QNX® Neutrino® Realtime Operating System

Photon® microGUI
Building Custom Widgets

For QNX® Neutrino® 6.5.0

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About This Manual

What you'll find in this guide

The *Building Custom Widgets* guide is intended for Photon programmers who want to create custom widgets.

If you're familiar with earlier versions of Photon, you should read the What's New appendix to find out what has changed in this version..

This manual contains everything you need to know about building your own Photon widgets. Sample code is used throughout this manual to demonstrate new concepts.

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Typographical conventions

Throughout this manual, we use certain typographical conventions to distinguish technical terms. In general, the conventions we use conform to those found in IEEE POSIX publications. The following table summarizes our conventions:

Reference	Example
Code examples	`if( stream == NULL )`
Command options	**`-lR`**
Commands	**`make`**
Environment variables	**PATH**
File and pathnames	**`/dev/null`**
Function names	*exit()*
Keyboard chords	Ctrl-Alt-Delete
Keyboard input	**`something you type`**
Keyboard keys	Enter
Program output	`login:`
Programming constants	NULL
Programming data types	**`unsigned short`**
Programming literals	`0xFF`, `"message string"`
Variable names	*stdin*
User-interface components	**Cancel**

We use an arrow (→) in directions for accessing menu items, like this:

> You'll find the **Other...** menu item under **Perspective→Show View**.

We use notes, cautions, and warnings to highlight important messages:

Notes point out something important or useful.

CAUTION: Cautions tell you about commands or procedures that may have unwanted or undesirable side effects.

WARNING: Warnings tell you about commands or procedures that could be dangerous to your files, your hardware, or even yourself.

Note to Windows users

In our documentation, we use a forward slash (`/`) as a delimiter in *all* pathnames, including those pointing to Windows files.

We also generally follow POSIX/UNIX filesystem conventions.

Technical support

To obtain technical support for any QNX product, visit the **Support** area on our website (**`www.qnx.com`**). You'll find a wide range of support options, including community forums.

Chapter 1
Overview

In this chapter. . .

When you build an application, you typically use the standard widgets provided with the Photon widget library. But occasionally you'll have a reason for *not* using these standard widgets.

For example, Photon widgets require a fair amount of memory, so if you're drawing a diagram having several **`PtRect`**, **`PtLine`** and **`PtPolygon`** widgets, it might be better to create a single widget that can draw the entire diagram using *Pg*()* graphic primitives.

Another reason for creating a custom widget is the need for a user interface object whose features aren't supported by standard widgets. In this case, you have three options:

- Code the required user interface functionality directly into your application.
- Use the raw widget, **`PtRaw`** — see the Raw Drawing and Animation chapter of the Photon *Programmer's Guide*.
- Build a custom widget.

Placing custom user-interface code within a widget has its advantages:

- The widget becomes a self-contained module that can be used within other applications.
- The widget can take advantage of the Photon widget engine, which has several features available only to widgets (e.g. automatic routing of events to the appropriate widgets, which allows widgets to automatically redraw and repair themselves when required).
- The user-interface code is separated from the application-specific code (the primary goal of widgets).

The process of building a widget in Photon is very straightforward. Because all widgets follow a specific structure or layout, you can start with a standard widget template or an existing widget that has similar functionality.

Subclassing widgets

Building a custom widget is also known as *subclassing* a widget because widgets are always built as descendants of existing widget *superclasses*. Subclassing lets you enhance or modify the behavior associated with an existing widget superclass, provided you understand how the superclass is implemented. The Using Widget Superclasses chapter describes the most common widget superclasses.

When creating a custom widget, you should subclass it under **`PtBasic`** or one of **`PtBasic`**'s subclasses. The **`PtBasic`** superclass is the ancestral widget class of most standard Photon widgets. Subclassing a widget under **`PtBasic`** lets the widget inherit the features common to most Photon widgets, such as support for keyboard traversal, highlighting, and focus. If you create a widget that doesn't support these common features, it may look out of place in a Photon application.

CAUTION:

If you’ll be adding a custom widget to the Photon Application Builder (PhAB) widget palette, there are a few special design considerations you must be aware of. Before you begin designing your widget, read the Binding Widgets into PhAB chapter.

Design considerations

Part of building a custom widget involves deciding what it will look like and how the user will interact with it. You’ll need to decide on the *resources* that control the widget and pick an appropriate widget superclass to start with.

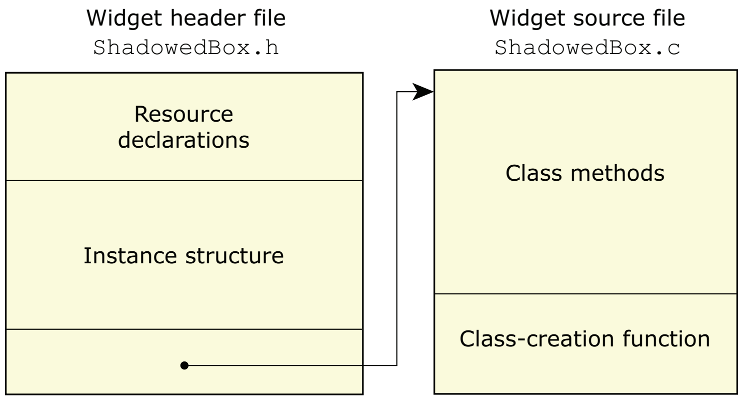
Appearance	Designing the look of a widget involves an exercise in visualization. The widget’s appearance could depend on whether a user will interact with the widget. You should also consider whether a developer may need to customize your widget. Once you’ve decided on the look, you can start designing the widget’s attributes.
Attributes	Widget attributes are defined as resources within your widget. The resources should be all things that the developer can customize. The resources should also define all the callbacks your widget will generate. When deciding on these attributes, consider how to represent them in the widget’s *instance structure*. For example, will the attribute be a string, a structure, or a pointer to an allocated array? Each of these attributes (whether they are read, write, or read/write) will be your widget’s resources.
Widget actions	If your widget will be interactive, you’ll have to determine which Photon events your widget will be sensitive to. These events must be set up in the *class-creation function*. You can have all events go through the same function, or you can define a function for each event type. The functions that handle events should read the event data and take the appropriate action. For example, a click on your widget might change its internal state. If appropriate, your widget may need to be damaged so a subsequent redraw operation can reflect the widget’s new state.
Superclass	More often than not, some or most of the resources your widget requires are already available within an existing widget superclass. When you build your widget as a subclass of a superclass, much of your widget’s behavior will be inherited from the superclass.

A quick look at a widget

A widget is usually made up of two files:

- a header file, which defines the widget's instance structure and resource declarations needed by applications to use the widget
- a source code file, which contains the widget's class structure and the actual code to implement the widget. This code includes *methods*, class-level functions that define how the widget initializes itself, draws itself, calculates its extent, and so on.

