and modifiers are stored for the duration of the action procedure and are made available to the client.

To retrieve the KeySym and modifiers that matched the final event specification in the translation table entry, use **XtGetActionKeysym**.
KeySym XtGetActionKeysym(event, modifiers_return)

XEvent *event;
Modifi ers *modifiers_return;

event Specifi es the event pointer passed to the action procedure by the Intrinsic s.

modifiers_return Returns the modifi ers that caused the match, if non-NUL L.

If XtGetActionKeysym is called after an action procedure has been invoked by the Intrinsic s and before that action procedure returns, and if the event pointer has the same value as the event pointer passed to that action routine, and if the event is a KeyPress or KeyRelease event, then XtGetActionKeysym returns the KeySym that matched the fi nal event specifi cation in the translation table and, if modifiers_return is non-NUL L, the modifi er state actually used to generate this KeySym; otherwise, if the event is a KeyPress or KeyRelease event, then XtGetActionKeysym calls XtTranslateKeycode and returns the results; else it returns NoSymbol and does not examine modifiers_return.

Note that if an action procedure invoked by the Intrinsic s invokes a subsequent action procedure (and so on) via XtCallActionProc, the nested action procedure may also call XtGetActionKeysym to retrieve the Intrinsic s’ KeySym and modifi ers.

10.7. KeySym-to-KeyCode Conversions
To return the list of KeyCodes that map to a particular KeySym in the keyboard mapping table maintained by the Intrinsic s, use XtKeysymToKeycodeList.

void XtKeysymToKeycodeList(display, keysym, keycodes_return, keycount_return)

Display *display;
KeySym keysym;
KeyCode **keycodes_return;
Cardinal *keycount_return;

display Specifi es the display whose table is required.

keysym Specifi es the KeySym for which to search.

keycodes_return Returns a list of KeyCodes that have keysym associated with them, or NULL if keycount_return is 0.

keycount_return Returns the number of KeyCodes in the keycode list.

The XtKeysymToKeycodeList procedure returns all the KeyCodes that have keysym in their entry for the keyboard mapping table associated with display. For each entry in the table, the fi rst four KeySym s (groups 1 and 2) are interpreted as specifi ed by X Window System Protocol, Section 5. If no KeyCodes map to the specifi ed KeySym, keycount_return is zero and *keycodes_return is NULL.

The caller should free the storage pointed to by keycodes_return using XtFree when it is no longer useful. If the caller needs to examine the KeyCode-to-KeySym table for a particular KeyCode, it should call XtGetKeysymTable.

10.8. Registering Button and Key Grabs for Actions
To register button and key grabs for a widget’s window according to the event bindings in the widget’s translation table, use XtRegisterGrabAction.
void XtRegisterGrabAction(action_proc, owner_events, event_mask, pointer_mode, keyboard_mode)

XtActionProc action_proc;
Boolean owner_events;
unsigned int event_mask;
int pointer_mode, keyboard_mode;

action_proc  Specifies the action procedure to search for in translation tables.

owner_events
event_mask
pointer_mode
keyboard_mode  Specify arguments to XtGrabButton or XtGrabKey.

XtRegisterGrabAction adds the specified action_proc to a list known to the translation manager. When a widget is realized, or when the translations of a realized widget or the accelerators installed on a realized widget are modified, its translation table and any installed accelerators are scanned for action procedures on this list. If any are invoked on ButtonPress or KeyPress events as the only or final event in a sequence, the Intrinsics will call XtGrabButton or XtGrabKey for the widget with every button or KeyCode which maps to the event detail field, passing the specified owner_events, event_mask, pointer_mode, and keyboard_mode. For ButtonPress events, the modifiers specified in the grab are determined directly from the translation specification and confine_to and cursor are specified as None. For KeyPress events, if the translation table entry specifies colon (:) in the modifier list, the modifiers are determined by calling the key translator procedure registered for the display and calling XtGrabKey for every combination of standard modifiers which map the KeyCode to the specified event detail KeySym, and ORing any modifiers specified in the translation table entry, and event_mask is ignored. If the translation table entry does not specify colon in the modifier list, the modifiers specified in the grab are those specified in the translation table entry only. For both ButtonPress and KeyPress events, don’t-care modifiers are ignored unless the translation entry explicitly specifies “Any” in the modifier field.

If the specified action_proc is already registered for the calling process, the new values will replace the previously specified values for any widgets that become realized following the call, but existing grabs are not altered on currently realized widgets.

When translations or installed accelerators are modified for a realized widget, any previous key or button grabs registered as a result of the old bindings are released if they do not appear in the new bindings and are not explicitly grabbed by the client with XtGrabKey or XtGrabButton.

10.9. Invoking Actions Directly

Normally action procedures are invoked by the Intrinsics when an event or event sequence arrives for a widget. To invoke an action procedure directly, without generating (or synthesizing) events, use XtCallActionProc.
void XtCallActionProc(widget, action, event, params, num_params)
    Widget widget;
    String action;
    XEvent *event;
    String *params;
    Cardinal num_params;

    widget Specifies the widget in which the action is to be invoked. Must be of class Core or any subclass thereof.
    action Specifies the name of the action routine.
    event Specifies the contents of the event passed to the action routine.
    params Specifies the contents of the params passed to the action routine.
    num_params Specifies the number of entries in params.

XtCallActionProc searches for the named action routine in the same manner and order as translation tables are bound, as described in Section 10.1.2, except that application action tables are searched, if necessary, as of the time of the call to XtCallActionProc. If found, the action routine is invoked with the specified widget, event pointer, and parameters. It is the responsibility of the caller to ensure that the contents of the event, params, and num_params arguments are appropriate for the specified action routine and, if necessary, that the specified widget is realized or sensitive. If the named action routine cannot be found, XtCallActionProc generates a warning message and returns.

10.10. Obtaining a Widget’s Action List
Occasionally a subclass will require the pointers to one or more of its superclass’s action procedures. This would be needed, for example, in order to envelop the superclass’s action. To retrieve the list of action procedures registered in the superclass’s actions field, use XtGetActionList.

void XtGetActionList(widget_class, actions_return, num_actions_return)
    WidgetClass widget_class;
    XtActionList *actions_return;
    Cardinal *num_actions_return;

    widget_class Specifies the widget class whose actions are to be returned.
    actions_return Returns the action list.
    num_actions_return Returns the number of action procedures declared by the class.

XtGetActionList returns the action table defined by the specified widget class. This table does not include actions defined by the superclasses. If widget_class is not initialized, or is not coreWidgetClass or a subclass thereof, or if the class does not define any actions, *actions_return will be NULL and *num_actions_return will be zero. If *actions_return is non-NULL the client is responsible for freeing the table using XtFree when it is no longer needed.
Chapter 11
Utility Functions

The Intrinsics provide a number of utility functions that you can use to
- Determine the number of elements in an array.
- Translate strings to widget instances.
- Manage memory usage.
- Share graphics contexts.
- Manipulate selections.
- Merge exposure events into a region.
- Translate widget coordinates.
- Locate a widget given a window id.
- Handle errors.
- Set the WM_COLORMAP_WINDOWS property.
- Locate files by name with string substitutions.
- Register callback functions for external agents.
- Locate all the displays of an application context.

11.1. Determining the Number of Elements in an Array
To determine the number of elements in a fixed-size array, use `XtNumber`.

```c
Cardinal XtNumber(array)
  ArrayType array;
array     Specifies a fixed-size array of arbitrary type.
```

The `XtNumber` macro returns the number of elements allocated to the array.

11.2. Translating Strings to Widget Instances
To translate a widget name to a widget instance, use `XtNameToWidget`.

```c
Widget XtNameToWidget(reference, names)
  Widget reference;
  String names;
reference    Specifies the widget from which the search is to start. Must be of class Core or
             any subclass thereof.
names        Specifies the partially qualified name of the desired widget.
```

The `XtNameToWidget` function searches for a descendant of the `reference` widget whose name
matches the specified names. The `names` parameter specifies a simple object name or a series of
simple object name components separated by periods or asterisks. `XtNameToWidget` returns the
descendant with the shortest name matching the specification according to the following rules, where child is either a pop-up child or a normal child if the widget’s class is a subclass of Composite:

- Enumerate the object subtree rooted at the reference widget in breadth-first order, qualifying the name of each object with the names of all its ancestors up to, but not including, the reference widget. The ordering between children of a common parent is not defined.
- Return the first object in the enumeration that matches the specified name, where each component of \( names \) matches exactly the corresponding component of the qualified object name and asterisk matches any series of components, including none.
- If no match is found, return NULL.

Since breadth-first traversal is specified, the descendant with the shortest matching name (i.e., the fewest number of components), if any, will always be returned. However, since the order of enumeration of children is undefined and since the Intrinsics do not require that all children of a widget have unique names, \texttt{XtNameToWidget} may return any child that matches if there are multiple objects in the subtree with the same name. Consecutive separators (periods or asterisks) including at least one asterisk are treated as a single asterisk. Consecutive periods are treated as a single period.

### 11.3. Managing Memory Usage

The Intrinsics memory management functions provide uniform checking for null pointers and error reporting on memory allocation errors. These functions are completely compatible with their standard C language runtime counterparts \texttt{malloc}, \texttt{calloc}, \texttt{realloc}, and \texttt{free} with the following added functionality:

- \texttt{XtMalloc}, \texttt{XtCalloc}, and \texttt{XtRealloc} give an error if there is not enough memory.
- \texttt{XtFree} simply returns if passed a NULL pointer.
- \texttt{XtRealloc} simply allocates new storage if passed a NULL pointer.

See the standard C library documentation on \texttt{malloc}, \texttt{calloc}, \texttt{realloc}, and \texttt{free} for more information.

To allocate storage, use \texttt{XtMalloc}.

```c
char *XtMalloc(size)
Cardinal size;
size Specifies the number of bytes desired.
```

The \texttt{XtMalloc} function returns a pointer to a block of storage of at least the specified \texttt{size} bytes. If there is insufficient memory to allocate the new block, \texttt{XtMalloc} calls \texttt{XtErrorMsg}.

To allocate and initialize an array, use \texttt{XtCalloc}.

```c
char *XtCalloc(num, size)
Cardinal num;
Cardinal size;
num Specifies the number of array elements to allocate.
size Specifies the size of each array element in bytes.
```

The \texttt{XtCalloc} function allocates space for the specified number of array elements of the specified
size and initializes the space to zero. If there is insufficient memory to allocate the new block, 
XtCalloc calls XtErrorMsg. XtCalloc returns the address of the allocated storage.

To change the size of an allocated block of storage, use XtRealloc.

```c
char *XtRealloc(ptr, num)
    char *ptr;
    Cardinal num;

ptr Specifies a pointer to the old storage allocated with XtMalloc, XtCalloc, or 
     XtRealloc, or NULL.
num Specifies number of bytes desired in new storage.
```

The XtRealloc function changes the size of a block of storage, possibly moving it. Then it copied the old contents (or as much as will fit) into the new block and frees the old block. If there is insufficient memory to allocate the new block, XtRealloc calls XtErrorMsg. If ptr is NULL, XtRealloc simply calls XtMalloc. XtRealloc then returns the address of the new block.

To free an allocated block of storage, use XtFree.

```c
void XtFree(ptr)
    char *ptr;

ptr Specifies a pointer to a block of storage allocated with XtMalloc, XtCalloc, or 
     XtRealloc, or NULL.
```

The XtFree function returns storage, allowing it to be reused. If ptr is NULL, XtFree returns immediately.

To allocate storage for a new instance of a type, use XtNew.

```c
type *XtNew(type)
    type t;

type Specifies a previously declared type.
```

XtNew returns a pointer to the allocated storage. If there is insufficient memory to allocate the new block, XtNew calls XtErrorMsg. XtNew is a convenience macro that calls XtMalloc with the following arguments specified:

```c
((type *) XtMalloc((unsigned) sizeof(type)))
```

The storage allocated by XtNew should be freed using XtFree.

To copy an instance of a string, use XtNewString.
String XtNewString(string)
    String string;

string Specifies a previously declared string.

XtNewString returns a pointer to the allocated storage. If there is insufficient memory to allocate the new block, XtNewString calls XtErrorMsg. XtNewString is a convenience macro that calls XtMalloc with the following arguments specified:

    (strcpy(XtMalloc((unsigned)strlen(str) + 1), str))

The storage allocated by XtNewString should be freed using XtFree.

11.4. Sharing Graphics Contexts

The Intrinsics provide a mechanism whereby cooperating objects can share a graphics context (GC), thereby reducing both the number of GCs created and the total number of server calls in any given application. The mechanism is a simple caching scheme and allows for clients to declare both modifiable and non-modifiable fields of the shared GCs.

To obtain a shareable GC with modifiable fields, use XtAllocateGC.

GC XtAllocateGC(widget, depth, value_mask, values, dynamic_mask, unused_mask)
    Widget object;
    Cardinal depth;
    XtGCMask value_mask;
    XGCValues *values;
    XtGCMask dynamic_mask;
    XtGCMask unused_mask;

object Specifies an object, giving the screen for which the returned GC is valid. Must be of class Object or any subclass thereof.

depth Specifies the depth for which the returned GC is valid, or 0.

value_mask Specifies fields of the GC that are initialized from values.

values Specifies the values for the initialized fields.

dynamic_mask Specifies fields of the GC that will be modified by the caller.

unused_mask Specifies fields of the GC that will not be needed by the caller.

The XtAllocateGC function returns a shareable GC that may be modified by the client. The screen field of the specified widget or of the nearest widget ancestor of the specified object and the specified depth argument supply the root and drawable depths for which the GC is to be valid. If depth is zero, the depth is taken from the depth field of the specified widget or of the nearest widget ancestor of the specified object.

The value_mask argument specifies fields of the GC that are initialized with the respective member of the values structure. The dynamic_mask argument specifies fields of the GC that the caller intends to modify during program execution. The caller must ensure that the corresponding GC field is set prior to each use of the GC. The unused_mask argument specifies fields of the GC that are of no interest to the caller. The caller may make no assumptions about the contents of any fields specified in unused_mask. The caller may assume that at all times all fields not specified in either dynamic_mask or unused_mask have their default value if not specified in value_mask or the value specified by values. If a field is specified in both value_mask and dynamic_mask, the effect is as if it were specified only in dynamic_mask and then immediately set to the value in values. If
a field is set in `unused_mask` and also in either `value_mask` or `dynamic_mask`, the specification in `unused_mask` is ignored.

**XtAllocateGC** tries to minimize the number of unique GCs created by comparing the arguments with those of previous calls and returning an existing GC when there are no conflicts. **XtAllocateGC** may modify and return an existing GC if it was allocated with a nonzero `unused_mask`.

To obtain a shareable GC with no modifiable fields, use **XtGetGC**.

```c
GC XtGetGC(object, value_mask, values)
    Widget object;
    XtGCMask value_mask;
    XGCValues *values;

object Specifies an object, giving the screen and depth for which the returned GC is valid. Must be of class Object or any subclass thereof.
value_mask Specifies which fields of the values structure are specified.
values Specifies the actual values for this GC.
```

The **XtGetGC** function returns a shareable, read-only GC. The parameters to this function are the same as those for **XCreateGC** except that an Object is passed instead of a Display. **XtGetGC** is equivalent to **XtAllocateGC** with `depth`, `dynamic_mask`, and `unused_mask` all zero. **XtGetGC** shares only GCs in which all values in the GC returned by **XCreateGC** are the same. In particular, it does not use the `value_mask` provided to determine which fields of the GC a widget considers relevant. The `value_mask` is used only to tell the server which fields should be filled in from `values` and which it should fill in with default values.

To deallocate a shared GC when it is no longer needed, use **XtReleaseGC**.

```c
void XtReleaseGC(object, gc)
    Widget object;
    GC gc;

object Specifies any object on the Display for which the GC was created. Must be of class Object or any subclass thereof.
gc Specifies the shared GC obtained with either **XtAllocateGC** or **XtGetGC**.
```

References to shareable GCs are counted and a free request is generated to the server when the last user of a given GC releases it.

### 11.5. Managing Selections

Arbitrary widgets in multiple applications can communicate with each other by means of the Intrinsics global selection mechanism, which conforms to the specifications in the *Inter-Client Communication Conventions Manual*. The Intrinsics supply functions for providing and receiving selection data in one logical piece (atomic transfers) or in smaller logical segments (incremental transfers).

The incremental interface is provided for a selection owner or selection requestor that cannot or prefers not to pass the selection value to and from the Intrinsics in a single call. For instance, either an application that is running on a machine with limited memory may not be able to store the entire selection value in memory or a selection owner may already have the selection value available in discrete chunks, and it would be more efficient not to have to allocate additional
storage to copy the pieces contiguously. Any owner or requestor that prefers to deal with the selection value in segments can use the incremental interfaces to do so. The transfer between the selection owner or requestor and the Intrinsics is not required to match the underlying transport protocol between the application and the X server; the Intrinsics will break too large a selection into smaller pieces for transport if necessary and will coalesce a selection transmitted incrementally if the value was requested atomically.

11.5.1. Setting and Getting the Selection Timeout Value

To set the Intrinsics selection timeout, use **XtAppSetSelectionTimeout**.

```c
void XtAppSetSelectionTimeout(app_context, timeout)
   XtAppContext app_context;
   unsigned long timeout;

app_context  Speciﬁes the application context.
timeout      Speciﬁes the selection timeout in milliseconds.
```

To get the current selection timeout value, use **XtAppGetSelectionTimeout**.

```c
unsigned long XtAppGetSelectionTimeout(app_context)
   XtAppContext app_context;

app_context  Speciﬁes the application context.
```

The **XtAppGetSelectionTimeout** function returns the current selection timeout value in milliseconds. The selection timeout is the time within which the two communicating applications must respond to one another. The initial timeout value is set by the selectionTimeout application resource as retrieved by **XtDisplayInitialize**. If selectionTimeout is not speciﬁed, the default is five seconds.

11.5.2. Using Atomic Transfers

When using atomic transfers, the owner will completely process one selection request at a time. The owner may consider each request individually, since there is no possibility for overlap between evaluation of two requests.

11.5.2.1. Atomic Transfer Procedures

The following procedures are used by the selection owner when providing selection data in a single unit.

The procedure pointer speciﬁed by the owner to supply the selection data to the Intrinsics is of type **XtConvertSelectionProc**.
    XtPointer*, unsigned long*, int*);

    Widget w;
    Atom *selection;
    Atom *target;
    Atom *type_return;
    XtPointer *value_return;
    unsigned long *length_return;
    int *format_return;

w    Specifies the widget that currently owns this selection.
selection    Specifies the atom naming the selection requested (for example, XA_PRIMARY or XA_SECONDARY).
target    Specifies the target type of the selection that has been requested, which indicates the desired information about the selection (for example, File Name, Text, Window).
type_return    Specifies a pointer to an atom into which the property type of the converted value of the selection is to be stored. For instance, either File Name or Text might have property type XA_STRING.
value_return    Specifies a pointer into which a pointer to the converted value of the selection is to be stored. The selection owner is responsible for allocating this storage. If the selection owner has provided an XtSelectionDoneProc for the selection, this storage is owned by the selection owner; otherwise, it is owned by the Intrinsics selection mechanism, which frees it by calling XtFree when it is done with it.
length_return    Specifies a pointer into which the number of elements in value_return, each of size indicated by format_return, is to be stored.
format_return    Specifies a pointer into which the size in bits of the data elements of the selection value is to be stored.

This procedure is called by the Intrinsics selection mechanism to get the value of a selection as a given type from the current selection owner. It returns True if the owner successfully converted the selection to the target type or False otherwise. If the procedure returns False, the values of the return arguments are undefined. Each XtConvertSelectionProc should respond to target value TARGETS by returning a value containing the list of the targets into which it is prepared to convert the selection. The value returned in format_return must be one of 8, 16, or 32 to allow the server to byte-swap the data if necessary. This procedure does not need to worry about responding to the MULTIPLE or the TIMESTAMP target values (see Section 2.6.2 in the Inter-Client Communication Conventions Manual). A selection request with the MULTIPLE target type is transparently transformed into a series of calls to this procedure, one for each target type, and a selection request with the TIMESTAMP target value is answered automatically by the Intrinsics using the time specified in the call to XtOwnSelection or XtOwnSelectionIncremental.

To retrieve the SelectionRequest event that triggered the XtConvertSelectionProc procedure, use XtGetSelectionRequest.
XSelectionRequestEvent *XtGetSelectionRequest(w, selection, request_id)
    
    Widget w;
    Atom selection;
    XtRequestId request_id;

    w Specifies the widget that currently owns this selection. Must be of class Core or any subclass thereof.
    selection Specifies the selection being processed.
    request_id Specifies the requestor id in the case of incremental selections, or NULL in the case of atomic transfers.

XtGetSelectionRequest may be called only from within an XtConvertSelectionProc procedure and returns a pointer to the SelectionRequest event that caused the conversion procedure to be invoked. Request_id specifies a unique id for the individual request in the case that multiple incremental transfers are outstanding. For atomic transfers, request_id must be specified as NULL. If no SelectionRequest event is being processed for the specified widget, selection, and request_id, XtGetSelectionRequest returns NULL.

