**X Windows Motif**

Early (1987) network transparent, vendor independent operating environment for workstation based software.

Applications can run on host best suited to support processing.

Information sharing & concurrency

![Diagram of X Windows Motif](image)
cc app.c -o app -lXm [-lXpm] -lXt -lX11

High level user interface components from Motif, Xt or other libraries: widgets (Object Based libraries)
   buttons, menus, dialog boxes, viewports, scrollbars, panes, etc.

Low level drawing functionality from Xlib.
   draw point, line, arc, fonts
Motif - Xt Programming Model

1. Include files for Motif & widgets

2. Initialize Xt Intrinsics
   XtVaAppInitialize(…)

3. Create Widgets { shell, manager, primitive, gadgets }
   XtVaCreate... Widget (…)
   XmCreate ...Dialog (…)

4. Event Handling -- register translation tables and callbacks
   XtAppAddActions(…)
   XtAddCallback(…)

5. Realize Widgets -- display widgets
   XtRealizeWidget(…)

6. Enter Event Loop -- respond to user
   XtAppMainLoop(…)

Widgets

**XtVaCreateManagedWidget(...)**

Enables the creation and setting of resources for managed, and **XtVaCreateWidget(...)** unmanaged, widgets.

```c
widget = XtVaCreateManagedWidget(
    widget name, // used for resource dbms
    widget class,
    parent, // a manager widget
    // remaining arguments are list of resource settings.
    // These use the form: XmNresourceName, resourceValue
    // XmNbackground, wheat
    NULL // end of resourceName, resourceValue pairs);
```

Resources can be set dynamically after widget creation in the application, or in various developer specified, system specified, and user specified resource database files...
Widget Class Hierarchy

Core
- Object
- RectObj
- WindowObj

Composite

Primitive
- ArrowButton
- label
- Scrollbar

many others

Motif

Xt

Constraint

Manager

many vendor shells

Shells

CascadeButton

PushButton

ToggleButton

other buttons
Primitive widgets are visible UI controls with default resources:
visible properties: fore / background, font, strings
callbacks for event handling

Manager widgets control geometry and layout of children (managed) widgets.
MainWindow convenience widget for generic application with optional menuBar, workArea, CommandArea, and MessageArea widgets

Form widget is a powerful manager with attachment constraints that can attach to the form or other widgets on top, left, right, bottom
Event Callbacks

Widget have predefined callback resources.

e.g. PushButton widget class defines:
   XmNactivateCallback
   XmNarmCallback
   XmNarmCallback
   XmNdisarmCallback

Callbacks are added (ie "addListener") with:

   XtAddCallback(Widget w, String resourceName,
                  XtCallbackProc functionName,
                  XtPointer clientData);

The resourceName specifies the widget's defined callback resource.

clientData is any scalar data you wish to be passed to the function when
the callback is invoked
   pointer to class (struct) or argv type approach to pass many values.

Other events handler mechanisms: translation tables and actions
Callback functions

The function associated with the callback must have a specific argument list

```c
void functionName( Widget w, XtPointer clientData, XtPointer callData);
```

XtPointer is a general pointer type casting is often needed -- especially w/ C++

clientData references the data in the XtAddCallback(...) statement.

callData references a CallbackStruct event structure returned by the event bound to the widget's callback resource.

X uses many CallbackStructs for different event classes.
The basic one is:

```c
typedef struct {
    int reason;
    XEvent * event;
} XmAnyCallbackStruct;
```
Menus
menus in menuBar with pulldown, cascade, popup, menuItems

Dialogs
convenience message, information, warning, error, fileI/O
custom: transient frame with managers and primitives

Convenience widgets
Menus, dialogs, MainWindow, others
many widgets have convenient forms with default arguments

Widget layout design requires layered manager widgets

Rich graphics drawing functions. GC (graphics context)

Resources include: bitmaps, images, cursors, fonts, colors
Example motif1.cc illustrates
• events: push button callback and keyboard event handling.
• resources: XtSetValue(…) and XtVa* techniques