The following diagram depicts the header and source code files for a simple example of a widget, **`ShadowedBox`**.



The header file and source file for a widget class.

This sample widget will draw a shadowed box, define a resource for changing the color of the shadow, and define a resource for specifying the offset of the shadow.

This sample widget will be subclassed as follows:

`PtWidget` → **`PtBasic`** → **`ShadowedBox`**

Since **`ShadowedBox`** will be a subclass of **`PtBasic`**, it will inherit all the resources and behavior of this standard Photon widget.

Widget header file

Photon widgets comprise two structures: the class structure and the instance structure. The class structure is defined in the source file and is discussed in the next section. The instance structure is contained in the header file, as shown below in an excerpt from the **`ShadowedBox.h`** header file:

```
/* ShadowedBox.h - widget header file */

#include <Pt.h>

/* widget resources */
#define SBW_SHADOW_COLOR      Pt_RESOURCE( Pt_USER( 0 ), 0 )
#define SBW_SHADOW_OFFSET     Pt_RESOURCE( Pt_USER( 0 ), 1 )
```

```
/* widget instance structure */
typedef struct shadowed_box_widget{
   PtBasicWidget_t   basic;
   PgColor_t    shadow_color;
   short        shadow_offset;
}  ShadowedBoxWidget;

/* widget class pointer */
extern PtWidgetClassRef_t *ShadowedBox;
```

Instance structure members

Each instance of a widget has its own copy of the instance structure, which carries the complete widget state including everything that can be unique to that instance. Widgets define public resource manifests, which correspond to the members of the instance structure.

The first member of the instance structure must be the instance structure of the widget's immediate superclass. **ShadowedBox** is a subclass of **PtBasic**, so the first member of its instance structure is of type **PtBasicWidget_t**.

When a widget class is created, the members of the instance structure are given default values or can be set using resource manifests. The instance structure members can be changed by calling *PtSetResources()* and read by calling *PtGetResources()*.

The header file also defines an external reference to the widget class pointer.

Widget source file

The organization of the source file is quite simple. First, it defines the class structure. There's only one copy of the class structure, which all widget instances use. It's initialized through the class-creation function when the first instance of this class is created.

Class structure members

The class structure's members contain pointers to methods and resources that control how the Photon library handles instances of this class.

The following class structure is found in the **ShadowedBox.c** source file:

```
/* ShadowedBox.c - widget source file */

#include "ShadowedBox.h"

/* prototype declarations */
PtWidgetClass_t *CreateShadowedBoxClass( void );

/* widget class pointer - class structure, create function */
PtWidgetClassRef_t WShadowedBox = { NULL,
                                    CreateShadowedBoxClass };
PtWidgetClassRef_t *ShadowedBox = &WShadowedBox;

//
// ShadowedBox defaults function
```

```
//
static void shadowedbox_dflts( PtWidget_t *widget )
{
    ShadowedBoxWidget    *sb = ( ShadowedBoxWidget * ) widget;
    PtBasicWidget_t      *basic = ( PtBasicWidget_t * ) widget;

    basic->fill_color    = Pg_WHITE;
    sb->shadow_color     = Pg_BLACK;
    sb->shadow_offset    = 4;
}

//
// ShadowedBox draw function
//
static void shadowedbox_draw( PtWidget_t *widget, PhTile_t *damage )
{
    ShadowedBoxWidget    *sb = ( ShadowedBoxWidget * ) widget;
    PtBasicWidget_t      *basic = ( PtBasicWidget_t * ) widget;
    PhRect_t             shadow_rect, rect;
    PgColor_t            color;

    // We want to use basic's draw function to get borders
    // and default focus rendering... but we don't want it to
    // fill the background with the basic fill color,
    // so we set the fill color to transparent for Basic's draw func.
    color = basic->fill_color;
    basic->fill_color = Pg_TRANSPARENT;
    PtSuperClassDraw( PtBasic, widget, damage );

    // we don't want to draw outside our canvas! So we clip.
    PtCalcCanvas( widget, &rect );
    PtClipAdd( widget, &rect );

    basic->fill_color = color;
    shadow_rect = rect;
    shadow_rect.ul.x += sb->shadow_offset;
    shadow_rect.ul.y += sb->shadow_offset;
    PgSetStrokeColor( sb->shadow_color );
    PgSetFillColor( sb->shadow_color );
    PgDrawRect( &shadow_rect, Pg_DRAW_FILL_STROKE );

    PgSetFillTransPat( basic->trans_pattern );
    PgSetStrokeColor( basic->color );
    PgSetFillColor( color );
    rect.lr.x -= sb->shadow_offset;
    rect.lr.y -= sb->shadow_offset;
    PgDrawRect( &rect, Pg_DRAW_FILL_STROKE );

    /* remove the clipping */
    PtClipRemove();
}

//
// ShadowedBox class creation function
//
PtWidgetClass_t *CreateShadowedBoxClass( void )
{
    // define our resources
    static PtResourceRec_t resources[] = {
        SBW_SHADOW_COLOR, Pt_CHANGE_REDRAW, 0,
            Pt_ARG_IS_NUMBER( ShadowedBoxWidget, shadow_color ), 0,
        SBW_SHADOW_OFFSET, Pt_CHANGE_RESIZE_REDRAW, 0,
            Pt_ARG_IS_NUMBER( ShadowedBoxWidget, shadow_offset ), 0,
        };

    // set up our class member values
    static PtArg_t args[] = {
        { Pt_SET_VERSION, 110},
        { Pt_SET_STATE_LEN, sizeof( ShadowedBoxWidget ) },
        { Pt_SET_DFLTS_F, (long)shadowedbox_dflts },
        { Pt_SET_DRAW_F, (long)shadowedbox_draw },
        { Pt_SET_FLAGS, 0, Pt_RECTANGULAR },
        { Pt_SET_NUM_RESOURCES,
          sizeof( resources ) / sizeof( resources[0] ) },
        { Pt_SET_RESOURCES, (long)resources,
          sizeof( resources ) / sizeof( resources[0] ) },
        };

    // create the widget class
    return( ShadowedBox->wclass = PtCreateWidgetClass(
        PtBasic, 0, sizeof( args )/sizeof( args[0] ), args ) );
}
```

In the source file above, the class definition defines the *shadowedbox_dflts()* and *shadowedbox_draw()* functions for the Defaults and Draw methods. It also defines how the *SBW_SHADOW_COLOR* and *SBW_SHADOW_OFFSET* resources are handled.

As you can see from this example, creating a simple widget doesn't take a lot of code.