The procedure pointer specified by the owner when it desires notification upon losing ownership is of type XtLoseSelectionProc.

typedef void (*XtLoseSelectionProc)(Widget, Atom*);
    
    Widget w;
    Atom *selection;

    w Specifies the widget that has lost selection ownership.
    selection Specifies the atom naming the selection.

This procedure is called by the Intrinsics selection mechanism to inform the specified widget that it has lost the given selection. Note that this procedure does not ask the widget to relinquish the selection ownership; it is merely informative.

The procedure pointer specified by the owner when it desires notification of receipt of the data or when it manages the storage containing the data is of type XtSelectionDoneProc.

typedef void (*XtSelectionDoneProc)(Widget, Atom*, Atom*);
    
    Widget w;
    Atom *selection;
    Atom *target;

    w Specifies the widget that owns the converted selection.
    selection Specifies the atom naming the selection that was converted.
    target Specifies the target type to which the conversion was done.

This procedure is called by the Intrinsics selection mechanism to inform the selection owner that a selection requestor has successfully retrieved a selection value. If the selection owner has registered an XtSelectionDoneProc, it should expect it to be called once for each conversion that it performs, after the converted value has been successfully transferred to the requestor. If the selection owner has registered an XtSelectionDoneProc, it also owns the storage containing the converted selection value.
### 11.5.2.2. Getting the Selection Value

The procedure pointer specified by the requestor to receive the selection data from the Intrinsics is of type `XtSelectionCallbackProc`.

```c
typedef void (*XtSelectionCallbackProc)(Widget, XtPointer, Atom*, Atom*, Xt Pointer, unsigned long*, int*);
```

- `w` is the widget that requested the selection value.
- `client_data` is a value passed in by the widget when it requested the selection.
- `selection` is the name of the selection that was requested.
- `type` is the representation type of the selection value (for example, `XA_STRING`). Note that it is not the target that was requested (which the client must remember for itself), but the type that is used to represent the target. The special symbolic constant `XT_CONVERT_FAIL` is used to indicate that the selection conversion failed because the selection owner did not respond within the Intrinsics selection timeout interval.
- `value` is a pointer to the selection value. The requesting client owns this storage and is responsible for freeing it by calling `XtFree` when it is done with it.
- `length` is the number of elements in `value`.
- `format` is the size in bits of the data in each element of `value`.

This procedure is called by the Intrinsics selection mechanism to deliver the requested selection to the requestor.

If the `SelectionNotify` event returns a property of `None`, meaning the conversion has been refused because there is no owner for the specified selection or the owner cannot convert the selection to the requested target for any reason, the procedure is called with a value of NULL and a length of zero.

To obtain the selection value in a single logical unit, use `XtGetSelectionValue` or `XtGetSelectionValues`.
void XtGetSelectionValue(w, selection, target, callback, client_data, time)
   Widget w;
   Atom selection;
   Atom target;
   XtSelectionCallbackProc callback;
   XtPointer client_data;
   Time time;

   w Specifies the widget making the request. Must be of class Core or any subclass thereof.

   selection Specifies the particular selection desired; for example, XA_PRIMARY.

   target Specifies the type of information needed about the selection.

   callback Specifies the procedure to be called when the selection value has been obtained.
   Note that this is how the selection value is communicated back to the client.

   client_data Specifies additional data to be passed to the specified procedure when it is called.

   time Specifies the timestamp that indicates when the selection request was initiated.
   This should be the timestamp of the event that triggered this request; the value CurrentTime is not acceptable.

The XtGetSelectionValue function requests the value of the selection converted to the target type. The specified callback is called at some time after XtGetSelectionValue is called, when the selection value is received from the X server. It may be called before or after XtGetSelectionValue returns. For more information about selection, target, and time, see Section 2.6 in the Inter-Client Communication Conventions Manual.

void XtGetSelectionValues(w, selection, targets, count, callback, client_data, time)
   Widget w;
   Atom selection;
   Atom *targets;
   int count;
   XtSelectionCallbackProc callback;
   XtPointer *client_data;
   Time time;

   w Specifies the widget making the request. Must be of class Core or any subclass thereof.

   selection Specifies the particular selection desired (that is, primary or secondary).

   targets Specifies the types of information needed about the selection.

   count Specifies the length of the targets and client_data lists.

   callback Specifies the callback procedure to be called with each selection value obtained.
   Note that this is how the selection values are communicated back to the client.

   client_data Specifies a list of additional data values, one for each target type, that are passed to the callback procedure when it is called for that target.

   time Specifies the timestamp that indicates when the selection request was initiated.
   This should be the timestamp of the event that triggered this request; the value CurrentTime is not acceptable.

The XtGetSelectionValues function is similar to multiple calls to XtGetSelectionValue except
that it guarantees that no other client can assert ownership between requests and therefore that all
the conversions will refer to the same selection value. The callback is invoked once for each tar-
get value with the corresponding client data. For more information about selection, target, and
time, see Section 2.6 in the Inter-Client Communication Conventions Manual.

11.5.2.3. Setting the Selection Owner
To set the selection owner and indicate that the selection value will be provided in one piece, use
XtOwnSelection.

```
Boolean XtOwnSelection(w, selection, time, convert_proc, lose_selection, done_proc)
  Widget w;
  Atom selection;
  Time time;
  XtConvertSelectionProc convert_proc;
  XtLoseSelectionProc lose_selection;
  XtSelectionDoneProc done_proc;
  w      Specifies the widget that wishes to become the owner. Must be of class Core or
         any subclass thereof.
  selection Specifies the name of the selection (for example, XA_PRIMARY).
  time Specifies the timestamp that indicates when the ownership request was initiated.
         This should be the timestamp of the event that triggered ownership; the value
         CurrentTime is not acceptable.
  convert_proc Specifies the procedure to be called whenever a client requests the current value
         of the selection.
  lose_selection Specifies the procedure to be called whenever the widget has lost selection own-
         ership, or NULL if the owner is not interested in being called back.
  done_proc Specifies the procedure called after the requestor has received the selection value,
         or NULL if the owner is not interested in being called back.
```

The XtOwnSelection function informs the Intrinsics selection mechanism that a widget wishes
to own a selection. It returns True if the widget successfully becomes the owner and False other-
wise. The widget may fail to become the owner if some other widget has asserted ownership at
a time later than this widget. The widget can lose selection ownership either because some other
widget asserted later ownership of the selection or because the widget voluntarily gave up own-
ership of the selection. The lose_selection procedure is not called if the widget fails to obtain selec-
tion ownership in the first place.

If a done_proc is specified, the client owns the storage allocated for passing the value to the
Intrinsics. If done_proc is NULL, the convert_proc must allocate storage using XtMalloc,
XtRealloc, or XtCalloc, and the value specified is freed by the Intrinsics when the transfer is
complete.

Usually, a selection owner maintains ownership indefinitely until some other widget requests
ownership, at which time the Intrinsics selection mechanism informs the previous owner that it
has lost ownership of the selection. However, in response to some user actions (for example,
when a user deletes the information selected), the application may wish to explicitly inform the
Intrinsics by using XtDisownSelection that it no longer is to be the selection owner.
void XtDisownSelection(w, selection, time)

    Widget w;
    Atom selection;
    Time time;

w Specifies the widget that wishes to relinquish ownership.

selection Specifies the atom naming the selection being given up.

time Specifies the timestamp that indicates when the request to relinquish selection ownership was initiated.

The XtDisownSelection function informs the Intrinsics selection mechanism that the specified widget is to lose ownership of the selection. If the widget does not currently own the selection, either because it lost the selection or because it never had the selection to begin with, XtDisownSelection does nothing.

After a widget has called XtDisownSelection, its convert procedure is not called even if a request arrives later with a timestamp during the period that this widget owned the selection. However, its done procedure is called if a conversion that started before the call to XtDisownSelection finishes after the call to XtDisownSelection.

11.5.3. Using Incremental Transfers
When using the incremental interface, an owner may have to process more than one selection request for the same selection, converted to the same target, at the same time. The incremental functions take a request_id argument, which is an identifier that is guaranteed to be unique among all incremental requests that are active concurrently.

For example, consider the following:

- Upon receiving a request for the selection value, the owner sends the first segment.
- While waiting to be called to provide the next segment value but before sending it, the owner receives another request from a different requestor for the same selection value.
- To distinguish between the requests, the owner uses the request_id value. This allows the owner to distinguish between the first requestor, which is asking for the second segment, and the second requestor, which is asking for the first segment.

11.5.3.1. Incremental Transfer Procedures
The following procedures are used by selection owners who wish to provide the selection data in multiple segments.

The procedure pointer specified by the incremental owner to supply the selection data to the Intrinsics is of type XtConvertSelectionIncrProc.

typedef XtPointer XtRequestId;
unsigned long*, int*, unsigned long*, XtPointer, XtRequestId*);

Widget w;
Atom *selection;
Atom *target;
Atom *type_return;
XtPointer *value_return;
unsigned long *length_return;
int *format_return;
unsigned long *max_length;
XtPointer client_data;
XtRequestId *request_id;

w Specifies the widget that currently owns this selection.
selection Specifies the atom that names the selection requested.
target Specifies the type of information required about the selection.
type_return Specifies a pointer to an atom into which the property type of the converted value
of the selection is to be stored.
value_return Specifies a pointer into which a pointer to the converted value of the selection is
to be stored. The selection owner is responsible for allocating this storage.
length_return Specifies a pointer into which the number of elements in value_return, each of
size indicated by format_return, is to be stored.
format_return Specifies a pointer into which the size in bits of the data elements of the selection
value is to be stored so that the server may byte-swap the data if necessary.
max_length Specifies the maximum number of bytes which may be transferred at any one
time.
client_data Specifies the value passed in by the widget when it took ownership of the selection.
request_id Specifies an opaque identification for a specific request.

This procedure is called repeatedly by the Intrinsics selection mechanism to get the next incre-
mental chunk of data from a selection owner who has called XtOwnSelectionIncremental. It
must return True if the procedure has succeeded in converting the selection data or False other-
wise. On the first call with a particular request id, the owner must begin a new incremental trans-
fer for the requested selection and target. On subsequent calls with the same request id, the owner
may assume that the previously supplied value is no longer needed by the Intrinsics; that is, a
fixed transfer area may be allocated and returned in value_return for each segment to be trans-
ferred. This procedure should store a non-NULL value in value_return and zero in length_return
to indicate that the entire selection has been delivered. After returning this final segment, the
request id may be reused by the Intrinsics to begin a new transfer.

To retrieve the SelectionRequest event that triggered the selection conversion procedure, use
XtGetSelectionRequest, described in Section 11.5.2.1.

The procedure pointer specified by the incremental selection owner when it desires notification
upon no longer having ownership is of type XtLoseSelectionIncrProc.
typedef void (*XtLoseSelectionIncrProc)(Widget, Atom*, XtPointer);
    Widget w;
    Atom *selection;
    XtPointer client_data;

    w     Specifies the widget that has lost the selection ownership.
    selection Specifies the atom that names the selection.
    client_data Specifies the value passed in by the widget when it took ownership of the selection.

This procedure, which is optional, is called by the Intrinsics to inform the selection owner that it no longer owns the selection.

The procedure pointer specified by the incremental selection owner when it desires notification of receipt of the data or when it manages the storage containing the data is of type XtSelectionDoneIncrProc.

typedef void (*XtSelectionDoneIncrProc)(Widget, Atom*, Atom*, XtRequestId*, XtPointer);
    Widget w;
    Atom *selection;
    Atom *target;
    XtRequestId *request_id;
    XtPointer client_data;

    w      Specifies the widget that owns the selection.
    selection Specifies the atom that names the selection being transferred.
    target Specifies the target type to which the conversion was done.
    request_id Specifies an opaque identification for a specific request.
    client_data Specifies the value passed in by the widget when it took ownership of the selection.

This procedure, which is optional, is called by the Intrinsics after the requestor has retrieved the final (zero-length) segment of the incremental transfer to indicate that the entire transfer is complete. If this procedure is not specified, the Intrinsics will free only the final value returned by the selection owner using XtFree.

The procedure pointer specified by the incremental selection owner to notify it if a transfer should be terminated prematurely is of type XtCancelConvertSelectionProc.
typedef void (*XtCancelConvertSelectionProc)(Widget, Atom*, Atom*, XtRequestId*, XtPointer);

Widget w;
Atom *selection;
Atom *target;
XtRequestId *request_id;
XtPointer client_data;

w Specifies the widget that owns the selection.
selection Specifies the atom that names the selection being transferred.
target Specifies the target type to which the conversion was done.
request_id Specifies an opaque identification for a specific request.
client_data Specifies the value passed in by the widget when it took ownership of the selection.

This procedure is called by the Intrinsics when it has been determined by means of a timeout or other mechanism that any remaining segments of the selection no longer need to be transferred. Upon receiving this callback, the selection request is considered complete and the owner can free the memory and any other resources that have been allocated for the transfer.

### 11.5.3.2. Getting the Selection Value Incrementally

To obtain the value of the selection using incremental transfers, use `XtGetSelectionValueIncremental` or `XtGetSelectionValuesIncremental`.

```c
void XtGetSelectionValueIncremental(Widget w, Atom selection, Atom target, XtSelectionCallbackProc selection_callback, XtPointer client_data, Time time);
```

w Specifies the widget making the request. Must be of class Core or any subclass thereof.
selection Specifies the particular selection desired.
target Specifies the type of information needed about the selection.
selection_callback Specifies the callback procedure to be called to receive each data segment.
client_data Specifies client-specific data to be passed to the specified callback procedure when it is invoked.
time Specifies the timestamp that indicates when the selection request was initiated. This should be the timestamp of the event that triggered this request; the value `CurrentTime` is not acceptable.

The `XtGetSelectionValueIncremental` function is similar to `XtGetSelectionValue` except that the selection_callback procedure will be called repeatedly upon delivery of multiple segments of the selection value. The end of the selection value is indicated when `selection_callback` is called with a non-NULL value of length zero, which must still be freed by the client. If the transfer of the selection is aborted in the middle of a transfer (for example, because of a timeout), the selection_callback procedure is called with a type value equal to the symbolic constant.
XT_CONVERT_FAIL so that the requestor can dispose of the partial selection value it has collected up until that point. Upon receiving XT_CONVERT_FAIL, the requesting client must determine for itself whether or not a partially completed data transfer is meaningful. For more information about selection, target, and time, see Section 2.6 in the Inter-Client Communication Conventions Manual.

```c
void XtGetSelectionValuesIncremental(w, selection, targets, count, selection_callback, client_data, time)  
    Widget w;  
    Atom selection;  
    Atom *targets;  
    int count;  
    XtSelectionCallbackProc selection_callback;  
    XtPointer *client_data;  
    Time time;  

    w    Speciﬁes the widget making the request. Must be of class Core or any subclass thereof.
    selection    Speciﬁes the particular selection desired.
    targets    Speciﬁes the types of information needed about the selection.
    count    Speciﬁes the length of the targets and client_data lists.
    selection_callback    Speciﬁes the callback procedure to be called to receive each selection value.
    client_data    Speciﬁes a list of client data (one for each target type) values that are passed to
                    the callback procedure when it is invoked for the corresponding target.
    time    Speciﬁes the timestamp that indicates when the selection request was initiated.
            This should be the timestamp of the event that triggered this request; the value CurrentTime is not acceptable.
```

The XtGetSelectionValuesIncremental function is similar to XtGetSelectionValueIncremental except that it takes a list of targets and client data. XtGetSelectionValuesIncremental is equivalent to calling XtGetSelectionValueIncremental successively for each target/client_data pair except that XtGetSelectionValuesIncremental does guarantee that all the conversions will use the same selection value because the ownership of the selection cannot change in the middle of the list, as would be possible when calling XtGetSelectionValueIncremental repeatedly. For more information about selection, target, and time, see Section 2.6 in the Inter-Client Communication Conventions Manual.

11.5.3.3. Setting the Selection Owner for Incremental Transfers
To set the selection owner when using incremental transfers, use XtOwnSelectionIncremental.
Boolean XtOwnSelectionIncremental(w, selection, time, convert_callback, lose_callback, done_callback, cancel_callback, client_data)

Widget w;
Atom selection;
Time time;
XtConvertSelectionIncrProc convert_callback;
XtLoseSelectionIncrProc lose_callback;
XtSelectionDoneIncrProc done_callback;
XtCancelConvertSelectionProc cancel_callback;
XtPointer client_data;

w Specifies the widget that wishes to become the owner. Must be of class Core or any subclass thereof.

selection Specifies the atom that names the selection.

time Specifies the timestamp that indicates when the selection ownership request was initiated. This should be the timestamp of the event that triggered ownership; the value CurrentTime is not acceptable.

convert_callback Specifies the procedure to be called whenever the current value of the selection is requested.

lose_callback Specifies the procedure to be called whenever the widget has lost selection ownership, or NULL if the owner is not interested in being notified.

done_callback Specifies the procedure called after the requestor has received the entire selection, or NULL if the owner is not interested in being notified.

cancel_callback Specifies the callback procedure to be called when a selection request aborts because a timeout expires, or NULL if the owner is not interested in being notified.

client_data Specifies the argument to be passed to each of the callback procedures when they are called.

The XtOwnSelectionIncremental procedure informs the Intrinsics incremental selection mechanism that the specified widget wishes to own the selection. It returns True if the specified widget successfully becomes the selection owner or False otherwise. For more information about selection, target, and time, see Section 2.6 in the Inter-Client Communication Conventions Manual.

If a done_callback procedure is specified, the client owns the storage allocated for passing the value to the Intrinsics. If done_callback is NULL, the convert_callback procedure must allocate storage using XtMalloc, XtRealloc, or XtCalloc, and the final value specified is freed by the Intrinsics when the transfer is complete. After a selection transfer has started, only one of the done_callback or cancel_callback procedures is invoked to indicate completion of the transfer.

The lose_callback procedure does not indicate completion of any in-progress transfers; it is invoked at the time a SelectionClear event is dispatched regardless of any active transfers, which are still expected to continue.

A widget that becomes the selection owner using XtOwnSelectionIncremental may use XtDisownSelection to relinquish selection ownership.

11.5.4. Setting and Retrieving Selection Target Parameters

To specify target parameters for a selection request with a single target, use XtSetSelectionParameters.
void XtSetSelectionParameters(requestor, selection, type, value, length, format)
    
    Widget requestor;
    Atom selection;
    Atom type;
    XtPointer value;
    unsigned long length;
    int format;

    requestor     Specifies the widget making the request. Must be of class Core or any subclass thereof.
    selection     Specifies the atom that names the selection.
    type          Specifies the type of the property in which the parameters are passed.
    value         Specifies a pointer to the parameters.
    length        Specifies the number of elements containing data in value, each element of a size indicated by format.
    format        Specifies the size in bits of the data in the elements of value.

    The specified parameters are copied and stored in a new property of the specified type and format
    on the requestor’s window. To initiate a selection request with a target and these parameters, a
    subsequent call to XtGetSelectionValue or to XtGetSelectionValueIncremental specifying the
    same requestor widget and selection atom will generate a ConvertSelection request referring to
    the property containing the parameters. If XtSetSelectionParameters is called more than once
    with the same widget and selection without a call to specify a request, the most recently specified
    parameters are used in the subsequent request.

    The possible values of format are 8, 16, or 32. If the format is 8, the elements of value are
    assumed to be sizeof(char); if 16, sizeof(short); if 32, sizeof(long).

    To generate a MULTIPLE target request with parameters for any of the multiple targets of the
    selection request, precede individual calls to XtGetSelectionValue and XtGetSelectionValueIn-
    cremental with corresponding individual calls to XtSetSelectionParameters, and enclose these
    all within XtCreateSelectionRequest and XtSendSelectionRequest. XtGetSelectionValues
    and XtGetSelectionValuesIncremental cannot be used to make selection requests with parameter-
    ized targets.

    To retrieve any target parameters needed to perform a selection conversion, the selection owner
    calls XtGetSelectionParameters.
void XtGetSelectionParameters(
    owner, selection, request_id, type_return, value_return,
    length_return, format_return)

    Widget owner;
    Atom selection;
    XtRequestId request_id;
    Atom *type_return;
    XtPointer *value_return;
    unsigned long *length_return;
    int *format_return;

owner     Specifies the widget that owns the specified selection.
selection  Specifies the selection being processed.
request_id Specifies the requestor id in the case of incremental selections, or NULL in the case of atomic transfers.
type_return Specifies a pointer to an atom in which the property type of the parameters is stored.
value_return Specifies a pointer into which a pointer to the parameters is to be stored. A NULL is stored if no parameters accompany the request.
length_return Specifies a pointer into which the number of data elements in value_return of size indicated by format_return are stored.
format_return Specifies a pointer into which the size in bits of the parameter data in the elements of value is stored.

XtGetSelectionParameters may be called only from within an XtConvertSelectionProc or from within the first call to an XtConvertSelectionIncrProc with a new request_id.

It is the responsibility of the caller to free the returned parameters using XtFree when the parameters are no longer needed.

11.5.5. Generating MULTIPLE Requests

To have the Intrinsics bundle multiple calls to make selection requests into a single request using a MULTIPLE target, use XtCreateSelectionRequest and XtSendSelectionRequest.

void XtCreateSelectionRequest(
    requestor, selection)

    Widget requestor;
    Atom selection;

requestor  Specifies the widget making the request. Must be of class Core or any subclass thereof.
selection   Specifies the particular selection desired.

When XtCreateSelectionRequest is called, subsequent calls to XtGetSelectionValue, XtGetSelectionValueIncremental, XtGetSelectionValues, and XtGetSelectionValuesIncremental, with the requestor and selection as specified to XtCreateSelectionRequest, are bundled into a single selection request with multiple targets. The request is made by calling XtSendSelectionRequest.
void XtSendSelectionRequest(requestor, selection, time)
    Widget requestor;
    Atom selection;
    Time time;

requestor Specifies the widget making the request. Must be of class Core or any subclass thereof.

selection Specifies the particular selection desired.

time Specifies the timestamp that indicates when the selection request was initiated. The value CurrentTime is not acceptable.

When XtSendSelectionRequest is called with a value of requestor and selection matching a previous call to XtCreateSelectionRequest, a selection request is sent to the selection owner. If a single target request is queued, that request is made. If multiple targets are queued, they are bundled into a single request with a target of MULTIPLE using the specified timestamp. As the values are returned, the callbacks specified in XtGetSelectionValue, XtGetSelectionValueIncremental, XtGetSelectionValues, and XtGetSelectionValueIncremental are invoked.

Multi-threaded applications should lock the application context before calling XtCreateSelectionRequest and release the lock after calling XtSendSelectionRequest to ensure that the thread assembling the request is safe from interference by another thread assembling a different request naming the same widget and selection.

To relinquish the composition of a MULTIPLE request without sending it, use XtCancelSelectionRequest.

void XtCancelSelectionRequest(requestor, selection)
    Widget requestor;
    Atom selection;

requestor Specifies the widget making the request. Must be of class Core or any subclass thereof.

selection Specifies the particular selection desired.

When XtCancelSelectionRequest is called, any requests queued since the last call to XtCreateSelectionRequest for the same widget and selection are discarded and any resources reserved are released. A subsequent call to XtSendSelectionRequest will not result in any request being made. Subsequent calls to XtGetSelectionValue, XtGetSelectionValues, XtGetSelectionValueIncremental, or XtGetSelectionValuesIncremental will not be deferred.

11.5.6. Auxiliary Selection Properties

Certain uses of parameterized selections require clients to name other window properties within a selection parameter. To permit reuse of temporary property names in these circumstances and thereby reduce the number of unique atoms created in the server, the Intrinsics provides two interfaces for acquiring temporary property names.

To acquire a temporary property name atom for use in a selection request, the client may call Xt ReservePropertyAtom.
Atom Xt ReservePropertyAtom(w)
    Widget w;

w Specifies the widget making a selection request.

Xt ReservePropertyAtom returns an atom that may be used as a property name during selection requests involving the specified widget. As long as the atom remains reserved, it is unique with respect to all other reserved atoms for the widget.

To return a temporary property name atom for reuse and to delete the property named by that atom, use Xt ReleasePropertyAtom.

void Xt ReleasePropertyAtom(w, atom)
    Widget w;
    Atom atom;

w Specifies the widget used to reserve the property name atom.

atom Specifies the property name atom returned by Xt ReservePropertyAtom that is to be released for reuse.

Xt ReleasePropertyAtom marks the specified property name atom as no longer in use and ensures that any property having that name on the specified widget’s window is deleted. If atom does not specify a value returned by Xt ReservePropertyAtom for the specified widget, the results are undefined.

11.5.7. Retreiving the Most Recent Timestamp

To retrieve the timestamp from the most recent call to Xt DispatchEvent that contained a timestamp, use Xt LastTimestampProcessed.

Time Xt LastTimestampProcessed(display)
    Display *display;

display Specifies an open display connection.

If no KeyPress, KeyRelease, ButtonPress, ButtonRelease, MotionNotify, EnterNotify, LeaveNotify, PropertyNotify, or SelectionClear event has yet been passed to Xt DispatchEvent for the specified display, Xt LastTimestampProcessed returns zero.

11.5.8. Retreiving the Most Recent Event

To retrieve the event from the most recent call to Xt DispatchEvent for a specified display, use Xt LastEventProcessed.

XEvent *Xt LastEventProcessed(display)
    Display *display;

display Specifies the display connection from which to retrieve the event.

Returns the last event passed to Xt DispatchEvent for the specified display. Returns NULL if there is no such event. The client must not modify the contents of the returned event.
11.6. Merging Exposure Events into a Region

The Intrinsics provide an `XtAddExposureToRegion` utility function that merges Expose and GraphicsExpose events into a region for clients to process at once rather than processing individual rectangles. For further information about regions, see Section 16.5 in Xlib — C Language X Interface.

To merge Expose and GraphicsExpose events into a region, use `XtAddExposureToRegion`.

```c
void XtAddExposureToRegion(event, region)
    XEvent *event;
    Region region;

    event Specifi es a pointer to the Expose or GraphicsExpose event.
    region Specifi es the region object (as defi ned in <X11/Xutil.h>).
```

The `XtAddExposureToRegion` function computes the union of the rectangle defined by the exposure event and the specified region. Then it stores the results back in `region`. If the event argument is not an Expose or GraphicsExpose event, `XtAddExposureToRegion` returns without an error and without modifying `region`.

This function is used by the exposure compression mechanism; see Section 7.9.3.

11.7. Translating Widget Coordinates

To translate an x-y coordinate pair from widget coordinates to root window absolute coordinates, use `XtTranslateCoords`.

```c
void XtTranslateCoords(w, x, y, rootx_return, rooty_return)
    Widget w;
    Position x, y;
    Position *rootx_return, *rooty_return;

    w Specifi es the widget. Must be of class RectObj or any subclass thereof.
    x y Specify the widget-relative x and y coordinates.
    rootx_return rooty_return Return the root-relative x and y coordinates.
```

While `XtTranslateCoords` is similar to the Xlib `XTranslateCoordinates` function, it does not generate a server request because all the required information already is in the widget’s data structures.

11.8. Translating a Window to a Widget

To translate a given window and display pointer into a widget instance, use `XtWindowToWidget`.
Widget XtWindowToWidget(display, window)
    Display *display;
    Window window;

display Specifi es the display on which the window is defi ned.
window Specifi es the drawable for which you want the widget.

If there is a realized widget whose window is the specifi ed drawable on the specifi ed display, XtWindowToWidget returns that widget. If not and if the drawable has been associated with a widget through XtRegisterDrawable, XtWindowToWidget returns the widget associated with the drawable. In other cases it returns NULL.

11.9. Handling Errors
The Intrinsics allow a client to register procedures that are called whenever a fatal or nonfatal error occurs. These facilities are intended for both error reporting and logging and for error correction or recovery.

Two levels of interface are provided:
- A high-level interface that takes an error name and class and retrieves the error message text from an error resource database.
- A low-level interface that takes a simple string to display.

The high-level functions construct a string to pass to the lower-level interface. The strings may be specifi ed in application code and are overridden by the contents of an external systemwide fi le, the “error database fi le”. The location and name of this fi le are implementation-dependent.

Note
The application-context-specifi c error handling is not implemented on many systems, although the interfaces are always present. Most implementations will have just one set of error handlers for all application contexts within a process. If they are set for different application contexts, the ones registered last will prevail.

To obtain the error database (for example, to merge with an application- or widget-specifi c database), use XtAppGetErrorDatabase.

XrmDatabase *XtAppGetErrorDatabase(app_context)
    XtAppContext app_context;

app_context Specifi es the application context.

The XtAppGetErrorDatabase function returns the address of the error database. The Intrinsics do a lazy binding of the error database and do not merge in the database fi le until the fi rst call to XtAppGetErrorDatabaseText.
For a complete listing of all errors and warnings that can be generated by the Intrinsics, see Appendix D.

The high-level error and warning handler procedure pointers are of type XtErrorMsgHandler.
typedef void (*XtErrorMsgHandler)(String, String, String, String, String*, Cardinal*);

String name;
String type;
String class;
String defaultp;
String *params;
Cardinal *num_params;

name Specifies the name to be concatenated with the specified type to form the resource name of the error message.
type Specifies the type to be concatenated with the name to form the resource name of the error message.
class Specifies the resource class of the error message.
defaultp Specifies the default message to use if no error database entry is found.
params Specifies a pointer to a list of parameters to be substituted in the message.
num_params Specifies the number of entries in params.

The specified name can be a general kind of error, like “invalidParameters” or “invalidWindow”, and the specified type gives extra information such as the name of the routine in which the error was detected. Standard printf notation is used to substitute the parameters into the message.

An error message handler can obtain the error database text for an error or a warning by calling XtAppGetErrorDatabaseText.

void XtAppGetErrorDatabaseText(app_context, name, type, class, default, buffer_return, nbytes, database)

app_context Specifies the application context.
name type Specify the name and type concatenated to form the resource name of the error message.
class Specifies the resource class of the error message.
default Specifies the default message to use if an error database entry is not found.
buffer_return Specifies the buffer into which the error message is to be returned.
nbytes Specifies the size of the buffer in bytes.
database Specifies the name of the alternative database to be used, or NULL if the application context’s error database is to be used.

The XtAppGetErrorDatabaseText returns the appropriate message from the error database or returns the specified default message if one is not found in the error database. To form the full resource name and class when querying the database, the name and type are concatenated with a single “.” between them and the class is concatenated with itself with a single “.” if it does not already contain a “.”.
To return the application name and class as passed to `XtDisplayInitialize` for a particular Display, use `XtGetApplicationNameAndClass`.

```c
void XtGetApplicationNameAndClass(display, name_return, class_return)
    Display* display;
    String* name_return;
    String* class_return;
```

display Specifies an open display connection that has been initialized with `XtDisplayInitialize`.

name_return Returns the application name.

class_return Returns the application class.

`XtGetApplicationNameAndClass` returns the application name and class passed to `XtDisplayInitialize` for the specified display. If the display was never initialized or has been closed, the result is undefined. The returned strings are owned by the Intrinsics and must not be modified or freed by the caller.

To register a procedure to be called on fatal error conditions, use `XtAppSetErrorMsgHandler`.

```c
XtErrorMsgHandler XtAppSetErrorMsgHandler(app_context, msg_handler)
    XtAppState app_context;
    XtErrorMsgHandler msg_handler;
```

app_context Specifies the application context.

msg_handler Specifies the new fatal error procedure, which should not return.

`XtAppSetErrorMsgHandler` returns a pointer to the previously installed high-level fatal error handler. The default high-level fatal error handler provided by the Intrinsics is named `_XtDefaultErrorMsg` and constructs a string from the error resource database and calls `XtError`. Fatal error message handlers should not return. If one does, subsequent Intrinsics behavior is undefined.

To call the high-level error handler, use `XtAppErrorMsg`.
void XtAppErrorMsg(app_context, name, type, class, default, params, num_params)

  XtAppContext app_context;
  String name;
  String type;
  String class;
  String default;
  String *params;
  Cardinal *num_params;

  app_context  Specifies the application context.
  name        Specifies the general kind of error.
  type        Specifies the detailed name of the error.
  class       Specifies the resource class.
  default     Specifies the default message to use if an error database entry is not found.
  params      Specifies a pointer to a list of values to be stored in the message.
  num_params  Specifies the number of entries in params.

The Intrinsics internal errors all have class “XtToolkitError”.

To register a procedure to be called on nonfatal error conditions, use XtAppSetWarningMsgHandler.

XtErrorMsgHandler XtAppSetWarningMsgHandler(app_context, msg_handler)

  XtAppContext app_context;
  XtErrorMsgHandler msg_handler;

  app_context  Specifies the application context.
  msg_handler  Specifies the new nonfatal error procedure, which usually returns.

XtAppSetWarningMsgHandler returns a pointer to the previously installed high-level warning handler. The default high-level warning handler provided by the Intrinsics is named _XtDefaultWarningMsg and constructs a string from the error resource database and calls XtWarning.

To call the installed high-level warning handler, use XtAppWarningMsg.
void XtAppWarningMsg(app_context, name, type, class, default, params, num_params)
    XtAppContext app_context;
    String name;
    String type;
    String class;
    String default;
    String *params;
    Cardinal *num_params;

app_context Specifies the application context.
name Specifies the general kind of error.
type Specifies the detailed name of the error.
class Specifies the resource class.
default Specifies the default message to use if an error database entry is not found.
params Specifies a pointer to a list of values to be stored in the message.
num_params Specifies the number of entries in params.

The Intrinsics internal warnings all have class “XtToolkitError”.

The low-level error and warning handler procedure pointers are of type XtErrorHandler.

typedef void (*XtErrorHandler)(String);
    String message;

message Specifies the error message.

The error handler should display the message string in some appropriate fashion.

To register a procedure to be called on fatal error conditions, use XtAppSetErrorHandler.

XtErrorHandler XtAppSetErrorHandler(app_context, handler)
    XtAppContext app_context;
    XtErrorHandler handler;

app_context Specifies the application context.
handler Specifies the new fatal error procedure, which should not return.

XtAppSetErrorHandler returns a pointer to the previously installed low-level fatal error handler. The default low-level error handler provided by the Intrinsics is _XtDefaultError. On POSIX-based systems, it prints the message to standard error and terminates the application. Fatal error message handlers should not return. If one does, subsequent Intrinsics behavior is undefined.

To call the installed fatal error procedure, use XtAppError.
void XtAppError(app_context, message)
    XtAppContext app_context;
    String message;

    app_context Specifies the application context.
    message Specifies the message to be reported.

Most programs should use XtAppErrorMsg, not XtAppError, to provide for customization and internationalization of error messages.

To register a procedure to be called on nonfatal error conditions, use XtAppSetWarningHandler.

XtErrorHandler XtAppSetWarningHandler(app_context, handler)
    XtAppContext app_context;
    XtErrorHandler handler;

    app_context Specifies the application context.
    handler Specifies the new nonfatal error procedure, which usually returns.

XtAppSetWarningHandler returns a pointer to the previously installed low-level warning handler. The default low-level warning handler provided by the Intrinsics is _XtDefaultWarning. On POSIX-based systems, it prints the message to standard error and returns to the caller.

To call the installed nonfatal error procedure, use XtAppWarning.

void XtAppWarning(app_context, message)
    XtAppContext app_context;
    String message;

    app_context Specifies the application context.
    message Specifies the nonfatal error message to be reported.

Most programs should use XtAppWarningMsg, not XtAppWarning, to provide for customization and internationalization of warning messages.

11.10. Setting WM_COLORMAP_WINDOWS

A client may set the value of the WM_COLORMAP_WINDOWS property on a widget’s window by calling XtSetWMColormapWindows.
void XtSetWMColormapWindows(widget, list, count)
    Widget widget;
    Widget* list;
    Cardinal count;

    widget Specifies the widget on whose window the WM_COLORMAP_WINDOWS property is stored. Must be of class Core or any subclass thereof.
    list Specifies a list of widgets whose windows are potentially to be listed in the WM_COLORMAP_WINDOWS property.
    count Specifies the number of widgets in list.

XtSetWMColormapWindows returns immediately if widget is not realized or if count is 0. Otherwise, XtSetWMColormapWindows constructs an ordered list of windows by examining each widget in list in turn and ignoring the widget if it is not realized, or adding the widget’s window to the window list if the widget is realized and if its colormap resource is different from the colormap resources of all widgets whose windows are already on the window list.

Finally, XtSetWMColormapWindows stores the resulting window list in the WM_COLORMAP_WINDOWS property on the specified widget’s window. Refer to Section 4.1.8 in the Inter-Client Communication Conventions Manual for details of the semantics of the WM_COLORMAP_WINDOWS property.

11.11. Finding File Names

The Intrinsics provide procedures to look for a file by name, allowing string substitutions in a list of file specifications. Two routines are provided for this: XtFindFile and XtResolvePathname. XtFindFile uses an arbitrary set of client-specified substitutions, and XtResolvePathname uses a set of standard substitutions corresponding to the X/Open Portability Guide language localization conventions. Most applications should use XtResolvePathname.

A string substitution is defined by a list of Substitution entries.

typedef struct {
    char match;
    String substitution;
} SubstitutionRec, *Substitution;

File name evaluation is handled in an operating-system-dependent fashion by an XtFilePredicate procedure.

typedef Boolean (*XtFilePredicate)(String);
    String fi lename;
    fi lename Specifies a potential file name.

A file predicate procedure is called with a string that is potentially a file name. It should return True if this string specifies a file that is appropriate for the intended use and False otherwise.

To search for a file using substitutions in a path list, use XtFindFile.
String XtFindFile(path, substitutions, num_substitutions, predicate)
  String path;
  Substitution substitutions;
  Cardinal num_substitutions;
  XtFilePredicate predicate;

path  Specifies a path of file names, including substitution characters.
substitutions  Specifies a list of substitutions to make into the path.
num_substitutions  Specifies the number of substitutions passed in.
predicate  Specifies a procedure called to judge each potential file name, or NULL.

The path parameter specifies a string that consists of a series of potential file names delimited by colons. Within each name, the percent character specifies a string substitution selected by the following character. The character sequence “%:” specifies an embedded colon that is not a delimiter; the sequence is replaced by a single colon. The character sequence “%%” specifies a percent character that does not introduce a substitution; the sequence is replaced by a single percent character. If a percent character is followed by any other character, XtFindFile looks through the specified substitutions for that character in the match field and, if found, replaces the percent and match characters with the string in the corresponding substitution field. A substitution field entry of NULL is equivalent to a pointer to an empty string. If the operating system does not interpret multiple embedded name separators in the path (i.e., “/” in POSIX) the same way as a single separator, XtFindFile will collapse multiple separators into a single one after performing all string substitutions. Except for collapsing embedded separators, the contents of the string substitutions are not interpreted by XtFindFile and may therefore contain any operating-system-dependent characters, including additional name separators. Each resulting string is passed to the predicate procedure until a string is found for which the procedure returns True; this string is the return value for XtFindFile. If no string yields a True return from the predicate, XtFindFile returns NULL.

If the predicate parameter is NULL, an internal procedure that checks if the file exists, is readable, and is not a directory is used.

It is the responsibility of the caller to free the returned string using XtFree when it is no longer needed.

To search for a file using standard substitutions in a path list, use XtResolvePathname.
String XtResolvePathname(display, type, filename, suffix, path, substitutions, num_substitutions, predicate)

Display *display;
String type, filename, suffix, path;
Substitution substitutions;
Cardinal num_substitutions;
XtFilePredicate predicate;

display Specifi es the display to use to fi nd the language for language substitutions.
type filename Specify values to substitute into the path.
suffix Specifi es the list of fi le speciﬁ cations, or NULL.
path Specifi es a list of additional substitutions to make into the path, or NULL.
substitutions Specifi es the number of entries in substitutions.
um_substitutions Specifi es a procedure called to judge each potential fi le name, or NULL.
predicate

The substitutions speciﬁ ed by XtResolvePathname are determined from the value of the language string retrieved by XtDisplayInitialize for the speciﬁ ed display. To set the language for all applications specify “*xnl_language: lang” in the resource database. The format and content of the language string are implementation-deﬁ ned. One suggested syntax is to compose the language string of three parts; a “language part”, a “territory part” and a “codeset part”. The manner in which this composition is accomplished is implementation-deﬁ ned, and the Intrinsics make no interpretation of the parts other than to use them in substitutions as described below.

XtResolvePathname calls XtFindFile with the following substitutions in addition to any passed by the caller and returns the value returned by XtFindFile:

%N The value of the filename parameter, or the application’s class name if filename is NULL.
%T The value of the type parameter.
%S The value of the suffix parameter.
%L The language string associated with the speciﬁ ed display.
%l The language part of the display’s language string.
%t The territory part of the display’s language string.
%c The codeset part of the display’s language string.
%C The customization string retrieved from the resource database associated with display.
%D The value of the implementation-speciﬁ c default path.

If a path is passed to XtResolvePathname, it is passed along to XtFindFile. If the path argument is NULL, the value of the XFILESEARCHPATH environment variable is passed to XtFindFile. If XFILESEARCHPATH is not deﬁ ned, an implementation-speciﬁ c default path is used that contains at least six entries. These entries must contain the following substitutions:

1. %C, %N, %S, %T, %L or %C, %N, %S, %T, %l, %t, %c
2. %C, %N, %S, %T, %l
3. %C, %N, %S, %T
4. %N, %S, %T, %L or %N, %S, %T, %l, %t, %c
5. %N, %S, %T, %l
6. %N, %S, %T

The order of these six entries within the path must be as given above. The order and use of substitutions within a given entry are implementation-dependent. If the path begins with a colon, it is
preceded by %N%S. If the path includes two adjacent colons, %N%S is inserted between them.
The type parameter is intended to be a category of files, usually being translated into a directory in the pathname. Possible values might include “app-defaults”, “help”, and “bitmap”.
The suffix parameter is intended to be appended to the file name. Possible values might include “.txt”, “.dat”, and “.bm”.