Let's review the fundamental structure of a widget source code file:

Section	Example
Header files	`#include "ShadowedBox.h"`
Class pointer declaration	`PtWidgetClassRef_t *ShadowedBox`
Method functions	*shadowedbox_dflts()*, *shadowedbox_draw()*
Class-creation function	*CreateShadowedBoxClass()*

Types of widgets

The Photon library supplies a number of widget classes that can be used as the basis for custom widgets. To make this easy to understand, we've categorized widgets into three general types:

- Basic
- Container
- Compound

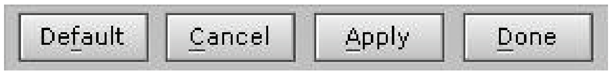
Class hierarchy

All Photon widgets are based on the **`PtWidget`** core widget class. It defines the characteristics common to all standard widgets, such as position and dimension. Even if your widget is different from any other widget, it will still inherit the features of the **`PtWidget`** widget class. Most custom widgets, however, will be subclassed under one of the other widget superclasses.

`PtWidget` also supports anchoring features that allow widgets to be anchored to their parent.

Basic widgets

Basic widgets are single-entity objects. They don't contain other widgets and aren't built from other widgets. An example would be a button widget.



Button widgets.

You can't put other widgets inside a button, and the button itself isn't built from other widgets. Our sample **`ShadowedBox`** widget is a basic widget.

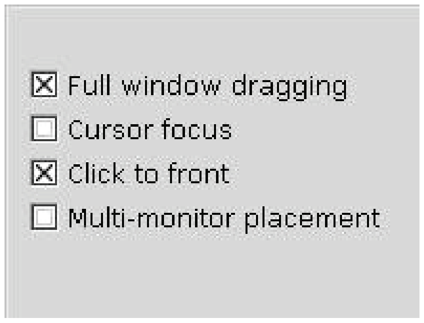
Although we call them "basic" widgets, this is only a classification and doesn't imply that they can't be powerful. In fact, one of the most complex widgets in the Photon library, **`PtText`**, is a basic widget.

Container widgets

Container widgets can have other widgets as children. Containers have the option of managing the geometry of their children (e.g. **`PtGroup`**) or leaving the widgets as they are (e.g. **`PtContainer`**).

The **`PtContainer`** class extends the **`PtBasic`** class definition to include many new methods for controlling and reacting to the widget children placed inside the container. Using these new methods, a container could, for example, detect when a new child is added and automatically resize itself to accommodate the new widget.

Widget children can be selectively blocked by a *child-redirector* function. This is useful when you want to create a widget that accepts only specific widgets as children (e.g. **`PtMenuBar`** accepts only **`PtMenuButton`** widgets as children). All other widgets are redirected to the container's parent widget. This causes them to be created at the same level as the container instead of as a child of the container.



A container with toggle-button children.

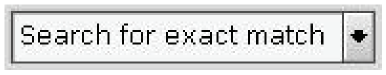
Compound widgets

Compound widgets are built from exported subordinate widgets. The exporting mechanism allows access to the underlying widgets using their resources and convenience functions. This reduces the need to duplicate every subordinate widget resource in the compound widget's resource list.

You have to set up resources only for new functionality or for resolving conflicts when more than one of the same widget class has been exported. A blocking mechanism lets compound widgets block access to any of the subordinate resources. This lets you prevent any actions that would adversely affect the look and behavior of the compound widget.

Since the **`PtCompound`** class is a descendant of **`PtContainer`**, it inherits all the functionality of a container widget. This means compound widgets can support child widgets other than the ones they're built from. Since this feature isn't usually desired, you can use a compound widget's child-redirector function to automatically reject the addition of unwanted widgets.

A good example of a compound widget is **`PtComboBox`** — it's built using the **`PtText`** and **`PtList`** widget classes and adds its own functionality.



A compound widget.

Another good example is **`PtDivider`** — it's built using a **`PtGroup`** widget; separator bars are added automatically between the widgets in the group.

Chapter 2

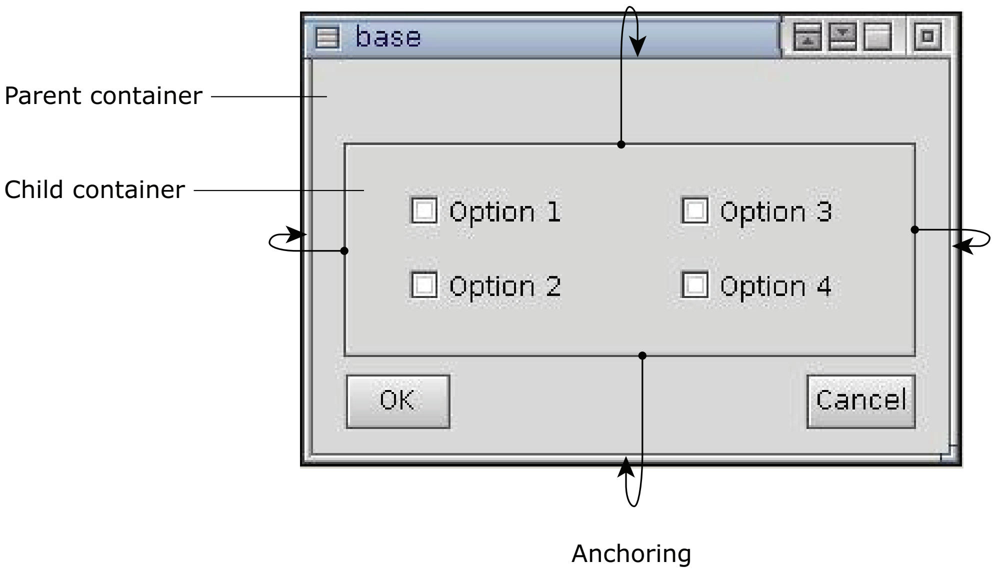
Life Cycle of a Widget

In this chapter. . .

This chapter examines the life cycle of a basic widget using the **ShadowedBox** widget as an example. We'll show you how to create, use, and destroy this widget. We'll also outline the life cycle differences between basic, container, and compound widgets.

All widgets

If a widget is already realized or in the process of being realized, it's automatically anchored by the widget library.



Default anchoring for a container widget.

PtAnchorWidget() and *PtApplyAnchors()* in the widget-building library allow anchoring to be applied at any time, provided the parent widget's extent is valid.

Basic widgets

If we were building an application and wanted to use the custom **ShadowedBox** widget (a "basic" widget), we would simply create it by calling *PtCreateWidget()*:

```
PtWidget_t  *box;
PhArea_t    area = { 10, 10, 100, 100 };
PtArg_t     args[2];

PtSetArg( &args[0], Pt_ARG_AREA, &area, 0 );
PtSetArg( &args[1], SBW_SHADOW_COLOR, Pg_BLUE, 0 );
box = PtCreateWidget( ShadowedBox, Pt_DEFAULT_PARENT,
                      2, args );
PtRealizeWidget( box );
```

What happens when we call *PtCreateWidget()*? What does the widget library do? Let's follow through the widget creation process and examine the various parts of the widget code as they get executed.