A suggested value for the default path on POSIX-based systems is
/usr/lib/X11/%L/%T/%N%C%S:/usr/lib/X11/%l/%T/%N%C%S:
/usr/lib/X11/%T/%N%C%S:/usr/lib/X11/%L/%T/%N%S:
/usr/lib/X11/%l/%T/%N%S:/usr/lib/X11/%T/%N%S

Using this example, if the user has specified a language, it is used as a subdirectory of /usr/lib/X11 that is searched for other files. If the desired file is not found there, the lookup is tried again using just the language part of the specification. If the file is not there, it is looked for in /usr/lib/X11. The type parameter is used as a subdirectory of the language directory or of /usr/lib/X11, and suffix is appended to the file name.
The %D substitution allows the addition of path elements to the implementation-specific default path, typically to allow additional directories to be searched without preventing resources in the system directories from being found. For example, a user installing resource files under a directory called “ourdir” might set XFILESEARCHPATH to
%D:ourdir/%T/%N%C:ourdir/%T/%N

The customization string is obtained by querying the resource database currently associated with the display (the database returned by XrmGetDatabase) for the resource application_name:customization, class application_class:Customization, where application_name and application_class are the values returned by XtGetApplicationNameAndClass. If no value is specified in the database, the empty string is used.

It is the responsibility of the caller to free the returned string using XtFree when it is no longer needed.

11.12. Hooks for External Agents
Applications may register functions that are called at a particular control points in the Intrinsics. These functions are intended to be used to provide notification of an “X Toolkit event”, such as widget creation, to an external agent, such as an interactive resource editor, drag-and-drop server, or an aid for physically challenged users. The control points containing such registration hooks are identified in a “hook registration” object.

To retrieve the hook registration widget, use XtHooksOfDisplay.

```
Widget XtHooksOfDisplay(display)
    Display *display;
```

declare

The class of this object is a private, implementation-dependent subclass of Object. The hook object has no parent. The resources of this object are the callback lists for hooks and the read-only resources for getting a list of parentless shells. All of the callback lists are initially empty. When a display is closed, the hook object associated with it is destroyed.
The following procedures can be called with the hook registration object as an argument:

XtAddCallback, XtAddCallbacks, XtRemoveCallback, XtRemoveCallbacks, XtRemoveAllCallbacks, XtCallCallbacks, XtHasCallbacks, XtCallbackList
11.12.1. Hook Object Resources

The resource names, classes, and representation types that are specified in the hook object resource list are:

<table>
<thead>
<tr>
<th>Name</th>
<th>Class</th>
<th>Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>XtNcreateHook</td>
<td>XtCCallback</td>
<td>XtRCallback</td>
</tr>
<tr>
<td>XtNchangeHook</td>
<td>XtCCallback</td>
<td>XtRCallback</td>
</tr>
<tr>
<td>XtNconfigureHook</td>
<td>XtCCallback</td>
<td>XtRCallback</td>
</tr>
<tr>
<td>XtNgeometryHook</td>
<td>XtCCallback</td>
<td>XtRCallback</td>
</tr>
<tr>
<td>XtNdestroyHook</td>
<td>XtCCallback</td>
<td>XtRCallback</td>
</tr>
<tr>
<td>XtNshells</td>
<td>XtCReadOnly</td>
<td>XtRWidgetList</td>
</tr>
<tr>
<td>XtNnumShells</td>
<td>XtCReadOnly</td>
<td>XtRCardinal</td>
</tr>
</tbody>
</table>

Descriptions of each of these resources:

The XtNcreateHook callback list is called from: XtCreateWidget, XtCreateManagedWidget, XtCreatePopupShell, XtAppCreateShell, and their corresponding varargs versions.

The call_data parameter in a createHook callback may be cast to type XtCreateHookData.

```c
typedef struct {
    String type;
    Widget widget;
    ArgList args;
    Cardinal num_args;
} XtCreateHookDataRec, *XtCreateHookData;
```

The type is set to XtHcreate, widget is the newly created widget, and args and num_args are the arguments passed to the create function. The callbacks are called before returning from the create function.

The XtNchangeHook callback list is called from:

XtSetValues, XtVaSetValues

XtManageChild, XtManageChildren, XtUnmanageChild, XtUnmanageChildren
XtRealizeWidget, XtUnrealizeWidget
XtAddCallback, XtRemoveCallback, XtAddCallbacks, XtRemoveCallbacks, XtRemoveAllCallbacks
XtAugmentTranslations, XtOverrideTranslations, XtUninstallTranslations
XtSetKeyboardFocus, XtSetWMColormapWindows
The `call_data` parameter in a changeHook callback may be cast to type `XtChangeHookData`.

```c
typedef struct {
    String type;
    Widget widget;
    XtPointer event_data;
    Cardinal num_event_data;
} XtChangeHookDataRec, *XtChangeHookData;
```

When the changeHook callbacks are called as a result of a call to `XtSetValues` or `XtVaSetValues`, `type` is set to `XtHsetValues`, `widget` is the new widget passed to the set_values procedure, and `event_data` may be cast to type `XtChangeHookSetValuesData`.

```c
typedef struct {
    Widget old, req;
    ArgList args;
    Cardinal num_args;
} XtChangeHookSetValuesDataRec, *XtChangeHookSetValuesData;
```

The `old`, `req`, `args`, and `num_args` are the parameters passed to the set_values procedure. The callbacks are called after the set_values and constraint set_values procedures have been called.

When the changeHook callbacks are called as a result of a call to `XtManageChild` or `XtManageChildren`, `type` is set to `XtHmanageChildren`, `widget` is the parent, `event_data` may be cast to type WidgetList and is the list of children being managed, and `num_event_data` is the length of the widget list. The callbacks are called after the children have been managed.

When the changeHook callbacks are called as a result of a call to `XtUnmanageChild` or `XtUnmanageChildren`, `type` is set to `XtHunmanageChildren`, `widget` is the parent, `event_data` may be cast to type WidgetList and is a list of the children being unmanaged, and `num_event_data` is the length of the widget list. The callbacks are called after the children have been unmanaged.

The changeHook callbacks are called twice as a result of a call to `XtChangeManagedSet`, once after unmanaging and again after managing. When the callbacks are called the first time, `type` is set to `XtHunmanageSet`, `widget` is the parent, `event_data` may be cast to type WidgetList and is a list of the children being unmanaged, and `num_event_data` is the length of the widget list.

When the callbacks are called the second time, the `type` is set to `XtHmanageSet`, `widget` is the parent, `event_data` may be cast to type WidgetList and is a list of the children being managed, and `num_event_data` is the length of the widget list.

When the changeHook callbacks are called as a result of a call to `XtRealizeWidget`, the `type` is set to `XtHrealizeWidget` and `widget` is the widget being realized. The callbacks are called after the widget has been realized.

When the changeHook callbacks are called as a result of a call to `XtUnrealizeWidget`, the `type` is set to `XtHunrealizeWidget`, and `widget` is the widget being unrealized. The callbacks are called after the widget has been unrealized.

When the changeHook callbacks are called as a result of a call to `XtAddCallback`, `type` is set to `XtHaddCallback`, `widget` is the widget to which the callback is being added, and `event_data` may be cast to type String and is the name of the callback being added. The callbacks are called after the callback has been added to the widget.
When the changeHook callbacks are called as a result of a call to 

**XtAddCallbacks**, the *type* is set to **XtHaddCallbacks**, *widget* is the widget to which the callbacks are being added, and *event_data* may be cast to type String and is the name of the callbacks being added. The callbacks are called after the callbacks have been added to the widget.

When the changeHook callbacks are called as a result of a call to **XtRemoveCallback**, the *type* is set to **XtHremoveCallback**, *widget* is the widget from which the callback is being removed, and *event_data* may be cast to type String and is the name of the callback being removed. The callbacks are called after the callback has been removed from the widget.

When the changeHook callbacks are called as a result of a call to **XtRemoveCallbacks**, the *type* is set to **XtHremoveCallbacks**, *widget* is the widget from which the callbacks are being removed, and *event_data* may be cast to type String and is the name of the callbacks being removed. The callbacks are called after the callbacks have been removed from the widget.

When the changeHook callbacks are called as a result of a call to **XtRemoveAllCallbacks**, the *type* is set to **XtHremoveAllCallbacks** and *widget* is the widget from which the callbacks are being removed. The callbacks are called after the callbacks have been removed from the widget.

When the changeHook callbacks are called as a result of a call to **XtAugmentTranslations**, the *type* is set to **XtHaugmentTranslations** and *widget* is the widget whose translations are being modified. The callbacks are called after the widget’s translations have been modified.

When the changeHook callbacks are called as a result of a call to **XtOverrideTranslations**, the *type* is set to **XtHoverrideTranslations** and *widget* is the widget whose translations are being modified. The callbacks are called after the widget’s translations have been modified.

When the changeHook callbacks are called as a result of a call to **XtUninstallTranslations**, the *type* is **XtHuninstallTranslations** and *widget* is the widget whose translations are being uninstalled. The callbacks are called after the widget’s translations have been uninstalled.

When the changeHook callbacks are called as a result of a call to **XtSetKeyboardFocus**, the *type* is set to **XtHsetKeyboardFocus** and *event_data* may be cast to type Widget and is the value of the descendant argument passed to **XtSetKeyboardFocus**. The callbacks are called before returning from **XtSetKeyboardFocus**.

When the changeHook callbacks are called as a result of a call to **XtSetWMColormapWindows**, the *type* is set to **XtHsetWMColormapWindows**, *event_data* may be cast to type WidgetList and is the value of the list argument passed to **XtSetWMColormapWindows**, and *num_event_data* is the length of the list. The callbacks are called before returning from **XtSetWMColormapWindows**.

When the changeHook callbacks are called as a result of a call to **XtSetMappedWhenManaged**, the *type* is set to **XtHsetMappedWhenManaged** and *event_data* may be cast to type Boolean and is the value of the mapped_when Managed argument passed to **XtSetMappedWhenManaged**. The callbacks are called after setting the widget’s mapped_when Managed field and before realizing or unrealizing the widget.

When the changeHook callbacks are called as a result of a call to **XtMapWidget**, the *type* is set to **XtHmapWidget** and *widget* is the widget being mapped. The callbacks are called after mapping the widget.

When the changeHook callbacks are called as a result of a call to **XtUnmapWidget**, the *type* is set to **Xt HunmapWidget** and *widget* is the widget being unmapped. The callbacks are called after unmapping the widget.

When the changeHook callbacks are called as a result of a call to **XtPopup**, the *type* is set to **XtHpopup**, *widget* is the widget being popped up, and *event_data* may be cast to type XtGrabKind and is the value of the grab_kind argument passed to **XtPopup**. The callbacks are called before returning from **XtPopup**.

When the changeHook callbacks are called as a result of a call to **XtPopupSpringLoaded**, the *type* is set to **XtHpopupSpringLoaded** and *widget* is the widget being popped up. The callbacks are called before returning from **XtPopupSpringLoaded**.
When the changeHook callbacks are called as a result of a call to `XtPopdown`, the `type` is set to `XtHpopdown` and `widget` is the widget being popped down. The callbacks are called before returning from `XtPopdown`.

A widget set that exports interfaces that change application state without employing the Intrinsics library should invoke the change hook itself. This is done by:

```c
XtCallCallbacks(XtHooksOfDisplay(dpy), XtNchangeHook, call_data);
```

The XtNconfigureHook callback list is called anytime the Intrinsics move, resize, or configure a widget and when `XtResizeWindow` is called. The `call_data` parameter may be cast to type `XtConfigureHookData`.

```c
typedef struct {
    String type;
    Widget widget;
    XtGeometryMask changeMask;
    XWindowChanges changes;
} XtConfigureHookDataRec, *XtConfigureHookData;
```

When the configureHook callbacks are called, the `type` is `XtHconfigure`, `widget` is the widget being configured, and `changeMask` and `changes` reflect the changes made to the widget. The callbacks are called after changes have been made to the widget.

The XtNgeometryHook callback list is called from `XtMakeGeometryRequest` and `XtMakeResizeRequest` once before and once after geometry negotiation occurs. The `call_data` parameter may be cast to type `XtGeometryHookData`.

```c
typedef struct {
    String type;
    Widget widget;
    XtWidgetGeometry* request;
    XtWidgetGeometry* reply;
    XtGeometryResult result;
} XtGeometryHookDataRec, *XtGeometryHookData;
```

When the geometryHook callbacks are called prior to geometry negotiation, the `type` is `XtHpreGeometry`, `widget` is the widget for which the request is being made, and `request` is the requested geometry. When the geometryHook callbacks are called after geometry negotiation, the `type` is `XtHpostGeometry`, `widget` is the widget for which the request was made, `request` is the requested geometry, `reply` is the resulting geometry granted, and `result` is the value returned from the geometry negotiation.

The XtNdestroyHook callback list is called when a widget is destroyed. The `call_data` parameter may be cast to type `XtDestroyHookData`.

```c
typedef struct {
    String type;
    Widget widget;
    XtWidgetGeometry* request;
    XtWidgetGeometry* reply;
    XtGeometryResult result;
} XtDestroyHookDataRec, *XtDestroyHookData;
```
typedef struct {
    String type;
    Widget widget;
} XtDestroyHookDataRec, *XtDestroyHookData;

When the destroyHook callbacks are called as a result of a call to XtDestroyWidget, the type is XtHdestroy and widget is the widget being destroyed. The callbacks are called upon completion of phase one destroy for a widget.

The XtNshells and XtnumShells are read-only resources that report a list of all parentless shell widgets associated with a display.

Clients who use these hooks must exercise caution in calling Intrinsics functions in order to avoid recursion.

11.12.2. Querying Open Displays
To retrieve a list of the Displays associated with an application context, use XtGetDisplays.

```c
void XtGetDisplays(app_context, dpy_return, num_dpy_return)
    XtAppContext app_context;
    Display ***dpy_return;
    Cardinal *num_dpy_return;
```

- `app_context` specifies the application context.
- `dpy_return` returns a list of open Display connections in the specified application context.
- `num_dpy_return` returns the count of open Display connections in `dpy_return`.

XtGetDisplays may be used by an external agent to query the list of open displays that belong to an application context. To free the list of displays, use XtFree.
Chapter 12
Nonwidget Objects

Although widget writers are free to treat Core as the base class of the widget hierarchy, there are actually three classes above it. These classes are Object, RectObj (Rectangle Object), and (unnamed), and members of these classes are referred to generically as \textit{objects}. By convention, the term \textit{widget} refers only to objects that are a subclass of Core, and the term \textit{nonwidget} refers to objects that are not a subclass of Core. In the preceding portion of this specification, the interface descriptions indicate explicitly whether the generic \textit{widget} argument is restricted to particular subclasses of Object. Sections 12.2.5, 12.3.5, and 12.5 summarize the permissible classes of the arguments to, and return values from, each of the Intrinsics routines.

12.1. Data Structures
In order not to conflict with previous widget code, the data structures used by nonwidget objects do not follow all the same conventions as those for widgets. In particular, the class records are not composed of parts but instead are complete data structures with filler for the widget fields they do not use. This allows the static class initializers for existing widgets to remain unchanged.

12.2. Object Objects
The Object object contains the definitions of fields common to all objects. It encapsulates the mechanisms for resource management. All objects and widgets are members of subclasses of Object, which is defined by the \texttt{ObjectClassPart} and \texttt{ObjectPart} structures.

12.2.1. ObjectClassPart Structure
The common fields for all object classes are defined in the \texttt{ObjectClassPart} structure. All fields have the same purpose, function, and restrictions as the corresponding fields in \texttt{CoreClassPart}; fields whose names are \texttt{obj}\texttt{n} for some integer \texttt{n} are not used for Object, but exist to pad the data structure so that it matches Core's class record. The class record initialization must fill all \texttt{obj}\texttt{n} fields with NULL or zero as appropriate to the type.
typedef struct _ObjectClassPart {
    WidgetClass superclass;
    String class_name;
    Cardinal widget_size;
    XtProc class_initialize;
    XtWidgetClassProc class_part_initialize;
    XtEnum class_inited;
    XtInitProc initialize;
    XtProc obj1;
    XtPointer obj2;
    Cardinal obj3;
    XtResourceList resources;
    Cardinal num_resources;
    XrmClass xrm_class;
    Boolean obj4;
    XtEnum obj5;
    Boolean obj6;
    Boolean obj7;
    XtWidgetProc destroy;
    XtProc obj8;
    XtProc obj9;
    XtSetValuesFunc set_values;
    XtArgsFunc set_values_hook;
    XtProc obj10;
    XtArgsProc get_values_hook;
    XtProc obj11;
    XtVersionType version;
    XtPointer callback_private;
    String obj12;
    XtProc obj13;
    XtProc obj14;
    XtPointer extension;
} ObjectClassPart;

The extension record defined for **ObjectClassPart** with a **record_type** equal to **NULLQUARK** is **ObjectClassExtensionRec**.

typedef struct {
    XtPointer next_extension; /* See Section 1.6.12 */
    XrmQuark record_type; /* See Section 1.6.12 */
    long version; /* See Section 1.6.12 */
    Cardinal record_size; /* See Section 1.6.12 */
    XtAllocateProc allocate; /* See Section 2.5.5. */
    XtDeallocateProc deallocate; /* See Section 2.8.4. */
} ObjectClassExtensionRec, *ObjectClassExtension;

The prototypical **ObjectClass** consists of just the **ObjectClassPart**.
typedef struct _ObjectClassRec {
    ObjectClassPart object_class;
} ObjectClassRec, *ObjectClass;

The predefined class record and pointer for ObjectClassRec are
In IntrinsicP.h:

extern ObjectClassRec objectClassRec;

In Intrinsic.h:

extern WidgetClass objectClass;

The opaque types Object and ObjectClass and the opaque variable objectClass are defined for
generic actions on objects. The symbolic constant for the ObjectClassExtension version identi-
fi er is XtObjectExtensionVersion (see Section 1.6.12). Intrinsic.h uses an incomplete structure
definition to ensure that the compiler catches attempts to access private data:

typedef struct _ObjectClassRec* ObjectClass;

12.2.2. ObjectPart Structure
The common fields for all object instances are defined in the ObjectPart structure. All fields
have the same meaning as the corresponding fields in CorePart.

typedef struct _ObjectPart {
    Widget self;
    WidgetClass widget_class;
    Widget parent;
    Boolean being_destroyed;
    XtCallbackList destroy_callbacks;
    XtPointer constraints;
} ObjectPart;

All object instances have the Object fields as their first component. The prototypical type Object
is defined with only this set of fields. Various routines can cast object pointers, as needed, to spe-
cific object types.
In IntrinsicP.h:

typedef struct _ObjectRec {
    ObjectPart object;
} ObjectRec, *Object;
In *Intrinsic.h*:

typedef struct _ObjectRec *Object;

### 12.2.3. Object Resources

The resource names, classes, and representation types specified in the `objectClassRec` resource list are:

<table>
<thead>
<tr>
<th>Name</th>
<th>Class</th>
<th>Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>XtNdestroyCallback</td>
<td>XtCCallback</td>
<td>XtRCallback</td>
</tr>
</tbody>
</table>

### 12.2.4. ObjectPart Default Values

All fields in `ObjectPart` have the same default values as the corresponding fields in `CorePart`.

### 12.2.5. Object Arguments to Intrinsics Routines

The WidgetClass arguments to the following procedures may be `objectClass` or any subclass:

- `XtInitializeWidgetClass`, `XtCreateWidget`, `XtVaCreateWidget`  
- `XtIsSubclass`, `XtCheckSubclass`  
- `XtGetResourceList`, `XtGetConstraintResourceList`  

The Widget arguments to the following procedures may be of class Object or any subclass:

- `XtAddCallback`, `XtAddCallbacks`, `XtRemoveCallback`, `XtRemoveCallbacks`, `XtRemoveAllCallbacks`, `XtCallCallbacks`, `XtHasCallbacks`, `XtCallablebackList`  
- `XtClass`, `XtSuperclass`, `XtIsSubclass`, `XtCheckSubclass`, `XtIsObject`, `XtIsRectObj`, `XtIsWidget`, `XtIsComposite`, `XtIsConstraint`, `XtIsShell`, `XtIsOverrideShell`, `XtIsWMShell`, `XtIsVendorShell`, `XtIsTransientShell`, `XtIsToplevelShell`, `XtIsApplicationShell`, `XtIsSessionShell`  
- `XtIsManaged`, `XtIsSensitive`  
  (both will return `False` if argument is not a subclass of RectObj)  
- `XtIsRealized`  
  (returns the state of the nearest windowed ancestor if class of argument is not a subclass of Core)  
- `XtWidgetToApplicationContext`  
- `XtDestroyWidget`  
- `XtParent`, `XtDisplayOfObject`, `XtScreenOfObject`, `XtWindowOfObject`
X Toolkit Intrinsics

XtSetKeyboardFocus (descendant)
XtGetGC, XtReleaseGC
XtName
XtSetValues, XtGetValues, XtVaSetValues, XtVaGetValues
XtGetSubresources, XtGetApplicationResources, XtVaGetSubresources, XtVaGetApplicationResources
XtConvert, XtConvertAndStore

The return value of the following procedures will be of class Object or a subclass:

XtCreateWidget, XtVaCreateWidget
XtParent
XtNameToWidget

The return value of the following procedures will be objectClass or a subclass:

XtClass, XtSuperclass

12.2.6. Use of Objects

The Object class exists to enable programmers to use the Intrinsics’ classing and resource-handling mechanisms for things smaller and simpler than widgets. Objects make obsolete many common uses of subresources as described in Sections 9.4, 9.7.2.4, and 9.7.2.5.

Composite widget classes that wish to accept nonwidget children must set the accepts_objects field in the CompositeClassExtension structure to True. XtCreateWidget will otherwise generate an error message on an attempt to create a nonwidget child.

Of the classes defined by the Intrinsics, ApplicationShell and SessionShell accept nonwidget children, and the class of any nonwidget child must not be rectObjClass or any subclass. The intent of allowing Object children of ApplicationShell and SessionShell is to provide clients a simple mechanism for establishing the resource-naming root of an object hierarchy.

12.3. Rectangle Objects

The class of rectangle objects is a subclass of Object that represents rectangular areas. It encapsulates the mechanisms for geometry management and is called RectObj to avoid conflict with the Xlib Rectangle data type.

12.3.1. RectObjClassPart Structure

As with the ObjectClassPart structure, all fields in the RectObjClassPart structure have the same purpose and function as the corresponding fields in CoreClassPart; fields whose names are rectn for some integer n are not used for RectObj, but exist to pad the data structure so that it matches Core’s class record. The class record initialization must fill all rectn fields with NULL or zero as appropriate to the type.
typedef struct _RectObjClassPart {
    WidgetClass superclass;
    String class_name;
    Cardinal widget_size;
    XtProc class_initialize;
    XtWidgetClassProc class_part_initialize;
    XtEnum class_inited;
    XtInitProc initialize;
    XtArgsProc initialize_hook;
    XtProc rect1;
    XtPointer rect2;
    Cardinal rect3;
    XtResourceList resources;
    Cardinal num_resources;
    XrmClass xrm_class;
    Boolean rect4;
    XtEnum rect5;
    Boolean rect6;
    Boolean rect7;
    XtWidgetProc destroy;
    XtWidgetProc resize;
    XtExposeProc expose;
    XtSetValuesFunc set_values;
    XtArgsFunc set_values_hook;
    XtAlmostProc set_values_almost;
    XtArgsProc get_values_hook;
    XtProc rect9;
    XtVersionType version;
    XtPointer callback_private;
    String rect10;
    XtGeometryHandler query_geometry;
    XtProc rect11;
    XtPointer extension;
} RectObjClassPart;

The RectObj class record consists of just the RectObjClassPart.

typedef struct _RectObjClassRec {
    RectObjClassPart rect_class;
} RectObjClassRec, *RectObjClass;

The predefined class record and pointer for RectObjClassRec are
In Intrinsic.h:

extern RectObjClassRec rectObjClassRec;

In Intrinsic.h:
The opaque types `RectObj` and `RectObjClass` and the opaque variable `rectObjClass` are defined for generic actions on objects whose class is RectObj or a subclass of RectObj. Intrinsics.h uses an incomplete structure definition to ensure that the compiler catches attempts to access private data:

```c
typedef struct _RectObjClassRec* RectObjClass;
```

### 12.3.2. RectObjPart Structure

In addition to the `ObjectPart` fields, RectObj objects have the following fields defined in the `RectObjPart` structure. All fields have the same meaning as the corresponding field in `CorePart`.

```c
typedef struct _RectObjPart {
    Position x, y;
    Dimension width, height;
    Dimension border_width;
    Boolean managed;
    Boolean sensitive;
    Boolean ancestor_sensitive;
} RectObjPart;
```

RectObj objects have the RectObj fields immediately following the Object fields.

```c
typedef struct _RectObjRec {
    ObjectPart object;
    RectObjPart rectangle;
} RectObjRec, *RectObj;
```

In Intrinsics.h:

```c
typedef struct _RectObjRec* RectObj;
```

### 12.3.3. RectObj Resources

The resource names, classes, and representation types that are specified in the `rectObjClassRec` resource list are:

<table>
<thead>
<tr>
<th>Name</th>
<th>Class</th>
<th>Representation</th>
</tr>
</thead>
</table>

---

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12.3.4. **RectObjPart Default Values**

All fields in *RectObjPart* have the same default values as the corresponding fields in *CorePart*.

12.3.5. **Widget Arguments to Intrinsics Routines**

The WidgetClass arguments to the following procedures may be *rectObjClass* or any subclass:

- `XtCreateManagedWidget`, `XtVaCreateManagedWidget`

The Widget arguments to the following procedures may be of class RectObj or any subclass:

- `XtConfigureWidget`, `XtMoveWidget`, `XtResizeWidget`
- `XtMakeGeometryRequest`, `XtMakeResizeRequest`
- `XtManageChildren`, `XtManageChild`, `XtUnmanageChildren`, `XtUnmanageChild`, `XtChangeManagedSet`
- `XtQueryGeometry`
- `XtSetSensitive`
- `XtTranslateCoords`

The return value of the following procedures will be of class RectObj or a subclass:

- `XtCreateManagedWidget`, `XtVaCreateManagedWidget`

12.3.6. **Use of Rectangle Objects**

RectObj can be subclassed to provide widgetlike objects (sometimes called gadgets) that do not use windows and do not have those features that are seldom used in simple widgets. This can save memory resources both in the server and in applications but requires additional support code in the parent. In the following discussion, *rectobj* refers only to objects whose class is RectObj or a subclass of RectObj, but not Core or a subclass of Core.

Composite widget classes that wish to accept rectobj children must set the *accepts_objects* field in the *CompositeClassExtension* extension structure to `True`. `XtCreateWidget` or `XtCreateManagedWidget` will otherwise generate an error if called to create a nonwidget child. If the composite widget supports only children of class RectObj or a subclass (i.e., not of the general Object class), it must declare an `insert_child` procedure and check the subclass of each new child in that procedure. None of the classes defined by the Intrinsics accept rectobj children.

If gadgets are defined in an object set, the parent is responsible for much more than the parent of a widget. The parent must request and handle input events that occur for the gadget and is responsible for making sure that when it receives an exposure event the gadget children get drawn.
correctly. Rectobj children may have expose procedures specified in their class records, but the parent is free to ignore them, instead drawing the contents of the child itself. This can potentially save graphics context switching. The precise contents of the exposure event and region arguments to the RectObj expose procedure are not specified by the Intrinsics; a particular rectangle object is free to define the coordinate system origin (self-relative or parent-relative) and whether or not the rectangle or region is assumed to have been intersected with the visible region of the object.

In general, it is expected that a composite widget that accepts nonwidget children will document those children it is able to handle, since a gadget cannot be viewed as a completely self-contained entity, as can a widget. Since a particular composite widget class is usually designed to handle nonwidget children of only a limited set of classes, it should check the classes of newly added children in its insert_child procedure to make sure that it can deal with them.

The Intrinsics will clear areas of a parent window obscured by rectobj children, causing exposure events, under the following circumstances:

- A rectobj child is managed or unmanaged.
- In a call to XtSetValues on a rectobj child, one or more of the set_values procedures returns True.
- In a call to XtConfigureWidget on a rectobj child, areas will be cleared corresponding to both the old and the new child geometries, including the border, if the geometry changes.
- In a call to XtMoveWidget on a rectobj child, areas will be cleared corresponding to both the old and the new child geometries, including the border, if the geometry changes.
- In a call to XtResizeWidget on a rectobj child, a single rectangle will be cleared corresponding to the larger of the old and the new child geometries if they are different.
- In a call to XtMakeGeometryRequest (or XtMakeResizeRequest) on a rectobj child with XtQueryOnly not set, if the manager returns XtGeometryYes, two rectangles will be cleared corresponding to both the old and the new child geometries.

Stacking order is not supported for rectobj children. Composite widgets with rectobj children are free to define any semantics desired if the child geometries overlap, including making this an error.

When a rectobj is playing the role of a widget, developers must be reminded to avoid making assumptions about the object passed in the Widget argument to a callback procedure.

12.4. Undeclared Class

The Intrinsics define an unnamed class between RectObj and Core for possible future use by the X Consortium. The only assumptions that may be made about the unnamed class are

- The core_class.superclass field of coreWidgetClassRec contains a pointer to the unnamed class record.
- A pointer to the unnamed class record when dereferenced as an ObjectClass will contain a pointer to rectObjClassRec in its object_class.superclass field.

Except for the above, the contents of the class record for this class and the result of an attempt to subclass or to create a widget of this unnamed class are undefined.

12.5. Widget Arguments to Intrinsics Routines

The WidgetClass arguments to the following procedures must be of class Shell or a subclass:

XtCreatePopupShell, XtVaCreatePopupShell, XtAppCreateShell, XtVaAppCreateShell, XtOpenApplication, XtVaOpenApplication
The Widget arguments to the following procedures must be of class Core or any subclass:

- XtCreatePopupShell, XtVaCreatePopupShell
- XtAddEventHandler, XtAddRawEventHandler, XtRemoveEventHandler,
  XtRemoveRawEventHandler, XtInsertEventHandler, XtInsertRawEventHandler
- XtInsertEventTypeHandler, XtRemoveEventTypeHandler
- XtRegisterDrawable, XtDispatchEventToWidget
- XtAddGrab, XtRemoveGrab, XtGrabKey, XtGrabKeyboard, XtUngrabKey, XtUn-
  grabKeyboard, XtGrabButton, XtGrabPointer, XtUngrabButton,
  XtUngrabPointer
- XtBuildEventMask
- XtCreateWindow, XtDisplay, XtScreen, XtWindow
- XtNameToWidget
- XtGetSelectionValue, XtGetSelectionValues, XtOwnSelection, XtDisownSelection,
  XtOwnSelectionIncremental, XtGetSelectionValueIncremental, XtGetSelectionVal-
  uesIncremental,
- XtGetSelectionRequest
- XtInstallAccelerators, XtInstallAllAccelerators (both destination and source)
- XtAugmentTranslations, XtOverrideTranslations, XtUninstallTranslations,
  XtCallActionProc
- XtMapWidget, XtUnmapWidget
- XtRealizeWidget, XtUnrealizeWidget
- XtSetMappedWhenManaged
- XtCallAcceptFocus, XtSetKeyboardFocus (subtree)
- XtResizeWindow
- XtSetWMColormapWindows

The Widget arguments to the following procedures must be of class Composite or any subclass:

- XtCreateManagedWidget, XtVaCreateManagedWidget

The Widget arguments to the following procedures must be of a subclass of Shell:

- XtPopdown, XtCallbackPopdown, XtPopup, XtCallbackNone, XtCallbackNonexclu-
  sive, XtCallbackExclusive, XtPopupSpringLoaded

The return value of the following procedure will be of class Core or a subclass:

- XtWindowToWidget

The return value of the following procedures will be of a subclass of Shell:

- XtAppCreateShell, XtVaAppCreateShell, XtAppInitialize, XtVaAppInitialize, XtCre-
  atePopupShell, XtVaCreatePopupShell
Chapter 13
Evolution of the Intrinsics

The interfaces described by this specification have undergone several sets of revisions in the course of adoption as an X Consortium standard specification. Having now been adopted by the Consortium as a standard part of the X Window System, it is expected that this and future revisions will retain backward compatibility in the sense that fully conforming implementations of these specifications may be produced that provide source compatibility with widgets and applications written to previous Consortium standard revisions.

The Intrinsics do not place any special requirement on widget programmers to retain source or binary compatibility for their widgets as they evolve, but several conventions have been established to assist those developers who want to provide such compatibility.

In particular, widget programmers may wish to conform to the convention described in Section 1.6.12 when defining class extension records.

13.1. Determining Specification Revision Level

Widget and application developers who wish to maintain a common source pool that will build properly with implementations of the Intrinsics at different revision levels of these specifications but that take advantage of newer features added in later revisions may use the symbolic macro `XtSpecificationRelease`.

```c
#define XtSpecificationRelease 6
```

As the symbol `XtSpecificationRelease` was new to Release 4, widgets and applications desiring to build against earlier implementations should test for the presence of this symbol and assume only Release 3 interfaces if the definition is not present.

13.2. Release 3 to Release 4 Compatibility

At the data structure level, Release 4 retains binary compatibility with Release 3 (the first X Consortium standard release) for all data structures except `WMShellPart`, `TopLevelShellPart`, and `TransientShellPart`. Release 4 changed the argument type to most procedures that now take arguments of type `XtPointer` and structure members that are now of type `XtPointer` in order to avoid potential ANSI C conformance problems. It is expected that most implementations will be binary compatible with the previous definition.

Two fields in `CoreClassPart` were changed from `Boolean` to `XtEnum` to allow implementations additional freedom in specifying the representations of each. This change should require no source modification.

13.2.1. Additional Arguments

Arguments were added to the procedure definitions for `XtInitProc`, `XtSetValuesFunc`, and `XtEventHandler` to provide more information and to allow event handlers to abort further dispatching of the current event (caution is advised!). The added arguments to `XtInitProc` and `XtSetValuesFunc` make the initialize_hook and set_values_hook methods obsolete, but the hooks have been retained for those widgets that used them in Release 3.
13.2.2. set_values_almost Procedures

The use of the arguments by a set_values_almost procedure was poorly described in Release 3 and was inconsistent with other conventions.

The current specification for the manner in which a set_values_almost procedure returns information to the Intrinsics is not compatible with the Release 3 specification, and all widget implementations should verify that any set_values_almost procedures conform to the current interface.

No known implementation of the Intrinsics correctly implemented the Release 3 interface, so it is expected that the impact of this specification change is small.

13.2.3. Query Geometry

A composite widget layout routine that calls XtQueryGeometry is now expected to store the complete new geometry in the intended structure; previously the specification said “store the changes it intends to make”. Only by storing the complete geometry does the child have any way to know what other parts of the geometry may still be flexible. Existing widgets should not be affected by this, except to take advantage of the new information.

13.2.4. unrealizeCallback Callback List

In order to provide a mechanism for widgets to be notified when they become unrealized through a call to XtUnrealizeWidget, the callback list name “unrealizeCallback” has been defined by the Intrinsics. A widget class that requires notification on unrealize may declare a callback list resource by this name. No class is required to declare this resource, but any class that did so in a prior revision may find it necessary to modify the resource name if it does not wish to use the new semantics.

13.2.5. Subclasses of WMShell

The formal adoption of the Inter-Client Communication Conventions Manual as an X Consortium standard has meant the addition of four fields to WMShellPart and one field to TopLevelShellPart. In deference to some widget libraries that had developed their own additional conventions to provide binary compatibility, these five new fields were added at the end of the respective data structures.

To provide more convenience for TransientShells, a field was added to the previously empty TransientShellPart. On some architectures the size of the part structure will not have changed as a result of this.

Any widget implementation whose class is a subclass of TopLevelShell or TransientShell must at minimum be recompiled with the new data structure declarations. Because WMShellPart no longer contains a contiguous XSizeHints data structure, a subclass that expected to do a single structure assignment of an XSizeHints structure to the size_hints field of WMShellPart must be revised, though the old fields remain at the same positions within WMShellPart.

13.2.6. Resource Type Converters

A new interface declaration for resource type converters was defined to provide more information to converters, to support conversion cache cleanup with resource reference counting, and to allow additional procedures to be declared to free resources. The old interfaces remain (in the compatibility section), and a new set of procedures was defined that work only with the new type converter interface.

In the now obsolete old type converter interface, converters are reminded that they must return the size of the converted value as well as its address. The example indicated this, but the description
of XtConverter was incomplete.

13.2.7. KeySym Case Conversion Procedure
The specification for the XtCaseProc function type has been changed to match the Release 3 implementation, which included necessary additional information required by the function (a pointer to the display connection), and corrects the argument type of the source KeySym parameter. No known implementation of the Intrinsics implemented the previously documented interface.

13.2.8. Nonwidget Objects
Formal support for nonwidget objects is new to Release 4. A prototype implementation was latent in at least one Release 3 implementation of the Intrinsics, but the specification has changed somewhat. The most significant change is the requirement for a composite widget to declare the CompositeClassExtension record with the accepts_objects field set to True in order to permit a client to create a nonwidget child.

The addition of this extension field ensures that composite widgets written under Release 3 will not encounter unexpected errors if an application attempts to create a nonwidget child. In Release 4 there is no requirement that all composite widgets implement the extra functionality required to manage windowless children, so the accept_objects field allows a composite widget to declare that it is not prepared to do so.

13.3. Release 4 to Release 5 Compatibility
At the data structure level, Release 5 retains complete binary compatibility with Release 4. The specification of the ObjectPart, RectObjPart, CorePart, CompositePart, ShellPart, WMShellPart, TopLevelShellPart, and ApplicationShellPart instance records was made less strict to permit implementations to add internal fields to these structures. Any implementation that chooses to do so would, of course, force a recompilation. The Xlib specification for Xrm-Value and XrmOptionDescRec was updated to use a new type, XPointer, for the addr and value fields, respectively, to avoid ANSI C conformance problems. The definition of XPointer is binary compatible with the previous implementation.

13.3.1. baseTranslations Resource
A new pseudo-resource, XtNbaseTranslations, was defined to permit application developers to specify translation tables in application defaults files while still giving end users the ability to augment or override individual event sequences. This change will affect only those applications that wish to take advantage of the new functionality or those widgets that may have previously defined a resource named “baseTranslations”.

Applications wishing to take advantage of the new functionality would change their application defaults file, e.g., from

```plaintext
app.widget.translations: value
```

to

```plaintext
app.widget.baseTranslations: value
```

If it is important to the application to preserve complete compatibility of the defaults file between different versions of the application running under Release 4 and Release 5, the full translations can be replicated in both the “translations” and the “baseTranslations” resource.
13.3.2. Resource File Search Path

The current specification allows implementations greater flexibility in defining the directory structure used to hold the application class and per-user application defaults files. Previous specifications required the substitution strings to appear in the default path in a certain order, preventing sites from collecting all the files for a specific application together in one directory. The Release 5 specification allows the default path to specify the substitution strings in any order within a single path entry. Users will need to pay close attention to the documentation for the specific implementation to know where to find these files and how to specify their own XFILESEARCHPATH and XUSERFILESEARCHPATH values when overriding the system defaults.

13.3.3. Customization Resource

XtResolvePathname supports a new substitution string, %C, for specifying separate application class resource files according to arbitrary user-specified categories. The primary motivation for this addition was separate monochrome and color application class defaults files. The substitution value is obtained by querying the current resource database for the application resource name “customization”, class “Customization”. Any application that previously used this resource name and class will need to be aware of the possibly conflicting semantics.

13.3.4. Per-Screen Resource Database

To allow a user to specify separate preferences for each screen of a display, a per-screen resource specification string has been added and multiple resource databases are created; one for each screen. This will affect any application that modified the (formerly unique) resource database associated with the display subsequent to the Intrinsics database initialization. Such applications will need to be aware of the particular screen on which each shell widget is to be created.

Although the wording of the specification changed substantially in the description of the process by which the resource database(s) is initialized, the net effect is the same as in prior releases with the exception of the added per-screen resource specification string and the new customization substitution string in XtResolvePathname.

13.3.5. Internationalization of Applications

Internationalization as defined by ANSI is a technology that allows support of an application in a single locale. In adding support for internationalization to the Intrinsics the restrictions of this model have been followed. In particular, the new Intrinsics interfaces are designed not to preclude an application from using other alternatives. For this reason, no Intrinsics routine makes a call to establish the locale. However, a convenience routine to establish the locale at initialize time has been provided, in the form of a default procedure that must be explicitly installed if the application desires ANSI C locale behavior.

As many objects in X, particularly resource databases, now inherit the global locale when they are created, applications wishing to use the ANSI C locale model should use the new function XtSetLanguageProc to do so.

The internationalization additions also define event filters as a part of the Xlib Input Method specifications. The Intrinsics enable the use of event filters through additions to XtDispatchEvent. Applications that may not be dispatching all events through XtDispatchEvent should be reviewed in the context of this new input method mechanism.
In order to permit internationalization of error messages, the name and path of the error database file are now allowed to be implementation-dependent. No adequate standard mechanism has yet been suggested to allow the Intrinsics to locate the database from localization information supplied by the client.

The previous specification for the syntax of the language string specified by `xnilLanguage` has been dropped to avoid potential conflicts with other standards. The language string syntax is now implementation-defined. The example syntax cited is consistent with the previous specification.

### 13.3.6. Permanently Allocated Strings

In order to permit additional memory savings, an Xlib interface was added to allow the resource manager to avoid copying certain string constants. The Intrinsics specification was updated to explicitly require the Object `class_name`, `resource_name`, `resource_class`, `resource_type`, `default_type` in resource tables, Core actions string field, and Constraint `resource_name`, `resource_class`, `resource_type`, and `default_type` resource fields to be permanently allocated. This explicit requirement is expected to affect only applications that may create and destroy classes on the fly.

### 13.3.7. Arguments to Existing Functions

The `args` argument to `XtAppInitialize`, `XtVaAppInitialize`, `XtOpenDisplay`, `XtDisplayInitialize`, and `XtInitialize` were changed from `Cardinal*` to `int*` to conform to pre-existing convention and avoid otherwise annoying typecasting in ANSI C environments.