Instantiating the widget

The first step, instantiating the widget, creates an instance of the widget class. The process of instantiating a widget is as follows:

1. The widget class is created and initialized.
2. All members of the widget instance structure are initialized to default values.
3. The resources specified through *PtCreateWidget()* are applied.

Creating and initializing the widget class

When a widget is created via a call to *PtCreateWidget()*, the specified widget class (i.e. **ShadowedBox**) is first checked to see if it has been initialized. Since this is the first time this widget has been created, the widget's initialization function is called to create the widget class.

In the **ShadowedBox.c** source file, the widget class is defined as a class reference structure:

```
PtWidgetClassRef_t WShadowedBox = { NULL,
                                    CreateShadowedBoxClass };
PtWidgetClassRef_t *ShadowedBox = &WShadowedBox;
```

The first member is the widget class pointer, which is initialized to NULL. The second member is the widget class-creation function. If the value of the class pointer is NULL, the class-creation function is called and it sets the widget class pointer in the structure.

Let's look at *CreateShadowedBoxClass()* from our example to see how it defines the **ShadowedBox** class:

```
//
// ShadowedBox class creation function
//
PtWidgetClass_t *CreateShadowedBoxClass( void )
{
    // define our resources
    static PtResourceRec_t resources[] = {
        SBW_SHADOW_COLOR, Pt_CHANGE_REDRAW, 0,
            Pt_ARG_IS_NUMBER( ShadowedBoxWidget, shadow_color ), 0,
        SBW_SHADOW_OFFSET, Pt_CHANGE_RESIZE_REDRAW, 0,
            Pt_ARG_IS_NUMBER( ShadowedBoxWidget, shadow_offset ), 0,
        };

    // set up our class member values
    static PtArg_t args[] = {
        { Pt_SET_VERSION, 110},
        { Pt_SET_STATE_LEN, sizeof( ShadowedBoxWidget ) },
        { Pt_SET_DFLTS_F, (long)shadowedbox_dflts },
        { Pt_SET_DRAW_F, (long)shadowedbox_draw },
        { Pt_SET_FLAGS, 0, Pt_RECTANGULAR },
        { Pt_SET_NUM_RESOURCES,
          sizeof( resources ) / sizeof( resources[0] ) },
        { Pt_SET_RESOURCES, (long)resources,
          sizeof( resources ) / sizeof( resources[0] ) },
        };

    // create the widget class
    return( ShadowedBox->wclass = PtCreateWidgetClass(
        PtBasic, 0, sizeof( args )/sizeof( args[0] ), args ) );
}
```

The class definition includes:

Resources array
: The static array *resources* defines the class resources. The class resources are accessed through a table of resources unique to the **`ShadowedBox`** class.

Widget class array
: The static array *args* defines the **`ShadowedBox`** class. It defines **`ShadowedBox`**'s class methods and its table of resources.

  The *args* array is passed to *PtCreateWidgetClass()* as follows:

```
return( ShadowedBox->wclass = PtCreateWidgetClass(
   PtBasic, 0, sizeof( args )/sizeof( args[0] ), args )
   );
```

  In *PtCreateWidgetClass()*, space is allocated for the **`ShadowedBox`** class and its superclass's structure (i.e. **`PtBasic`**) is copied in. Then the *args* array is used to set up the custom class and its table of unique resources.

Setting default values

After the **`ShadowedBox`** class is initialized, space is allocated for its instance structure. The Defaults methods of all ancestors of the **`ShadowedBox`** class are called next, ending with **`ShadowedBox`**'s Defaults method (e.g. *shadowedbox_dflts()*):

```
//
// ShadowedBox defaults function
//
static void shadowedbox_dflts( PtWidget_t *widget )
{
    ShadowedBoxWidget    *sb = ( ShadowedBoxWidget * ) widget;
    PtBasicWidget_t      *basic = ( PtBasicWidget_t * ) widget;

    basic->fill_color    = Pg_WHITE;
    sb->shadow_color     = Pg_BLACK;
    sb->shadow_offset    = 4;
}
```

To access the private members of the instance structure, this Defaults method casts the *widget* pointer to a **`ShadowedBoxWidget`** pointer and a **`PtBasicWidget_t`** pointer. It then defaults the *fill_color* member to Pg_WHITE, the *shadow_color* member to Pg_BLACK and the *shadow_offset* member to 4.

Setting application resources

After the Defaults method is called, the array of resources provided to *PtCreateWidget()* is applied. In the sample source code, these two resources are passed in *args*:

```
PtSetArg( &args[0], Pt_ARG_AREA, &area, 0 );
PtSetArg( &args[1], SBW_SHADOW_COLOR, Pg_BLUE, 0 );
```

The first resource manifest, *Pt_ARG_AREA*, sets the widget area (position and size). Because this resource isn't defined by the **ShadowedBox** class, it's handled by the first superclass that defines *Pt_ARG_AREA* (i.e. **PtWidget**).

The second resource manifest *SBW_SHADOW_COLOR* is handled by the **ShadowedBox** class. Because **ShadowedBox** doesn't define a method for setting the resource value, the Photon widget library takes care of assigning a new value to this instance structure member (i.e. the value is changed from the default, Pg_BLACK, to Pg_BLUE).

Finally, *PtCreateWidget()* returns the widget pointer and the application receives access to a newly created instance of the **ShadowedBox** class:

```
box = PtCreateWidget( ShadowedBox, Pt_DEFAULT_PARENT,
                      2, args );
```

Now *box* points to an instance of the **ShadowedBox** class, but the widget itself won't be displayed until it's realized.

Realizing a widget instance

There are a number of class methods used in the process of realizing a widget. These methods are executed in a specific order that we'll call "steps":

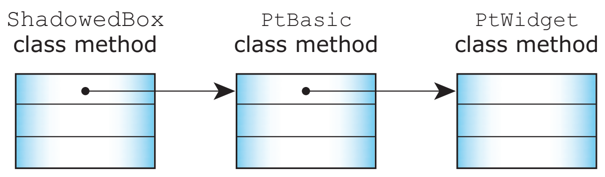
Step	What it does
Initialization method	Initializes the widget instance.
Extent method	Calculates the actual widget extent based on the area specified.
Connection method	Creates any optional Photon regions.
Realization method	Performs any operations required immediately prior to drawing.
Draw method	Draws the widget.

The **ShadowedBox** example doesn't define an Initialization method, an Extent method, or a Connection method. These methods are handled by **PtWidget** or **PtBasic**.

Processing methods

Before we get into a detailed discussion of the individual methods used in a widget class, we need to look at their usage in general. Class methods can be *chained* up or down or *inherited*.

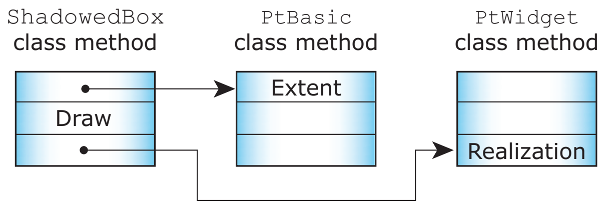
When a method is chained, the method of each class in the widget hierarchy is executed. Execution can start at the lowest class (e.g. **ShadowedBox**) in the hierarchy and go up, or at the highest class (i.e. **PtWidget**) and go down.



Methods being chained up.

Some chained methods can be stopped. This means any class in the hierarchy can stop the chaining process to prevent the superclass or subclassed methods from being executed. When chaining is stopped, the class stopping the chain is responsible for supplying the equivalent functionality otherwise provided by another class.

Inherited methods work differently: one method only is called, as determined by the lowest class in the hierarchy to define it (e.g. our **`ShadowedBox`** class doesn't define an Extent method, so the Extent method is inherited from the **`PtBasic`** superclass).



Inherited methods.

This means **`PtBasic`**'s Extent method is used to determine the size of the **`ShadowedBox`** widget. Inherited methods make building a widget class easier because only the methods unique to a class need to be defined.

Let's look at the class methods in more detail. The following table shows whether the methods of a basic widget are chained or inherited:

Method	Processing	Processing note
Defaults	Chained down	Can't be stopped
Initialization	Chained up	Return Pt_END to stop
Extent	Inherited	
Connection	Chained up	Return Pt_END to stop
Realization	Inherited	
Draw	Inherited	
Unrealization	Chained up	Can't be stopped

continued. . .

Method	Processing	Processing note
Destruction	Chained up	Can't be stopped
Set Resources	Inherited	
Get Resources	Inherited	

`PtBasic` extends these methods with three other methods. These methods are available only to subclasses of **`PtBasic`**:

Method	Processing
Got Focus	Inherited
Lost Focus	Inherited
Calc Opaque Rect	Inherited

Initialization method

This is the first class method called during the realization process. This method is chained up; the Initialization method of the **`ShadowedBox`** class would be called first, followed by the Initialization method of the **`PtBasic`** class, ending with **`PtWidget`**'s Initialization method.

Extent method

This inherited method is used to determine the exact size of the widget based on default values and/or the widget's position, size, margins, borders, and highlighting information, as set by the program. An Extent method isn't defined for **`ShadowedBox`**, so the Extent method is inherited from the **`PtBasic`** superclass.

Connection method

The Connection method is chained up. It's used primarily for creating any Photon regions needed by a widget. Due to its simplicity, the **`ShadowedBox`** widget doesn't require any regions — a superclass method will create regions for **`ShadowedBox`** only if needed (e.g. a custom cursor is defined).

Realization method

The Realization method is used to adjust any region attributes prior to the actual drawing of a widget. Because **`ShadowedBox`** doesn't define a Realization method, it's inherited from a superclass.

Draw method

This is the last class method called during the realization process. It's used to render a widget on the screen. This method can be inherited, but since **`ShadowedBox`** defines its own Draw method (shown below), it's executed instead of a superclass's Draw method:

```
//
// ShadowedBox draw function
//
static void shadowedbox_draw( PtWidget_t *widget, PhTile_t *damage )
{
    ShadowedBoxWidget    *sb = ( ShadowedBoxWidget * ) widget;
    PtBasicWidget_t      *basic = ( PtBasicWidget_t * ) widget;
    PhRect_t             shadow_rect, rect;
    PgColor_t            color;

    // We want to use basic's draw function to get borders
    // and default focus rendering... but we don't want it to
    // fill the background with the basic fill color,
    // so we set the fill color to transparent for Basic's draw func.
    color = basic->fill_color;
    basic->fill_color = Pg_TRANSPARENT;
    PtSuperClassDraw( PtBasic, widget, damage );

    // we don't want to draw outside our canvas! So we clip.
    PtCalcCanvas( widget, &rect );
    PtClipAdd( widget, &rect );

    basic->fill_color = color;
    shadow_rect = rect;
    shadow_rect.ul.x += sb->shadow_offset;
    shadow_rect.ul.y += sb->shadow_offset;
    PgSetStrokeColor( sb->shadow_color );
    PgSetFillColor( sb->shadow_color );
    PgDrawRect( &shadow_rect, Pg_DRAW_FILL_STROKE );

    PgSetFillTransPat( basic->trans_pattern );
    PgSetStrokeColor( basic->color );
    PgSetFillColor( color );
    rect.lr.x -= sb->shadow_offset;
    rect.lr.y -= sb->shadow_offset;
    PgDrawRect( &rect, Pg_DRAW_FILL_STROKE );

    /* remove the clipping */
    PtClipRemove();
}
```

Let's look at the code in more detail. From the function declaration:

```
static void shadowedbox_draw( PtWidget_t *widget, PhTile_t *damage )
```

The Draw method is passed two arguments. The *widget* argument is the widget's pointer and the *damage* argument is a list of damage rectangles to be applied to the widget when it's drawn.

The program can use the damage list to make intelligent decisions about what to draw. However, drawing operations for most widgets are minimal and any extra processing might not be worthwhile.

Notice the widget pointer is of type **PtWidget_t**, which means the pointer must be cast to a **ShadowedBoxWidget** pointer to allow access to the **ShadowedBox** widget's internal structure members. Since **PtBasic** is a superclass of **ShadowedBox**, we can cast the widget pointer to a **PtBasicWidget_t** structure too; this allows access to the *basic* widget members without resorting to *sb*->*basic*.

```
 ShadowedBoxWidget *sb = ( ShadowedBoxWidget * ) widget;
 PtBasicWidget_t   *basic = ( PtBasicWidget_t * ) widget;
```

Since the Draw method isn't chained, all drawing of the **ShadowedBox** widget, including the borders and highlighting common to all Photon-style widgets, must be done within the Draw method of the **ShadowedBox** class. For convenience, the Photon widget building library allows you to call the draw method of a superclass using *PtSuperClassDraw()* as shown below:

```
    // We want to use basic's draw function to get borders
    // and default focus rendering... but we don't want it to
    // fill the background with the basic fill color,
    // so we set the fill color to transparent for Basic's draw func.
    color = basic->fill_color;
    basic->fill_color = Pg_TRANSPARENT;
    PtSuperClassDraw( PtBasic, widget, damage );
```

After this, we add clipping so we won't draw beyond the widget's canvas:

```
    // we don't want to draw outside our canvas! So we clip.
    PtCalcCanvas( widget, &rect );
    PtClipAdd( widget, &rect );
```

The rest of the code in the Draw method determines the widget's position and size based on its area and margins, and then draws a shadowed box using low-level Photon *Pg*()* graphics functions. Before leaving the Draw method, the clipping we added is removed by calling *PtClipRemove()*.