### 13.4. Release 5 to Release 6 Compatibility

At the data structure level, Release 6 retains binary compatibility with Release 5 for all data structures except `WMShellPart`. Three resources were added to the specification. The known implementations had unused space in the data structure, therefore on some architectures and implementations, the size of the part structure will not have changed as a result of this.

#### 13.4.1. Widget Internals

Two new widget methods for instance allocation and deallocation were added to the Object class. These new methods allow widgets to be treated as C++ objects in the C++ environment when an appropriate allocation method is specified or inherited by the widget class.

The textual descriptions of the processes of widget creation and widget destruction have been edited to provide clarification to widget writers. Widgets writers may have reason to rely on the specific order of the stages of widget creation and destruction; with that motivation, the specification now more exactly describes the process.

As a convenience, an interface to locate a widget class extension record on a linked list, `XtClassExtension`, has been added.

A new option to allow bundled changes to the managed set of a Composite widget is introduced in the Composite class extension record. Widgets that define a change_managed procedure that can accommodate additions and deletions to the managed set of children in a single invocation should set `allows_change_managed_set` to `True` in the extension record.

The wording of the process followed by `XtUnmanageChildren` has changed slightly to better handle changes to the managed set during phase 2 destroy processing.
A new exposure event compression flag, `XtExposeNoRegion`, was added. Many widgets specify exposure compression, but either ignore the actual damage region passed to the core expose procedure or use only the cumulative bounding box data available in the event. Widgets with expose procedures that do not make use of exact exposure region information can indicate that the Intrinsics need not compute the region.

### 13.4.2. General Application Development

`XtOpenApplication` is a new convenience procedure to initialize the toolkit, create an application context, open an X display connection, and create the root of the widget instance tree. It is identical to the interface it replaces, `XtAppInitialize`, in all respects except that it takes an additional argument specifying the widget class of the root shell to create. This interface is now the recommended one so that clients may easily become session participants. The old convenience procedures appear in the compatibility section.

The toolkit initialization function `XtToolkitInitialize` may be called multiple times without penalty.

In order to optimize changes in geometry to a set of geometry-managed children, a new interface, `XtChangeManagedSet`, has been added.

### 13.4.3. Communication with Window and Session Managers

The revision of the `Inter-Client Communication Conventions Manual` as an X Consortium standard has resulted in the addition of three fields to the specification of `WMShellPart`. These are `urgency`, `client_leader`, and `window_role`.

The adoption of the `X Session Management Protocol` as an X Consortium standard has resulted in the addition of a new shell widget, `SessionShell`, and an accompanying subclass verification interface, `XtIsSessionShell`. This widget provides support for communication between an application and a session manager, as well as a window manager. In order to preserve compatibility with existing subclasses of `ApplicationShell`, the `ApplicationShell` was subclassed to create the new widget class. The session protocol requires a modal response to certain checkpointing operations by participating applications. The `SessionShell` structures the application’s notification of and responses to messages from the session manager by use of various callback lists and by use of the new interfaces `XtSessionGetToken` and `XtSessionReturnToken`. There is also a new command line argument, `-xtsessionID`, which facilitates the session manager in restarting applications based on the Intrinsics.

The resource name and class strings defined by the Intrinsics shell widgets in `<X11/Shell.h>` are now listed in Appendix E. The addition of a new symbol for the `WMShell wait for wm` resource was made to bring the external symbol and the string it represents into agreement. The actual resource name string in `WMShell` has not changed. The resource representation type of the `XtNwinGravity resource of the WMShell` was changed to `XtRGravity` in order to register a type converter so that window gravity resource values could be specified by name.

### 13.4.4. Geometry Management

A clarification to the specification was made to indicate that geometry requests may include current values along with the requested changes.

### 13.4.5. Event Management

In Release 6, support is provided for registering selectors and event handlers for events generated by X protocol extensions and for dispatching those events to the appropriate widget. The new event handler registration interfaces are `XtInsertEventTypeHandler` and
XtRemoveEventTypeHandler. Since the mechanism to indicate selection of extension events is specific to the extension being used, the Intrinsics introduces XtRegisterExtensionSelector, which allows the application to select for the events of interest. In order to change the dispatching algorithm to accommodate extension events as well as core X protocol events, the Intrinsics event dispatcher may now be replaced or enveloped by the application with XtSetEventDispatcher. The dispatcher may wish to call XtGetKeyboardFocusWidget to determine the widget with the current Intrinsics keyboard focus. A dispatcher, after determining the destination widget, may use XtDispatchEventToWidget to cause the event to be dispatched to the event handlers registered by a specific widget.

To permit the dispatching of events for nonwidget drawables, such as pixmaps that are not associated with a widget’s window, XtRegisterDrawable and XtUnregisterDrawable have been added to the library. A related update was made to the description of XtWindowToWidget.

The library is now thread-safe, allowing one thread at a time to enter the library and protecting global data as necessary from concurrent use. Threaded toolkit applications are supported by the new interfaces XtToolkitThreadInitialize, XtAppLock, XtAppUnlock, XtAppSetExitFlag, and XtAppGetExitFlag. Widget writers may also use XtProcessLock and XtProcessUnlock.

Safe handling of POSIX signals and other asynchronous notifications is now provided by use of XtAppAddSignal, XtNoticeSignal, and XtRemoveSignal.

The application can receive notification of an impending block in the Intrinsics event manager by registering interest through XtAppAddBlockHook and XtRemoveBlockHook.

XtLastEventProcessed returns the most recent event passed to XtDispatchEvent for a specified display.

13.4.6. Resource Management

Resource converters are registered by the Intrinsics for window gravity and for three new resource types associated with session participation: RestartStyle, CommandArgArray and DirectoryString.

The file search path syntax has been extended to make it easier to include the default search path, which controls resource database construction, by using the new substitution string, %D.

13.4.7. Translation Management

The default key translator now recognizes the NumLock modifier. If NumLock is on and the second keysym is a keypad keysym (a standard keysym named with a “KP” prefix or a vendor-specific keysym in the hexadecimal range 0x11000000 to 0x1100FFFF), then the default key translator will use the first keysym if Shift and/or ShiftLock is on and will use the second keysym if neither is on. Otherwise, it will ignore NumLock and apply the normal protocol semantics.

13.4.8. Selections

The targets of selection requests may be parameterized, as described by the revised Inter-Client Communication Conventions Manual. When such requests are made, XtSetSelectionParameters is used by the requestor to specify the target parameters and XtGetSelectionParameters is used by the selection owner to retrieve the parameters. When a parameterized target is specified in the context of a bundled request for multiple targets, XtCreateSelectionRequest, XtCancelSelectionRequest, and XtSendSelectionRequest are used to envelop the assembly of the request. When the parameters themselves are the names of properties, the Intrinsics provides support for the economical use of property atom names; see XtReservePropertyAtom and XtReleasePropertyAtom.
13.4.9. External Agent Hooks

External agent hooks were added for the benefit of applications that instrument other applications for purposes of accessibility, testing, and customization. The external agent and the application communicate by a shared protocol which is transparent to the application. The hook callbacks permit the external agent to register interest in groups or classes of toolkit activity and to be notified of the type and details of the activity as it occurs. The new interfaces related to this effort are `XtHooksOfDisplay`, which returns the hook registration widget, and `XtGetDisplays`, which returns a list of the X displays associated with an application context.
Appendix A

Resource File Format

A resource file contains text representing the default resource values for an application or set of applications.

The format of resource files is defined by Xlib — C Language X Interface and is reproduced here for convenience only.

The format of a resource specification is

```
ResourceLine = Comment | IncludeFile | ResourceSpec | <empty line>
Comment = "!" {<any character except null or newline>}
IncludeFile = "#" WhiteSpace "include" WhiteSpace FileName WhiteSpace
FileName = <valid fi lename 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.

If the last character on a line is a backslash (\), that line is assumed to continue on the next line.

To allow a Value to begin with whitespace, 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 " \nnnn " , 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.
Appendix B
Translation Table Syntax

Notation
Syntax is specified in EBNF notation with the following conventions:

- \[a\] means either nothing or “a”
- \{a\} means zero or more occurrences of “a”
- (a | b) means either “a” or “b”
- \n is the newline character

All terminals are enclosed in double quotation marks (“ ’”). Informal descriptions are enclosed in angle brackets (< >).

Syntax
The syntax of a translation table is

\[
\begin{align*}
\text{translationTable} & = \{ \text{directive} \} \{ \text{production} \} \\
\text{directive} & = ( \#\text{replace’} | \#\text{override’} | \#\text{augment’}) \text{ ‘\n’} \\
\text{production} & = \text{lhs} \text{ ‘:’} \text{rhs} \text{ ‘\n’} \\
\text{lhs} & = ( \text{event} | \text{keyseq} ) \{ \text{‘,’} \text{(event} | \text{keyseq}) \} \\
\text{keyseq} & = \text{‘”} \text{keychar} \{ \text{keychar} \text{‘”} \} \\
\text{keychar} & = \{ \text{‘ } \text{‘^’ ‘$’ ‘\’}\text{< ISO Latin 1 character>} \} \\
\text{event} & = \text{[modifier_list]} \text{ ‘<’} \text{event_type}> \text{ ‘>’ } \{ \text{‘+’} \text{ count[‘+’] ‘} \} \text{ {detail} } \\
\text{modifier_list} & = \{ \text{‘!’} \text{ modifier_name}\} | \text{‘None’} \\
\text{modifier_name} & = \text{‘@’} \text{keysym} | \text{<see ModifierNames table below>} \\
\text{event_type} & = \text{<see Event Types table below>} \\
\text{detail} & = \text{<event specific details>} \\
\text{rhs} & = \{ \text{name ‘(’} \text{params} \text{‘)’} \} \\
\text{name} & = \text{namechar} \{ \text{namechar} \} \\
\text{namechar} & = \{ \text{‘a’} ‘z’ | ‘A’ ‘Z’ | ‘0’ ‘9’ | ‘_’ | ‘-’ \} \\
\text{params} & = \text{string} \{ ‘,’ \text{ string} \} \\
\text{string} & = \text{quoted_string} | \text{unquoted_string} \\
\text{quoted_string} & = \text{‘””} \text{<Latin 1 character> \text{escape_char} \text{[‘\\\’] ‘”’} \\
\text{escape_char} & = \text{‘\’’} \\
\text{unquoted_string} & = \{ \text{<Latin 1 character except space, tab, ‘,’ ‘\n’, ‘’}> \} \\
\end{align*}
\]

The params field is parsed into a list of String values that will be passed to the named action procedure. A quoted string may contain an embedded quotation mark if the quotation mark is preceded by a single backslash (\). The three-character sequence “\\” is interpreted as “single backslash followed by end-of-string”.

Modifier Names
The modifier field is used to specify standard X keyboard and button modifier mask bits. Modifiers are legal on event types KeyPress, KeyRelease, ButtonPress, ButtonRelease, MotionNotify, EnterNotify, LeaveNotify, and their abbreviations. An error is generated when a
If the modifier list has no entries and is not “None”, it means “don’t care” on all modifiers.

If an exclamation point (!) is specified at the beginning of the modifier list, it means that the listed modifiers must be in the correct state and no other modifiers can be asserted.

If any modifiers are specified and an exclamation point (!) is not specified, it means that the listed modifiers must be in the correct state and “don’t care” about any other modifiers.

If a modifier is preceded by a tilde (˜), it means that that modifier must not be asserted.

If “None” is specified, it means no modifiers can be asserted.

If a colon (:) is specified at the beginning of the modifier list, it directs the Intrinsics to apply any standard modifiers in the event to map the event keycode into a KeySym. The default standard modifiers are Shift and Lock, with the interpretation as defined in X Window System Protocol, Section 5. The resulting KeySym must exactly match the specified KeySym, and the nonstandard modifiers in the event must match the modifier list. For example, “:<Key>a” is distinct from “:<Key>A”, and “:Shift<Key>A” is distinct from “:<Key>A”.

If both an exclamation point (!) and a colon (:) are specified at the beginning of the modifier list, it means that the listed modifiers must be in the correct state and that no other modifiers except the standard modifiers can be asserted. Any standard modifiers in the event are applied as for colon (:) above.

If a colon (:) is not specified, no standard modifiers are applied. Then, for example, “:<Key>A” and “:<Key>a” are equivalent.

In key sequences, a circumflex (ˆ) is an abbreviation for the Control modifier, a dollar sign ($) is an abbreviation for Meta, and a backslash (\) can be used to quote any character, in particular a double quote ("), a circumflex (ˆ), a dollar sign ($), and another backslash (\). Briefly:

<table>
<thead>
<tr>
<th>No modifiers:</th>
<th>None &lt;event&gt; detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any modifiers:</td>
<td>&lt;event&gt; detail</td>
</tr>
<tr>
<td>Only these modifiers:</td>
<td>! mod1 mod2 &lt;event&gt; detail</td>
</tr>
<tr>
<td>These modifiers and any others:</td>
<td>mod1 mod2 &lt;event&gt; detail</td>
</tr>
</tbody>
</table>

The use of “None” for a modifier list is identical to the use of an exclamation point with no modifiers.

<table>
<thead>
<tr>
<th>Modifier</th>
<th>Abbreviation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ctrl</td>
<td>c</td>
<td>Control modifier bit</td>
</tr>
<tr>
<td>Shift</td>
<td>s</td>
<td>Shift modifier bit</td>
</tr>
<tr>
<td>Lock</td>
<td>l</td>
<td>Lock modifier bit</td>
</tr>
<tr>
<td>Meta</td>
<td>m</td>
<td>Meta key modifier</td>
</tr>
<tr>
<td>Hyper</td>
<td>h</td>
<td>Hyper key modifier</td>
</tr>
<tr>
<td>Super</td>
<td>su</td>
<td>Super key modifier</td>
</tr>
<tr>
<td>Alt</td>
<td>a</td>
<td>Alt key modifier</td>
</tr>
<tr>
<td>Mod1</td>
<td>Mod1</td>
<td>Mod1 modifier bit</td>
</tr>
<tr>
<td>Mod2</td>
<td>Mod2</td>
<td>Mod2 modifier bit</td>
</tr>
<tr>
<td>Mod3</td>
<td>Mod3</td>
<td>Mod3 modifier bit</td>
</tr>
<tr>
<td>Mod4</td>
<td>Mod4</td>
<td>Mod4 modifier bit</td>
</tr>
<tr>
<td>Mod5</td>
<td>Mod5</td>
<td>Mod5 modifier bit</td>
</tr>
<tr>
<td>Button1</td>
<td>Button1</td>
<td>Button1 modifier bit</td>
</tr>
<tr>
<td>Button2</td>
<td>Button2</td>
<td>Button2 modifier bit</td>
</tr>
<tr>
<td>Button3</td>
<td>Button3</td>
<td>Button3 modifier bit</td>
</tr>
</tbody>
</table>
Modifier Abbreviation Meaning

<table>
<thead>
<tr>
<th>Modifier</th>
<th>Abbreviation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Button4</td>
<td></td>
<td>Button4 modifier bit</td>
</tr>
<tr>
<td>Button5</td>
<td></td>
<td>Button5 modifier bit</td>
</tr>
<tr>
<td>None</td>
<td></td>
<td>No modifiers</td>
</tr>
<tr>
<td>Any</td>
<td></td>
<td>Any modifier combination</td>
</tr>
</tbody>
</table>

A key modifier is any modifier bit one of whose corresponding KeyCode contains the corresponding left or right KeySym. For example, “m” or “Meta” means any modifier bit mapping to a KeyCode whose KeySym list contains XK_Meta_L or XK_Meta_R. Note that this interpretation is for each display, not global or even for each application context. The Control, Shift, and Lock modifier names refer explicitly to the corresponding modifier bits; there is no additional interpretation of KeySyms for these modifiers.

Because it is possible to associate arbitrary KeySym with modifiers, the set of key modifiers is extensible. The “@” <keysym> syntax means any modifier bit whose corresponding KeyCode contains the specified KeySym name.

A modifier_list/KeySym combination in a translation matches a modifiers/KeyCode combination in an event in the following ways:

1. If a colon (:) is used, the Intrinsics call the display’s \texttt{XtKeyProc} with the KeyCode and modifiers. To match, (modifiers & modifiers\_return) must equal modifier\_list, and keysym\_return must equal the given KeySym.

2. If (:) is not used, the Intrinsics mask off all don’t-care bits from the modifiers. This value must be equal to modifier\_list. Then, for each possible combination of don’t-care modifiers in the modifier\_list, the Intrinsics call the display’s \texttt{XtKeyProc} with the KeyCode and that combination ORed with the cared-about modifier bits from the event. Keysym\_return must match the KeySym in the translation.

**Event Types**

The event-type field describes XEvent types. In addition to the standard Xlib symbolic event type names, the following event type synonyms are defined:

<table>
<thead>
<tr>
<th>Type</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key</td>
<td>KeyPress</td>
</tr>
<tr>
<td>KeyDown</td>
<td>KeyPress</td>
</tr>
<tr>
<td>KeyUp</td>
<td>KeyRelease</td>
</tr>
<tr>
<td>BtnDown</td>
<td>ButtonPress</td>
</tr>
<tr>
<td>BtnUp</td>
<td>ButtonRelease</td>
</tr>
<tr>
<td>Motion</td>
<td>MotionNotify</td>
</tr>
<tr>
<td>PrtMoved</td>
<td>MotionNotify</td>
</tr>
<tr>
<td>MouseMoved</td>
<td>MotionNotify</td>
</tr>
<tr>
<td>Enter</td>
<td>EnterNotify</td>
</tr>
<tr>
<td>EnterWindow</td>
<td>EnterNotify</td>
</tr>
<tr>
<td>Leave</td>
<td>LeaveNotify</td>
</tr>
<tr>
<td>LeaveWindow</td>
<td>LeaveNotify</td>
</tr>
<tr>
<td>FocusIn</td>
<td>FocusIn</td>
</tr>
<tr>
<td>FocusOut</td>
<td>FocusOut</td>
</tr>
<tr>
<td>Keymap</td>
<td>KeymapNotify</td>
</tr>
<tr>
<td>Expose</td>
<td>Expose</td>
</tr>
<tr>
<td>GrExp</td>
<td>GraphicsExpose</td>
</tr>
<tr>
<td>Type</td>
<td>Meaning</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>NoExp</td>
<td>NoExpose</td>
</tr>
<tr>
<td>Visible</td>
<td>VisibilityNotify</td>
</tr>
<tr>
<td>Create</td>
<td>CreateNotify</td>
</tr>
<tr>
<td>Destroy</td>
<td>DestroyNotify</td>
</tr>
<tr>
<td>Unmap</td>
<td>UnmapNotify</td>
</tr>
<tr>
<td>Map</td>
<td>MapNotify</td>
</tr>
<tr>
<td>MapReq</td>
<td>MapRequest</td>
</tr>
<tr>
<td>Reparent</td>
<td>ReparentNotify</td>
</tr>
<tr>
<td>Confgure</td>
<td>ConfgureNotify</td>
</tr>
<tr>
<td>ConfgureReq</td>
<td>ConfgureRequest</td>
</tr>
<tr>
<td>Grav</td>
<td>GravityNotify</td>
</tr>
<tr>
<td>ResReq</td>
<td>ResizeRequest</td>
</tr>
<tr>
<td>Circ</td>
<td>CirculateNotify</td>
</tr>
<tr>
<td>CircReq</td>
<td>CirculateRequest</td>
</tr>
<tr>
<td>Prop</td>
<td>PropertyNotify</td>
</tr>
<tr>
<td>SelClr</td>
<td>SelectionClear</td>
</tr>
<tr>
<td>SelReq</td>
<td>SelectionRequest</td>
</tr>
<tr>
<td>Select</td>
<td>SelectionNotify</td>
</tr>
<tr>
<td>Clrmap</td>
<td>ColormapNotify</td>
</tr>
<tr>
<td>Message</td>
<td>ClientMessage</td>
</tr>
<tr>
<td>Mapping</td>
<td>MappingNotify</td>
</tr>
</tbody>
</table>

The supported abbreviations are:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Event Type</th>
<th>Including</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ctrl</td>
<td>KeyPress</td>
<td>with Control modifier</td>
</tr>
<tr>
<td>Meta</td>
<td>KeyPress</td>
<td>with Meta modifier</td>
</tr>
<tr>
<td>Shift</td>
<td>KeyPress</td>
<td>with Shift modifier</td>
</tr>
<tr>
<td>Btn1Down</td>
<td>ButtonPress</td>
<td>with Button1 detail</td>
</tr>
<tr>
<td>Btn1Up</td>
<td>ButtonRelease</td>
<td>with Button1 detail</td>
</tr>
<tr>
<td>Btn2Down</td>
<td>ButtonPress</td>
<td>with Button2 detail</td>
</tr>
<tr>
<td>Btn2Up</td>
<td>ButtonRelease</td>
<td>with Button2 detail</td>
</tr>
<tr>
<td>Btn3Down</td>
<td>ButtonPress</td>
<td>with Button3 detail</td>
</tr>
<tr>
<td>Btn3Up</td>
<td>ButtonRelease</td>
<td>with Button3 detail</td>
</tr>
<tr>
<td>Btn4Down</td>
<td>ButtonPress</td>
<td>with Button4 detail</td>
</tr>
<tr>
<td>Btn4Up</td>
<td>ButtonRelease</td>
<td>with Button4 detail</td>
</tr>
<tr>
<td>Btn5Down</td>
<td>ButtonPress</td>
<td>with Button5 detail</td>
</tr>
<tr>
<td>Btn5Up</td>
<td>ButtonRelease</td>
<td>with Button5 detail</td>
</tr>
<tr>
<td>BtnMotion</td>
<td>MotionNotify</td>
<td>with any button modifier</td>
</tr>
<tr>
<td>Btn1Motion</td>
<td>MotionNotify</td>
<td>with Button1 modifier</td>
</tr>
<tr>
<td>Btn2Motion</td>
<td>MotionNotify</td>
<td>with Button2 modifier</td>
</tr>
<tr>
<td>Btn3Motion</td>
<td>MotionNotify</td>
<td>with Button3 modifier</td>
</tr>
<tr>
<td>Btn4Motion</td>
<td>MotionNotify</td>
<td>with Button4 modifier</td>
</tr>
<tr>
<td>Btn5Motion</td>
<td>MotionNotify</td>
<td>with Button5 modifier</td>
</tr>
</tbody>
</table>

The detail field is event-specific and normally corresponds to the detail field of the corresponding event as described by *X Window System Protocol*, Section 11. The detail field is supported for the following event types:
If the event type is **KeyPress** or **KeyRelease**, the detail field specifies a KeySym name in standard format which is matched against the event as described above, for example, `<Key>A`.

For the **PropertyNotify**, **SelectionClear**, **SelectionRequest**, **SelectionNotify**, and **ClientMessage** events the detail field is specified as an atom name; for example, `<Message>WM_PROTOCOLS`. For the **MotionNotify**, **EnterNotify**, **LeaveNotify**, **FocusIn**, **FocusOut**, and **MappingNotify** events, either the symbolic constants as defined by X Window System Protocol, Section 11, or the numeric values may be specified.

If no detail field is specified, then any value in the event detail is accepted as a match.

A KeySym can be specified as any of the standard KeySym names, a hexadecimal number prefixed with "0x" or "0X", an octal number prefixed with "0", or a decimal number. A KeySym expressed as a single digit is interpreted as the corresponding Latin 1 KeySym, for example, "0" is the KeySym XK_0. Other single character KeySysms are treated as literal constants from Latin 1, for example, "!" is treated as 0x21. Standard KeySym names are as defined in `<X11/keysymdef.h>` with the "XK_" prefix removed.

### Canonical Representation

Every translation table has a unique, canonical text representation. This representation is passed to a widget’s `display_accelerator` procedure to describe the accelerators installed on that widget. The canonical representation of a translation table is (see also “Syntax”)

```plaintext
translationTable = { production } 
production = { lhs “:” rhs “\n” } 
  lhs = event { “,” event } 
  event = [modifie r_list] “<”event_type”>” [“(” count[“+”] “)” ] { detail } 
  modifie r_list = [“!”] [“;”] { modifier } 
  modifier = [“˜”] modifier_name 
  count = (“1” | “2” | “3” | “4” | ...) 
  modifier_name = “@” <keysym> | <see canonical modifier names below> 
  event_type = <see canonical event types below> 
  detail = <event-specific details> 
  rhs = { name “(” [params] “)” } 
  name = namechar { namechar } 
  namechar = { “a”-“z” | “A”-“Z” | “0”-“9” | “_” | “.” }
```
params = string {``,'' string}
string = quoted_string
quoted_string = ``"" {<Latin 1 character> | escape_char} [``\\'' ] """
escape_char = ``\\''

The canonical modifier names are

<table>
<thead>
<tr>
<th>Mod</th>
<th>Button</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ctrl</td>
<td>Button1</td>
</tr>
<tr>
<td>Shift</td>
<td>Button2</td>
</tr>
<tr>
<td>Lock</td>
<td>Button3</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Button4</td>
</tr>
<tr>
<td></td>
<td>Button5</td>
</tr>
</tbody>
</table>

The canonical event types are

-KeyPress
-ButtonPress
-MotionNotify
-LeaveNotify
-FocusOut
-Expose
-NoExpose
-CreateNotify
-UnmapNotify
-MapRequest
-ConfigureNotify
-GravityNotify
-CirculateNotify
-PropertyNotify
-SelectionRequest
-ColormapNotify
-ClientMessage

Examples

- Always put more specific events in the table before more general ones:
  
  \[
  \text{Shift <Btn1Down>: twas()\n}\n  \text{<Btn1 Down>: brillig()}
  \]

- For double-click on Button1 Up with Shift, use this specification:
  
  \[
  \text{Shift<Btn1Up>(2): and()}
  \]

  This is equivalent to the following line with appropriate timers set between events:

  \[
  \text{Shift<Btn1Down>,Shift<Btn1Up>,Shift<Btn1Down>,Shift<Btn1Up>: and()}
  \]

- For double-click on Button1 Down with Shift, use this specification:

  \[
  \text{Shift<Btn1Down>(2): the()}
  \]

  This is equivalent to the following line with appropriate timers set between events:

  \[
  \text{Shift<Btn1Down>,Shift<Btn1Up>,Shift<Btn1Down>: the()}
  \]
• Mouse motion is always discarded when it occurs between events in a table where no motion event is specified:

```
<Btn1Down>,<Btn1Up> : slithy()
```

This is taken, even if the pointer moves a bit between the down and up events. Similarly, any motion event specified in a translation matches any number of motion events. If the motion event causes an action procedure to be invoked, the procedure is invoked after each motion event.

• If an event sequence consists of a sequence of events that is also a noninitial subsequence of another translation, it is not taken if it occurs in the context of the longer sequence. This occurs mostly in sequences like the following:

```
<Btn1Down>,<Btn1Up> : toves()
<Btn1Up> : did()
```

The second translation is taken only if the button release is not preceded by a button press or if there are intervening events between the press and the release. Be particularly aware of this when using the repeat notation, above, with buttons and keys, because their expansion includes additional events; and when specifying motion events, because they are implicitly included between any two other events. In particular, pointer motion and double-click translations cannot coexist in the same translation table.

• For single click on Button1 Up with Shift and Meta, use this specification:

```
Shift Meta <Btn1Down>, Shift Meta<Btn1Up>: gyre()
```

• For multiple clicks greater or equal to a minimum number, a plus sign (+) may be appended to the final (rightmost) count in an event sequence. The actions will be invoked on the count-th click and each subsequent one arriving within the multi-click time interval. For example:

```
Shift <Btn1Up>(2+) : and()
```

• To indicate `EnterNotify` with any modifiers, use this specification:

```
<Enter> : gimble()
```

• To indicate `EnterNotify` with no modifiers, use this specification:

```
None <Enter> : in()
```

• To indicate `EnterNotify` with Button1 Down and Button2 Up and “don’t care” about the other modifiers, use this specification:

```
Button1 ~Button2 <Enter> : the()
```

• To indicate `EnterNotify` with Button1 down and Button2 down exclusively, use this specification:

```
! Button1 Button2 <Enter> : wabe()
```

You do not need to use a tilde (~) with an exclamation point (!).
Appendix C

Compatibility Functions

In prototype versions of the X Toolkit each widget class implemented an Xt<Widget>Create function, in which most of the code was identical from widget to widget. In the Intrinsics, a single generic XtCreateWidget performs most of the common work and then calls the initialize procedure implemented for the particular widget class.

Each Composite class also implemented the procedures Xt<Widget>Add and an Xt<Widget>Delete (for example, XtButtonBoxAddButton and XtButtonBoxDeleteButton). In the Intrinsics, the Composite generic procedures XtManageChildren and XtUnmanageChildren perform error checking and screening out of certain children. Then they call the change_manage procedure implemented for the widget’s Composite class. If the widget’s parent has not yet been realized, the call to the change_manage procedure is delayed until realization time.

Old-style calls can be implemented in the X Toolkit by defining one-line procedures or macros that invoke a generic routine. For example, you could define the macro XtLabelCreate as:

```c
#define XtLabelCreate(name, parent, args, num_args) 
((LabelWidget) XtCreateWidget(name, labelWidgetClass, parent, args, num_args))
```

Pop-up shells in some of the prototypes automatically performed an XtManageChild on their child within their insert_child procedure. Creators of pop-up children need to call XtManageChild themselves.

XtAppInitialize and XtVaAppInitialize have been replaced by XtOpenApplication and XtVaOpenApplication.

To initialize the Intrinsics internals, create an application context, open and initialize a display, and create the initial application shell instance, an application may use XtAppInitialize or XtVaAppInitialize.

---

This appendix is part of the formal Intrinsics Specification.
Widget XtAppInitialize(app_context_return, application_class, options, num_options, argc_in_out, argv_in_out, fallback_resources, args, num_args)

XtAppContext *app_context_return;
String application_class;
XrmOptionDescList options;
Cardinal num_options;
int *argc_in_out;
String *argv_in_out;
String *fallback_resources;
ArgList args;
Cardinal num_args;

app_context_return Returns the application context, if non-NULL.
application_class Specifies the class name of the application.
options Specifies the command line options table.
um_options Specifies the number of entries in options.
argc_in_out Specifies a pointer to the number of command line arguments.
argv_in_out Specifies a pointer to the command line arguments.
fallback_resources Specifies resource values to be used if the application class resource file cannot be opened or read, or NULL.
args Specifies the argument list to override any other resource specifications for the created shell widget.
um_args Specifies the number of entries in the argument list.

The XtAppInitialize function calls XtToolkitInitialize followed by XtCreateApplicationContext, then calls XtOpenDisplay with display_string NULL and application_name NULL, and finally calls XtAppCreateShell with application_name NULL, widget_class applicationShellWidgetClass, and the specified args and num_args and returns the created shell. The modified argc and argv returned by XtDisplayInitialize are returned in argc_in_out and argv_in_out. If app_context_return is not NULL, the created application context is also returned. If the display specified by the command line cannot be opened, an error message is issued and XtAppInitialize terminates the application. If fallback_resources is non-NULL, XtAppSetFallbackResources is called with the value prior to calling XtOpenDisplay.
Widget XtVaAppInitialize(
  app_context_return, application_class, options, num_options,
  argc_in_out, argv_in_out, fallback_resources, ...)

  XtAppContext *app_context_return;
  String application_class;
  XrmOptionDescList options;
  Cardinal num_options;
  int *argc_in_out;
  String *argv_in_out;
  String *fallback_resources;

  app_context_return  Returns the application context, if non-NULL.
  application_class   Specifies the class name of the application.
  options            Specifies the command line options table.
  num_options        Specifies the number of entries in options.
  argc_in_out        Specifies a pointer to the number of command line arguments.
  argv_in_out        Specifies the command line arguments array.
  fallback_resources Specifies resource values to be used if the application class resource file
                        cannot be opened, or NULL.
  ...

The XtVaAppInitialize procedure is identical in function to XtAppInitialize with the args
and num_args parameters replaced by a varargs list, as described in Section 2.5.1.

As a convenience to people converting from earlier versions of the toolkit without application contexts, the following routines exist: XtInitialize, XtMainLoop, XtNextEvent, XtProcessEvent, XtPeekEvent, XtPending, XtAddInput, XtAddTimeout, XtAddWorkProc, XtCreateApplicationShell, XtAddActions, XtSetSelectionTimeout, and XtGetSelectionTimeout.

Widget XtInitialize(
  shell_name, application_class, options, num_options, argc, argv)

  String shell_name;
  String application_class;
  XrmOptionDescRec options[];
  Cardinal num_options;
  int *argc;
  String argv[];

  shell_name   This parameter is ignored; therefore, you can specify NULL.
  application_class   Specifies the class name of this application.
  options            Specifies how to parse the command line for any application-specific resources.
                      The options argument is passed as a parameter to XrmParseCommand.
  num_options        Specifies the number of entries in the options list.
  argc               Specifies a pointer to the number of command line parameters.
  argv               Specifies the command line parameters.

XtInitialize calls XtToolkitInitialize to initialize the toolkit internals, creates a default application context for use by the other convenience routines, calls XtOpenDisplay with display_string NULL and application_name NULL, and finally calls XtAppCreateShell with
application_name NULL and returns the created shell. The semantics of calling XtInitialize more than once are undefined. This routine has been replaced by XtOpenApplication.

void XtMainLoop(void)

XtMainLoop first reads the next alternate input, timer, or X event by calling XtNextEvent. Then it dispatches this to the appropriate registered procedure by calling XtDispatchEvent. This routine has been replaced by XtAppMainLoop.

void XtNextEvent(event_return)
    XEvent *event_return;

event_return Returns the event information to the specified event structure.

If no input is on the X input queue for the default application context, XtNextEvent flushes the X output buffer and waits for an event while looking at the alternate input sources and timeout values and calling any callback procedures triggered by them. This routine has been replaced by XtAppNextEvent. XtInitialize must be called before using this routine.

void XtProcessEvent(mask)
    XtInputMask mask;

mask Specifies the type of input to process.

XtProcessEvent processes one X event, timeout, or alternate input source (depending on the value of mask), blocking if necessary. It has been replaced by XtAppProcessEvent. XtInitialize must be called before using this function.

Boolean XtPeekEvent(event_return)
    XEvent *event_return;

event_return Returns the event information to the specified event structure.

If there is an event in the queue for the default application context, XtPeekEvent fills in the event and returns a nonzero value. If no X input is on the queue, XtPeekEvent flushes the output buffer and blocks until input is available, possibly calling some timeout callbacks in the process. If the input is an event, XtPeekEvent fills in the event and returns a nonzero value. Otherwise, the input is for an alternate input source, and XtPeekEvent returns zero. This routine has been replaced by XtAppPeekEvent. XtInitialize must be called before using this function.

Boolean XtPending()

XtPending returns a nonzero value if there are events pending from the X server or alternate input sources in the default application context. If there are no events pending, it flushes the output buffer and returns a zero value. It has been replaced by XtAppPending. XtInitialize must be called before using this routine.
XtInputId XtAddInput(source, condition, proc, client_data)
    int source;
    XtPointer condition;
    XtInputCallbackProc proc;
    XtPointer client_data;

source Specifies the source file descriptor on a POSIX-based system or other operating-system-dependent device specification.
condition Specifies the mask that indicates either a read, write, or exception condition or some operating-system-dependent condition.
proc Specifies the procedure called when input is available.
client_data Specifies the parameter to be passed to proc when input is available.

The XtAddInput function registers in the default application context a new source of events, which is usually file input but can also be file output. (The word file should be loosely interpreted to mean any sink or source of data.) XtAddInput also specifies the conditions under which the source can generate events. When input is pending on this source in the default application context, the callback procedure is called. This routine has been replaced by XtAppAddInput. XtInitialize must be called before using this routine.

XtIntervalId XtAddTimeOut(interval, proc, client_data)
    unsigned long interval;
    XtTimerCallbackProc proc;
    XtPointer client_data;

interval Specifies the time interval in milliseconds.
proc Specifies the procedure to be called when time expires.
client_data Specifies the parameter to be passed to proc when it is called.

The XtAddTimeOut function creates a timeout in the default application context and returns an identifier for it. The timeout value is set to interval. The callback procedure will be called after the time interval elapses, after which the timeout is removed. This routine has been replaced by XtAppAddTimeOut. XtInitialize must be called before using this routine.

XtWorkProcId XtAddWorkProc(proc, client_data)
    XtWorkProc proc;
    XtPointer client_data;

proc Procedure to call to do the work.
client_data Client data to pass to proc when it is called.

This routine registers a work procedure in the default application context. It has been replaced by XtAppAddWorkProc. XtInitialize must be called before using this routine.
Widget XtCreateApplicationShell(name, widget_class, args, num_args)
  String name;
  WidgetClass widget_class;
  ArgList args;
  Cardinal num_args;

name  This parameter is ignored; therefore, you can specify NULL.
widget_class  Specifies the widget class pointer for the created application shell widget. This
will usually be topLevelShellWidgetClass or a subclass thereof.
args  Specifies the argument list to override any other resource specifications.
num_args  Specifies the number of entries in args.

The procedure XtCreateApplicationShell calls XtAppCreateShell with application_name
NULL, the application class passed to XtInitialize, and the default application context created by
XtInitialize. This routine has been replaced by XtAppCreateShell.

An old-format resource type converter procedure pointer is of type XtConverter.

typedef void (*XtConverter)(XrmValue*, Cardinal*, XrmValue*, XrmValue*);
  XrmValue *args;
  Cardinal *num_args;
  XrmValue *from;
  XrmValue *to;

args  Specifies a list of additional XrmValue arguments to the converter if additional
context is needed to perform the conversion, or NULL.
num_args  Specifies the number of entries in args.
from  Specifies the value to convert.
to  Specifies the descriptor to use to return the converted value.

Type converters should perform the following actions:
- Check to see that the number of arguments passed is correct.
- Attempt the type conversion.
- If successful, return the size and pointer to the data in the to argument; otherwise, call
  XtWarningMsg and return without modifying the to argument.

Most type converters just take the data described by the specified from argument and return data
by writing into the specified to argument. A few need other information, which is available in the
specified argument list. A type converter can invoke another type converter, which allows differ-
ing sources that may convert into a common intermediate result to make maximum use of the type
converter cache.

Note that the address returned in to->addr cannot be that of a local variable of the converter
because this is not valid after the converter returns. It should be a pointer to a static variable.

The procedure type XtConverter has been replaced by XtTypeConverter.

The XtStringConversionWarning function is a convenience routine for old-format resource
converters that convert from strings.
void XtStringConversionWarning(src, dst_type)
    String src, dst_type;

    src Speciﬁes the string that could not be converted.
    dst_type Speciﬁes the name of the type to which the string could not be converted.

The XtStringConversionWarning function issues a warning message with name "conversion-
Error", type "string", class "XtToolkitError", and the default message string "Cannot convert
"src" to type dst_type". This routine has been superseded by XtDisplayStringConversion-
Warning.

To register an old-format converter, use XtAddConverter or XtAppAddConverter.

void XtAddConverter(from_type, to_type, converter, convert_args, num_args)
    String from_type;
    String to_type;
    XtConverter converter;
    XtConvertArgList convert_args;
    Cardinal num_args;

    from_type Speciﬁes the source type.
    to_type Speciﬁes the destination type.
    converter Speciﬁes the type converter procedure.
    convert_args Speciﬁes how to compute the additional arguments to the converter, or NULL.
    num_args Speciﬁes the number of entries in convert_args.

XtAddConverter is equivalent in function to XtSetTypeConverter with cache_type equal to
XtCacheAll for old-format type converters. It has been superseded by XtSetTypeConverter.

void XtAppAddConverter(app_context, from_type, to_type, converter, convert_args, num_args)
    XtAppContext app_context;
    String from_type;
    String to_type;
    XtConverter converter;
    XtConvertArgList convert_args;
    Cardinal num_args;

    app_context Speciﬁes the application context.
    from_type Speciﬁes the source type.
    to_type Speciﬁes the destination type.
    converter Speciﬁes the type converter procedure.
    convert_args Speciﬁes how to compute the additional arguments to the converter, or NULL.
    num_args Speciﬁes the number of entries in convert_args.

XtAppAddConverter is equivalent in function to XtAppSetTypeConverter with cache_type
equal to XtCacheAll for old-format type converters. It has been superseded by XtAppSetType-
Converter.
To invoke resource conversions, a client may use \textbf{XtConvert} or, for old-format converters only, \textbf{XtDirectConvert}.