When the draw buffer is flushed later on, the widget appears on the screen.

After realizing a widget

After a widget is realized, it must be ready to:

- handle any changes made to its resources
- redraw itself when damaged or exposed

Fortunately, both of these operations are handled automatically because of the way widget classes are defined — the resource list specifies what should be done if the value of a resource changes:

```
static PtResourceRec_t resources[] = {
    SBW_SHADOW_COLOR, Pt_CHANGE_REDRAW, 0,
        Pt_ARG_IS_NUMBER( ShadowedBoxWidget, shadow_color ), 0,
    SBW_SHADOW_OFFSET, Pt_CHANGE_RESIZE_REDRAW, 0,
        Pt_ARG_IS_NUMBER( ShadowedBoxWidget, shadow_offset ), 0,
    };
```

In the example source code for **ShadowedBox**, both resources are defined with a **Pt*REDRAW** manifest so they're automatically marked as damaged. This causes a redraw if the value changes.

When a widget is damaged for any reason, the Photon library automatically invokes the widget's Draw method to repair the damage. If any of the inherited resources are changed, they're handled according to the resource declaration of the first superclass to define that resource.

Destroying a widget

The widget must handle its own destruction. This process involves:

- unrealizing the widget
- destroying the widget

Unrealization method

The purpose of this method is to undo everything of consequence done during realization. The Unrealization method is responsible for:

- removing any open regions owned by a widget
- erasing the widget from the screen through the widget library
- making the widget noninteractive

This method is chained up. Since the **`ShadowedBox`** class doesn't define an Unrealization method, **`PtBasic`**'s Unrealization method will be called, followed by **`PtWidget`**'s Unrealization method.

Destruction method

This method is responsible for releasing any system resources used by a widget but not referenced by a widget resource. Like the Unrealization method, it's chained up. This lets all classes in the hierarchy release system resources in turn.

Other methods

The remaining class methods aren't described in this section, but you should now have a general understanding of the overall process. The Anatomy of a Widget chapter describes these methods in detail. Let's now look at some of the additional requirements for container and compound classes.

Container widgets

The life cycle of a container widget is similar to that of a basic widget. The main difference is that container widgets must support widget children, including the following features:

- child constraints
- child redirection

The Extent method of a container class is very important — it must enforce its resize policy based on its children. This means a container widget may need to determine its size based on the positions and sizes of its children. For this reason, all child widgets are extented before the container is extented.

Child constraints

The container class extends the **PtBasic** class definition with a number of child-constraint methods. These methods let a container adjust itself automatically according to any changes made to its children. These child-constraint methods include:

- Child Created
- Child Realized
- Child Moved/Resized
- Child Unrealized
- Child Destroyed
- Child Setting Resources
- Child Getting Resources
- Child Getting Focus
- Child Losing Focus

A container dynamically identifies which child constraints need to be handled by setting and clearing bits in the *flags* member of its instance of the class structure. For example:

```
    cntr->flags |= Pt_CHILD_CREATED;
```

Any child-constraint method a container will support must have its bit set in *cntr*->*flags* or the method won't be invoked.

Child redirection

A custom container class can optionally provide a child-redirector function to restrict certain widget classes from being added to the container. This function allows the container to redirect parentage to other widgets inside or outside the container itself. The redirector function is usually defined in the class-creation function. For example:

```
{ Pt_SET_CHILD_REDIRECT_F, (long)PtSampContainerRedirect },
```

The **PtMenuBar** widget uses this feature to prevent certain types of widgets from being added to a menu bar. For more information, see "Container widget anatomy" in the Anatomy of a Widget chapter.

Compound widgets

The compound class is used to design widgets made from other widgets. The compound class is a subclass of the container class, so it inherits the functionality described above for containers. In addition, the compound class adds a mechanism for *exporting* subordinate widgets. This is achieved by extending the container class definition to include:

- the number of subordinates
- a list of subordinates
- the number of blocked resources
- a list of blocked resources

The exporting mechanism lets users set and get the resources of subordinate widgets by treating the compound widget as if it actually were the subordinate widget.

A good example is the **PtComboBox** widget — it's built from a text widget and a list widget. It also defines its own behavior by supplying a pull-down button beside the text widget for accessing the list widget.

You can change the subordinate widgets inside a compound widget using the resources defined for the subordinate widgets. For example, you could change the **PtText** widget inside a **PtComboBox** widget by using the widget pointer of the **PtCompound** widget as follows:

```
PtArg_t args[1];

PtSetArg( &args[0], Pt_ARG_TEXT_STRING,
          "Subordinate Text", 0 );
PtSetResources( mycombobox_widget_pointer, 1, args );
```

This is a very powerful feature that greatly simplifies the construction of compound widgets since resources don't have to be duplicated.

However, changing the resources of subordinate widgets could destroy the look and feel of a compound widget. For this reason, we recommend that you consider using the blocking mechanism in a custom compound class. The blocking mechanism lets the compound class discard attempts to set specific resources on its subordinate widgets. The compound class can override any resource defined by its superclasses or by its subordinate widgets.

Exporting subordinate widgets

A compound widget identifies the widgets it intends to export in the class-creation function. This is done by setting values for the number of subordinates and the list of subordinates.

Each widget specified in the list of subordinates *must* be created in the Defaults method of the compound class.

For more information, see "Compound widget anatomy" in the Anatomy of a Widget chapter.

Chapter 3
Anatomy of a Widget

In this chapter. . .

The first part of this chapter discusses requirements applicable to all widget classes:

This section:	**Describes:**
Defining resources	All aspects of defining resources
Defining the widget class	The widget class structure and each of its fields
Class methods	Every class method and how each is used
Widget actions	How to make your widget interactive

You'll find information about the additional requirements for building container and compound widgets at the end of the chapter.

Defining resources

There are two steps to defining the resources of your widget class (aside from deciding what they should be in the first place):

1. Defining the resource manifests and numbers.
2. Defining the resource records to provide access to the resources of the widget class via resource manifests.

Resource manifests

Define the resources to introduce for a widget class (i.e. the resources that don't already exist in any of the widget superclasses). This is done in the widget's header file (e.g. **PtButton.h**) as a series of **#define** statements:

```
/*
 * PtButton public
 */

extern PtWidgetClassRef_t *PtButton;

#define Pt_BUTTON_ID    6

/* Resources */
#define Pt_ARG_ARM_COLOR        Pt_RESOURCE( 6, 0 )
#define Pt_ARG_ARM_IMAGE        Pt_RESOURCE( 6, 1 )
#define Pt_ARG_ARM_DATA         Pt_ARG_ARM_IMAGE
#define Pt_ARG_ARM_FILL         Pt_RESOURCE( 6, 2 )
#define Pt_ARG_SET_FILL         Pt_ARG_ARM_FILL

/*
 * PtButton private
 */

/* Widget structure */
typedef struct Pt_button_widget {
    PtLabelWidget_t         label;
    PgColor_t               arm_color;
    PhImage_t               *arm_data;
    PhImage_t               *unarmed_data;
    unsigned char                 arm_fill;
    PtCallbackList_t        *activate;
} PtButtonWidget_t;
```

All resource manifest names and numbers must be unique. In the above example, Pt_ARG_ARM_COLOR represents a unique resource manifest name, **`Pt_RESOURCE( 6, 0 )`** represents a unique resource number, and the resource itself has a corresponding entry in the widget instance structure called *arm_color*.

When you build a new widget, you need to pick a unique widget number for it. The header file **`PtT.h`** contains two macros to help you do this:

```
Pt_RESOURCE( widget_number, resource_number)
Pt_USER( widget_number )
```

The *Pt_USER()* macro is designed for widgets being created for in-house use only. If you intend to distribute the widgets you create as a public domain or commercial library, please contact QNX Software System's Customer Service. They'll give you a unique range of widget numbers and assign your widget set a prefix. This will prevent your widget library from conflicting with another third party's commercial widget library.

In your first in-house widget, use:

```
#define MY_1ST_WIDGET_RESOURCE1 Pt_RESOURCE( Pt_USER( 1 ), 0 );
#define MY_1ST_WIDGET_RESOURCE2 Pt_RESOURCE( Pt_USER( 1 ), 1 );
```

In your second in-house widget, use:

```
#define MY_2ND_WIDGET_RESOURCE1 Pt_RESOURCE( Pt_USER( 2 ), 0 );
#define MY_2ND_WIDGET_RESOURCE2 Pt_RESOURCE( Pt_USER( 2 ), 1 );
```

The macro *Pt_USER*`( 1 )` defines a widget number that allows up to 1000 resources: it specifies the widget number 5,001,000. The macro *Pt_USER*`( 2 )` defines the number 5,002,000, and so on.

The second part of the *Pt_RESOURCE()* macro defines the resource number: **`Pt_RESOURCE( Pt_USER( 2 ), 5 )`** defines the resource number 5,002,005. The widget defined by **`Pt_USER( 2 )`** can define unique resources numbers from 5,002,000 to 5,002,999.

`PtResourceRec_t` resource records

Resource records are used to connect the resource manifests described above with the widget's structure members. The resource records are defined as a table in the source code file and are passed as an argument when you first create the widget class.

This is a table of **`PtResourceRec_t`** items. This structure is declared as follows:

```
typedef struct Pt_resource_rec {
  unsigned long  type;
  void           (*mod_f)( PtWidget_t *, PtArg_t const *,
                  struct Pt_resource_rec const *  );
  int            (*query_f)( PtWidget_t *,
                 PtArg_t *, struct Pt_resource_rec const *  );
  unsigned long  arg_value;
  unsigned long  arg_len;
}  PtResourceRec_t;
```

type member

The value (manifest) to which this record is connected through a widget instance member. For example, Pt_ARG_FLAGS.

mod_f member

The function to call when this resource is being set by the user. You can provide your own function if you want to do addtional processing. The third argument is a pointer to a **`PtResourceRec_t`** with the data filled in by the library which your *mod_f* function can pass to *PtSetStruct()* to modify the resource.

This member recognizes several special convenience values other than the address of a function. Special values include:

Pt_CHANGE_INVISIBLE

Set the widget member but otherwise leave the widget unaffected.

Pt_CHANGE_REDRAW

Change the widget member and damage the widget (this causes a redraw).

Pt_CHANGE_INTERIOR

Same as Pt_CHANGE_REDRAW, except the widget's canvas alone is damaged (the borders aren't redrawn).

Pt_CHANGE_RESIZE

Change the widget structure member and flag the widget for resize. The resize is held off until the end of the *PtSetResources()* call in case other Pt_CHANGE_RESIZE-type resources are set in the same call. The resize is performed via *PtMoveResizeWidget()*, and the Extent method of the widget class is called.

Pt_CHANGE_RESIZE_REDRAW

Same as Pt_CHANGE_RESIZE, but forces a redraw even if the widget's dimensions or extent aren't changed.

Pt_CHANGE_PREVENT

Don't change the widget structure member and don't affect the widget. Indicates a read-only resource.

Pt_CHANGE_CANVAS

Invalidate the widget's canvas so that it's recalculated the next time it's requested. Additionally, resize the widget.

Pt_CHANGE_CANVAS_REDRAW

The same as Pt_CHANGE_CANVAS, but force the widget to be redrawn even if its canvas and extent aren't changed.

query_f member

The function to call when this resource is being queried via *PtGetResources()*. You can provide your own function if you want to do addtional processing. The third argument is a pointer to a `PtResourceRec_t` with the data filled in by the library which your *query_f* function can pass to *PtGetStruct()* to get the resource.

If no function is provided (i.e *query_f* is NULL), the resource is reported in the normal manner (see *PtSetArg()* and *PtGetResources()* in the Photon *Library Reference*).

The special values of the *query_f* field member include:

Pt_QUERY_PREVENT

Prevents access to the resource. Any pointers provided are set to NULL. Indicates a write-only resource.

arg_value and *arg_len* members

These are bit-encoded fields that set members of a widget structure. The *arg_value* member is used for all resources; *arg_len* is used to set a second widget structure member. For an array, *arg_len* has the type and offset of the array counter. For a Boolean value, *arg_len* is a bitmask. Unless the resource is an array or Boolean type, *arg_len* is normally 0.

The data encoded into these fields includes:

- the data type of the member this resource is associated with
- the offset from the address of the widget structure to the member to get/set
- if necessary for `struct` or array resources, the size of the structure member.

The following macros make using *arg_value* and *arg_len* more convenient:

- Pt_ARG_IS_NUMBER
- Pt_ARG_IS_FLAGS
- Pt_ARG_IS_STRING
- Pt_ARG_IS_STRUCT
- Pt_ARG_IS_POINTER
- Pt_ARG_IS_ALLOC
- Pt_ARG_IS_LINK
- Pt_ARG_IS_CALLBACK_LIST (or Pt_ARG_IS_CALLBACK)

- Pt_ARG_IS_BOOLEAN
- Pt_ARG_IS_ARRAY
- Pt_ARG_IS_IMAGE

The sections that follow describe the values of the *arg_value* and *arg_len* members for each type of resource. For most resources, *arg_len* isn't used; unless mentioned otherwise below, set it to 0.

Memory for some of the resources (indicated below) is allocated and freed as needed. If you have a Destruction method, you don't need to free the memory for these resources. If you do free any memory, you *must* set the pointers freed to NULL or unexpected results may occur.