```c
void XtConvert(w, from_type, from, to_type, to_return)
    Widget w;
    String from_type;
    XrmValuePtr from;
    String to_type;
    XrmValuePtr to_return;

    w Specifies the widget to use for additional arguments, if any are needed.
    from_type Specifies the source type.
    from Specifies the value to be converted.
    to_type Specifies the destination type.
    to_return Returns the converted value.
```

```c
void XtDirectConvert(converter, args, num_args, from, to_return)
    XtConverter converter;
    XrmValuePtr args;
    Cardinal num_args;
    XrmValuePtr from;
    XrmValuePtr to_return;

    converter Specifies the conversion procedure to be called.
    args Specifies the argument list that contains the additional arguments needed to perform the conversion (often NULL).
    num_args Specifies the number of entries in args.
    from Specifies the value to be converted.
    to_return Returns the converted value.
```

The \textbf{XtConvert} function looks up the type converter registered to convert \textit{from_type} to \textit{to_type}, computes any additional arguments needed, and then calls \textbf{XtDirectConvert} or \textbf{XtCallConverter}. The \textbf{XtDirectConvert} function looks in the converter cache to see if this conversion procedure has been called with the specified arguments. If so, it returns a descriptor for information stored in the cache; otherwise, it calls the converter and enters the result in the cache.

Before calling the specified converter, \textbf{XtDirectConvert} sets the return value size to zero and the return value address to NULL. To determine if the conversion was successful, the client should check \textit{to_return.addr} for non-NULL. The data returned by \textbf{XtConvert} must be copied immediately by the caller, as it may point to static data in the type converter.

\textbf{XtConvert} has been replaced by \textbf{XtConvertAndStore}, and \textbf{XtDirectConvert} has been superseded by \textbf{XtCallConverter}.

To deallocate a shared GC when it is no longer needed, use \textbf{XtDestroyGC}.
void XtDestroyGC(w, gc)
    Widget w;
    GC gc;

    w Specifies any object on the display for which the shared GC was created. Must be of class Object or any subclass thereof.
    gc Specifies the shared GC to be deallocated.

References to sharable GCs are counted and a free request is generated to the server when the last user of a given GC destroys it. Note that some earlier versions of XtDestroyGC had only a gc argument. Therefore, this function is not very portable, and you are encouraged to use XtReleaseGC instead.

To declare an action table in the default application context and register it with the translation manager, use XtAddActions.

void XtAddActions(actions, num_actions)
    XtActionList actions;
    Cardinal num_actions;

    actions Specifies the action table to register.
    num_actions Specifies the number of entries in actions.

If more than one action is registered with the same name, the most recently registered action is used. If duplicate actions exist in an action table, the first is used. The Intrinsics register an action table for XtMenuPopup and XtMenuPopdown as part of X Toolkit initialization. This routine has been replaced by XtAppAddActions. XtInitialize must be called before using this routine.

To set the Intrinsics selection timeout in the default application context, use XtSetSelectionTimeout.

void XtSetSelectionTimeout(timeout)
    unsigned long timeout;

    timeout Specifies the selection timeout in milliseconds. This routine has been replaced by XtAppSetSelectionTimeout. XtInitialize must be called before using this routine.

To get the current selection timeout value in the default application context, use XtGetSelectionTimeout.

unsigned long XtGetSelectionTimeout()

The selection timeout is the time within which the two communicating applications must respond to one another. If one of them does not respond within this interval, the Intrinsics abort the selection request.
This routine has been replaced by `XtAppGetSelectionTimeout`. `XtInitialize` must be called before using this routine.

To obtain the global error database (for example, to merge with an application- or widget-specific database), use `XtGetErrorDatabase`.

```c
XrmDatabase *XtGetErrorDatabase()
```

The `XtGetErrorDatabase` function returns the address of the error database. The Intrinsics do a lazy binding of the error database and do not merge in the database file until the first call to `XtGetErrorDatabaseText`. This routine has been replaced by `XtAppGetErrorDatabase`.

An error message handler can obtain the error database text for an error or a warning by calling `XtGetErrorDatabaseText`.

```c
void XtGetErrorDatabaseText(name, type, class, default, buffer_return, nbytes)
```

- `String name, type, class;`
- `String default;`
- `String buffer_return;`
- `int nbytes;`

- `String name`, `type`, `class` Specify the name and type that are concatenated to form the resource name of the error message.
- `String default` Specify the resource class of the error message.
- `String buffer_return` Specify the default message to use if an error database entry is not found.
- `int nbytes` Specify the buffer into which the error message is to be returned.

The `XtGetErrorDatabaseText` returns the appropriate message from the error database associated with the default application context or returns the specified default message if one is not found in the error database. To form the full resource name and class when querying the database, the `name` and `type` are concatenated with a single `.` between them and the `class` is concatenated with itself with a single `.` if it does not already contain a `.`. This routine has been superseded by `XtAppGetErrorDatabaseText`.

To register a procedure to be called on fatal error conditions, use `XtSetErrorMsgHandler`.

```c
void XtSetErrorMsgHandler(msg_handler)
```

- `XtErrorMsgHandler msg_handler;`

- `msg_handler` Specify the new fatal error procedure, which should not return.

The default error handler provided by the Intrinsics constructs a string from the error resource database and calls `XtError`. Fatal error message handlers should not return. If one does, subsequent Intrinsics behavior is undefined. This routine has been superseded by `XtAppSetErrorMsgHandler`.

To call the high-level error handler, use `XtErrorMsg`.
void XtErrorMsg(name, type, class, default, params, num_params)
  String name;
  String type;
  String class;
  String default;
  String *params;
  Cardinal *num_params;

  name Specifies the general kind of error.
  type Specifies the detailed name of the error.
  class Specifies the resource class.
  default Specifies the default message to use if an error database entry is not found.
  params Specifies a pointer to a list of values to be stored in the message.
  num_params Specifies the number of entries in params.

This routine has been superseded by **XtAppErrorMsg**.

To register a procedure to be called on nonfatal error conditions, use **XtSetWarningMsgHandler**.

void XtSetWarningMsgHandler(msg_handler)
  XtErrorMsgHandler msg_handler;

  msg_handler Specifies the new nonfatal error procedure, which usually returns.

The default warning handler provided by the Intrinsics constructs a string from the error resource database and calls **XtWarning**. This routine has been superseded by **XtAppSetWarningMsgHandler**.

To call the installed high-level warning handler, use **XtWarningMsg**.

void XtWarningMsg(name, type, class, default, params, num_params)
  String name;
  String type;
  String class;
  String default;
  String *params;
  Cardinal *num_params;

  name Specifies the general kind of error.
  type Specifies the detailed name of the error.
  class Specifies the resource class.
  default Specifies the default message to use if an error database entry is not found.
  params Specifies a pointer to a list of values to be stored in the message.
  num_params Specifies the number of entries in params.

This routine has been superseded by **XtAppWarningMsg**.
To register a procedure to be called on fatal error conditions, use `XtSetErrorHandler`.

```c
void XtSetErrorHandler(handler)
    XtErrorHandler handler;
```

`handler` specifies the new fatal error procedure, which should not return.

The default error handler provided by the Intrinsics is `_XtError`. On POSIX-based systems, it prints the message to standard error and terminates the application. Fatal error message handlers should not return. If one does, subsequent X Toolkit behavior is undefined. This routine has been superseded by `XtAppSetErrorHandler`.

To call the installed fatal error procedure, use `XtError`.

```c
void XtError(message)
    String message;
```

`message` specifies the message to be reported.

Most programs should use `XtAppErrorMsg`, not `XtError`, to provide for customization and internationalization of error messages. This routine has been superseded by `XtAppError`.

To register a procedure to be called on nonfatal error conditions, use `XtSetWarningHandler`.

```c
void XtSetWarningHandler(handler)
    XtErrorHandler handler;
```

`handler` specifies the new nonfatal error procedure, which usually returns.

The default warning handler provided by the Intrinsics is `_XtWarning`. On POSIX-based systems, it prints the message to standard error and returns to the caller. This routine has been superseded by `XtAppSetWarningHandler`.

To call the installed nonfatal error procedure, use `XtWarning`.

```c
void XtWarning(message)
    String message;
```

`message` specifies the nonfatal error message to be reported.

Most programs should use `XtAppWarningMsg`, not `XtWarning`, to provide for customization and internationalization of warning messages. This routine has been superseded by `XtAppWarning`.
Appendix D

Intrinsics Error Messages

All Intrinsics errors and warnings have class “XtToolkitError”. The following two tables summarize the common errors and warnings that can be generated by the Intrinsics. Additional implementation-dependent messages are permitted.

### Error Messages

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Default Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>allocError</td>
<td>calloc</td>
<td>Cannot perform calloc</td>
</tr>
<tr>
<td>allocError</td>
<td>malloc</td>
<td>Cannot perform malloc</td>
</tr>
<tr>
<td>allocError</td>
<td>realloc</td>
<td>Cannot perform realloc</td>
</tr>
<tr>
<td>internalError</td>
<td>xtMakeGeometryRequest</td>
<td>Internal error; ShellClassExtension is NULL</td>
</tr>
<tr>
<td>invalidArgCount</td>
<td>xtGetValues</td>
<td>Argument count &gt; 0 on NULL argument list in XtGetValues</td>
</tr>
<tr>
<td>invalidArgCount</td>
<td>xtSetValues</td>
<td>Argument count &gt; 0 on NULL argument list in XtSetValues</td>
</tr>
<tr>
<td>invalidClass</td>
<td>applicationShellInsertChild</td>
<td>ApplicationShell does not accept RectObj children; ignored</td>
</tr>
<tr>
<td>invalidClass</td>
<td>constraintSetValue</td>
<td>Subclass of Constraint required in CallConstraintSetValue</td>
</tr>
<tr>
<td>invalidClass</td>
<td>xtAppCreateShell</td>
<td>XtAppCreateShell requires non-NULL widget class</td>
</tr>
<tr>
<td>invalidClass</td>
<td>xtCreatePopupShell</td>
<td>XtCreatePopupShell requires non-NULL widget class</td>
</tr>
<tr>
<td>invalidClass</td>
<td>xtCreateWidget</td>
<td>XtCreateWidget requires non-NULL widget class</td>
</tr>
<tr>
<td>invalidClass</td>
<td>xtPopup</td>
<td>XtPopup requires a subclass of shellWidgetClass</td>
</tr>
<tr>
<td>invalidDimension</td>
<td>xtCreateWindow</td>
<td>Widget %s has zero width and/or height</td>
</tr>
<tr>
<td>invalidDimension</td>
<td>shellRealize</td>
<td>Shell widget %s has zero width and/or height</td>
</tr>
<tr>
<td>invalidDisplay</td>
<td>xtInitialize</td>
<td>Can’t open display: %s</td>
</tr>
<tr>
<td>invalidGetValues</td>
<td>xtGetValues</td>
<td>NULL ArgVal in XtGetValues</td>
</tr>
<tr>
<td>invalidExtension</td>
<td>shellClassPartInitialize</td>
<td>widget class %s has invalid ShellClassExtension record</td>
</tr>
<tr>
<td>invalidExtension</td>
<td>xtMakeGeometryRequest</td>
<td>widget class %s has invalid ShellClassExtension record</td>
</tr>
<tr>
<td>invalidGeometryManager</td>
<td>xtMakeGeometryRequest</td>
<td>XtMakeGeometryRequest - parent has no geometry manager</td>
</tr>
<tr>
<td>invalidParameter</td>
<td>xtAddInput</td>
<td>invalid condition passed to XtAddInput</td>
</tr>
<tr>
<td>invalidParameter</td>
<td>xtAddInput</td>
<td>invalid condition passed to XtAddInput</td>
</tr>
<tr>
<td>invalidParent</td>
<td>xtChangeManagedSet</td>
<td>Attempt to manage a child when parent is not Composite</td>
</tr>
<tr>
<td>invalidParent</td>
<td>xtChangeManagedSet</td>
<td>Attempt to unmanage a child when parent is not Composite</td>
</tr>
<tr>
<td>invalidParent</td>
<td>xtCreatePopupShell</td>
<td>XtCreatePopupShell requires non-NULL parent</td>
</tr>
<tr>
<td>invalidParent</td>
<td>xtCreateWidget</td>
<td>XtCreateWidget requires non-NULL parent</td>
</tr>
<tr>
<td>invalidParent</td>
<td>xtMakeGeometryRequest</td>
<td>non-shell has no parent in XtMakeGeometryRequest</td>
</tr>
<tr>
<td>invalidParent</td>
<td>xtMakeGeometryRequest</td>
<td>XtMakeGeometryRequest - parent not composite</td>
</tr>
<tr>
<td>invalidParent</td>
<td>xtManageChildren</td>
<td>Attempt to manage a child when parent is not Composite</td>
</tr>
<tr>
<td>invalidParent</td>
<td>xtUnmanageChildren</td>
<td>Attempt to unmanage a child when parent is not Composite</td>
</tr>
</tbody>
</table>
invalidProcedure: inheritanceProc
No unresolved inheritance operation
invalidProcedure: realizeProc
No realizable class procedure defined
invalidWindow: eventHandler
Event with wrong window
missingWidget: fetchDisplayArg
FetchDisplayArg called without a widget to reference
noWidget: xtCreateWidget
Attempt to add non-widget child "%s" to parent "%s"
which supports only widgets
noPerDisplay: closeDisplay
Couldn’t find per display information
noPerDisplay: getPerDisplay
Couldn’t find per display information
noSelectionProperties: freeSelectionProperty
Internal error: no selection property context for display
noWidgetAncestor: windowedAncestor
Object "%s" does not have windowed ancestor
nullDisplay: xtRegisterExtensionSelector
XtRegisterExtensionSelector requires a non-NULL display
nullProc: insertChild
"%s" parent has NULL insert_child method
r2versionMismatch: widget
Widget class %s must be re-compiled.
R3versionMismatch: widget
Widget class %s must be re-compiled.
R4orR5versionMismatch: widget
Widget class %s must be re-compiled.
rangeError: xtRegisterExtensionSelector
Attempt to register multiple selectors for one extension
event type
sessionManagement: SmcOpenConnection
Tried to connect to session manager, %s
subclassMismatch: xtCheckSubclass
Widget class %s found when subclass of %s expected: %s

---

Warning Messages

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Default Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>ambiguousParent</td>
<td>xtChangeManagedSet</td>
<td>Not all children have same parent</td>
</tr>
<tr>
<td>ambiguousParent</td>
<td>xtManageChildren</td>
<td>Not all children have same parent in XtManageChildren</td>
</tr>
<tr>
<td>ambiguousParent</td>
<td>xtUnmanageChildren</td>
<td>Not all children have same parent in XtUnmanageChildren</td>
</tr>
<tr>
<td>badFormat</td>
<td>xtGetSelectionValue</td>
<td>Selection owner returned type INCR property with format != 32</td>
</tr>
<tr>
<td>badGeometry</td>
<td>shellRealize</td>
<td>Shell widget &quot;%s&quot; has an invalid geometry specification: &quot;%s&quot;</td>
</tr>
<tr>
<td>badValue</td>
<td>cvtStringToPixel</td>
<td>Color name &quot;%s&quot; is not defined</td>
</tr>
<tr>
<td>communicationError</td>
<td>select</td>
<td>Select failed; error code %s</td>
</tr>
<tr>
<td>conversionError</td>
<td>string</td>
<td>Cannot convert string &quot;%s&quot; to type %s</td>
</tr>
<tr>
<td>conversionError</td>
<td>stringToVisual</td>
<td>Cannot find Visual of class %s for display %s</td>
</tr>
<tr>
<td>conversionFailed</td>
<td>xtConvertVarToArgList</td>
<td>Type conversion failed</td>
</tr>
<tr>
<td>conversionFailed</td>
<td>xtGetTypedArg</td>
<td>Type conversion (%s to %s) failed for widget '%s'</td>
</tr>
<tr>
<td>displayError</td>
<td>invalidDisplay</td>
<td>Can’t find display structure</td>
</tr>
<tr>
<td>grabError</td>
<td>xtAddGrab</td>
<td>XtAddGrab requires exclusive grab if spring_loaded is TRUE</td>
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<td>XtRemoveGrab asked to remove a widget not on the list</td>
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<td>xtGetTypedArg</td>
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<td>xtAddCallback</td>
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invalidCallbackList xtCallCallback Cannot find callback list in XtCallCallbacks
invalidCallbackList xtRemoveAllCallback Cannot find callback list in XtRemoveAllCallbacks
invalidCallbackList xtRemoveCallback Cannot find callback list in XtRemoveCallbacks
invalidChild xtChangeManagedSet Null child passed to UnmanageChildren
invalidChild xtManageChildren null child passed to ManageChildren
invalidChild xtUnmanageChildren Null child passed to XtUnmanageChildren
invalidChild xtUnmanageChildren Null child found in argument list to unmanage
invalidDepth setValues Can’t change widget depth
invalidExtension xtCreateWidget widget "%s" class %s has invalid CompositeClassExtension record
invalidExtension xtCreateWidget widget class %s has invalid ConstraintClassExtension record
invalidGrab ungrabKeyOrButton Attempt to remove nonexistent passive grab
invalidGrabKind xtPopup grab kind argument has invalid value: XtGrabNone assumed
invalidParameters freeTranslations Freeing XtTranslations requires no extra arguments
invalidParameters mergeTranslations MergeTM to TranslationTable needs no extra arguments
invalidParameters xtMenuPopdown XtMenuPopdown called with num_params != 0 or 1
invalidParameters xtMenuPopupAction MenuPopup wants exactly one argument
invalidParent xtCopyFromParent CopyFromParent must have non-NULL parent
invalidPopup xtMenuPopdown Can’t find popup widget "%s" in XtMenuPopdown
invalidPopup unsupportedOperation Pop-up menu creation is only supported on ButtonPress, Keypress or EnterNotify events.
invalidPopup unsupportedOperation Pop-up menu creation is only supported on Button, Key or EnterNotify events.
invalidProcedure deleteChild null delete_child procedure for class %s in XtDestroy
invalidProcedure inputHandler XtRemoveInput: Input handler not found
invalidProcedure set_values_almost set_values_almost procedure shouldn’t be NULL
invalidResourceCount computeArgs Cannot find resource name %s as argument to conversion
invalidShell xtTranslateCoords Widget has no shell ancestor
invalidSizeOverride xtDependencies Representation size %d must match superclass’s to override %s
missingCharsetList cvtStringToFontSet Missing charsets in String to FontSet conversion
noActionProc xtCallActionProc No action proc named "%s" is registered for widget "%s"
noColormap cvtStringToPixel Cannot allocate colormap entry for "%s"
noFont cvtStringToFont Unable to load any usable ISO8859-1 font
noFont cvtStringToFontSet Unable to load any usable fontset
notInConvertSelection xtGetSelectionRequest or XtGetSelectionParameters called for widget "%s" outside of ConvertSelection proc
notRectObj xtChangeManagedSet child "%s", class %s is not a RectObj
notRectObj xtManageChildren child "%s", class %s is not a RectObj
nullWidget xtConvertVarToArgList XtVaTypedArg conversion needs non-NULL widget handle
r3versionMismatch widget Shell Widget class %s binary compiled for R3
translationError nullTable Can’t remove accelerators from NULL table
translationError nullTable Tried to remove nonexistent accelerators
translationError ambiguousActions Overriding earlier translation manager actions.
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<td>nullTable: Table to (un)merge must not be null</td>
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<td>widget: Widget class %s version mismatch (recompilation needed): %d %d</td>
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Appendix E

Defined Strings

The **StringDefs.h** header file contains definitions for the following resource name, class, and representation type symbolic constants.

**Resource names:**

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The **Shell.h** header file contains definitions for the following resource name, class, and representation type symbolic constants.

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XtCProgramPath     "ProgramPath"
XtCResignCommand   "ResignCommand"
XtCRestartCommand  "RestartCommand"
XtCRestartStyle    "RestartStyle"
XtCSaveUnder       "SaveUnder"
XtCSessionID       "SessionID"
XtCShutdownCommand "ShutdownCommand"
XtCTitle           "Title"
XtCTitleEncoding   "TitleEncoding"
XtCTransient       "Transient"
XtCTransientFor    "TransientFor"
XtCUrgency         "Urgency"
XtCVisual          "Visual"
XtCWaitForWm       "Waitforwm"
XtCWaitforwm       "Waitforwm"
XtCWidthInc        "WidthInc"
XtCWindowGroup     "WindowGroup"
XtCWindowRole      "WindowRole"
XtCWinGravity      "WinGravity"
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Appendix F

Resource Configuration Management

Setting and changing resources in X applications can be difficult for both the application programmer and the end user. **Resource Configuration Management (RCM)** addresses this problem by changing the X Intrinsicsto immediately modify a resource for a specified widget and each child widget in the hierarchy. In this context, immediate means: no sourcing of a resource file is required; the application does not need to be restarted for the new resource values to take effect; and the change occurs immediately.

The main difference between RCM and the Editres protocol is that the RCM customizing hooks reside in the Intrinsics and thus are linked with other toolkits such as Motif and the Athena widgets. However, the EditRes protocol requires the application to link with the EditRes routines in the Xm library and Xm is not used by all applications that use Motif. Also, the EditRes protocol uses ClientMessage, whereas the RCM Intrinsics hooks use PropertyNotify events.

X Properties and the PropertyNotify events are used to implement RCM and allow on-the-fly resource customization. When the X Toolkit is initialized, two atoms are interned with the strings Custom Init and Custom Data. Both _XtCreatePopupShell and _XtAppCreateShell register a PropertyNotify event handler to handle these properties.

A customization tool uses the Custom Init property to ping an application to get the application’s toplevel window. When the application’s property notify event handler is invoked, the handler deletes the property. No data is transferred in this property.

A customization tool uses the Custom Data property to tell an application that it should change a resource’s value. The data in the property contains the length of the resource name (the number of bytes in the resource name), the resource name and the new value for the resource. This property’s type is XA_STRING and the format of the string is:

1. The length of the resource name (the number of bytes in the resource name)
2. One space character
3. The resource name
4. One space character
5. The resource value

When setting the application’s resource, the event handler calls functions to walk the application’s widget tree, determining which widgets are affected by the resource string, and then applying the value with XtSetValues. As the widget tree is recursively descended, at each level in the widget tree a resource part is tested for a match. When the entire resource string has been matched, the value is applied to the widget or widgets.

Before a value is set on a widget, it is first determined if the last part of the resource is a valid resource for that widget. It must also add the resource to the application’s resource database and then query it using specific resource strings that is builds from the widget information.
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