Scalar resources

arg_value	**C type of *member1***
Pt_ARG_IS_NUMBER(*wgt*, *member1*)	**`char`**, **`short`**, or **`long`** (**`signed`** or **`unsigned`**)

Flags resources

arg_value	**C type of *member1***
Pt_ARG_IS_FLAGS(*wgt*, *member1*)	**`char`**, **`short`**, or **`long`** (preferably **`unsigned`**)

For Flags resources, the "mask" isn't part of the resource — it's just a way of telling the resource-setting API which bits the application wants to preserve.

String resources

arg_value	**C type of *member1***
Pt_ARG_IS_STRING(*wgt*, *member1*)	**`char *`**

This resource is allocated, based on the value returned by *strlen()*; see the note above.

Struct resources

These are widget members that are of a fixed size. When setting such resources, you pass a pointer to the value, and the value is copied into the widget structure. This type is useful for structures, as well as other data types that won't fit into a **`long`** (such as **`float`** or **`double`**).

Pointer resources

arg_value	**C type of *member1***
Pt_ARG_IS_POINTER(*wgt*, *member1*)	Any type of pointer, including **`void *`**

The widget does a shallow copy of the pointer's value.

Alloc resources

arg_value	**C type of *member1***
Pt_ARG_IS_ALLOC(*wgt*, *member1*)	Any type of pointer, including **`void *`**

Space is allocated for the resource, with the size specified by the application; see the note above.

Link resources

arg_value	**C type of *member1***
Pt_ARG_IS_LINK(*wgt*, *member1*)	A pointer to a structure

The structure must start with a "next" pointer. Space is allocated for the resource; see the note above.

Callback resources

arg_value	**C type of *member1***
Pt_ARG_IS_CALLBACK_LIST(*wgt*, *member1*)	A pointer to a structure

The structure must start with a "next" pointer. Space is allocated for the resource; see the note above.

Boolean resources

arg_value	**C type of *member1***
Pt_ARG_IS_BOOLEAN(*wgt*, *member1*)	**`char`**, **`short`**, **`int`**, or **`long`** (preferably **`unsigned`**)

The *arg_len* is the bitmask. It's not stored anywhere in the widget — it's just a constant that determines in which bit of the widget structure the resource is stored.

Array resources

arg_value	**C type of *member1***
Pt_ARG_IS_ARRAY(*wgt*, *member1*)	A pointer to some type

This type of resource also uses *arg_len*:

arg_len	**C type of *member2***
Pt_ARG_IS_NUMBER(*wgt*, *member2*)	**`char`**, **`short`**, or **`long`**

The size of each array element is the size of the type pointed to by *member1*. Space is allocated for the resource; see the note above.

Image resources

arg_value	**C type of *member1***
Pt_ARG_IS_IMAGE(*wgt*, *member1*)	**`PhImage_t *`**

Space is allocated for the resource; see the note above. For more information about the **`PhImage_t`** structure, see the Photon *Library Reference*.

Examples

Now let's look at some sample resource declarations. First let's look back at our original widget example, the **`ShadowedBox`** widget. It defines two resources in the header file:

```
/* widget resources */
#define SBW_SHADOW_COLOR   Pt_RESOURCE( Pt_USER( 0 ), 0 )
#define SBW_SHADOW_OFFSET   Pt_RESOURCE( Pt_USER( 0 ), 1 )

/* widget instance structure */
typedef struct shadowed_box_widget{
  PtBasicWidget_t   basic;
  PgColor_t         shadow_color;
  short             shadow_offset;
}   ShadowedBoxWidget;
```

The source code file defines the table of resources, which connects the resources to the widget class:

```
static PtResourceRec_t resources[] = {
    SBW_SHADOW_COLOR, Pt_CHANGE_REDRAW, 0,
        Pt_ARG_IS_NUMBER( ShadowedBoxWidget, shadow_color ), 0,
    SBW_SHADOW_OFFSET, Pt_CHANGE_RESIZE_REDRAW, 0,
        Pt_ARG_IS_NUMBER( ShadowedBoxWidget, shadow_offset ), 0,
    };
```

Let's examine the first resource in the table in more detail:

- *SBW_SHADOW_COLOR* is the *type* member, which we defined as a unique resource number at the top of the widget code.
- Pt_CHANGE_REDRAW is the *mod_f* member, which tells the library how this resource should be handled if the resource is set. It could be either a special value (as in the example) or a function within the source file code. In the example, Pt_CHANGE_REDRAW tells the library that the widget needs to be redrawn if the resource value changes.
- The next member, 0, is the *query_f* member, which tells the library how this resource should be retrieved. It can be one of:
  - 0, which causes the widget library to retrieve the resource based on the information provided by the *arg_value* and *arg_len* bit fields
  - a function within the source file
  - Pt_QUERY_PREVENT
- The next member is *arg_value*. This is a bit-encoded field. In our example, Pt_ARG_IS_NUMBER indicates that the widget structure member associated with this resource is a value of type **`char`**, **`short`**, or **`long`**.
- The last member, *arg_len*, is 0 (not used).

Now let's look at a more detailed example. In the widget header file we have:

```
/* widget resources */
#define MW_ARG_MY_CHARACTER     Pt_RESOURCE( Pt_USER(1), 0 )
#define MW_ARG_MY_STRING        Pt_RESOURCE( Pt_USER(1), 1 )
#define MW_ARG_MY_SHORT         Pt_RESOURCE( Pt_USER(1), 2 )
#define MW_ARG_MY_FLAGS         Pt_RESOURCE( Pt_USER(1), 3 )
#define MW_ARG_MY_FLAG_BIT      Pt_RESOURCE( Pt_USER(1), 4 )
#define MW_ARG_MY_POINT_ARRAY   Pt_RESOURCE( Pt_USER(1), 5 )
#define MW_ARG_MY_TAG_DATA      Pt_RESOURCE( Pt_USER(1), 6 )
#define MW_CB_MY_CALLBACK       Pt_RESOURCE( Pt_USER(1), 7 )

#define MW_MY_FLAG_BIT 0x04000000

/* widget instance structure */
typedef struct my_widget{
   PtBasicWidget_t  basic;          //Subclass of PtBasic.
   char       character;
   char       *my_string;
   short      my_short;
   long       flags;
   PhPoint_t  *points;              //Array of points.
   unsigned short   num_points;
   void       *tag_data;
   PtCallbackList_t  *my_callbacks; //Linked list of callbacks.
  } MyWidget_t;
```

In the class-creation function in the source code file we have:

```
static const PtResourceRec_t resources = {
     Pt_ARG_POS, arg_pos_override, 0,
       Pt_ARG_IS_NUMBER( PtWidget_t, area.pos ), 0,

     MW_ARG_MY_CHARACTER, Pt_CHANGE_REDRAW, 0,
       Pt_ARG_IS_NUMBER( MyWidget_t, character ), 0,

     MW_ARG_MY_STRING, Pt_CHANGE_RESIZE_REDRAW, 0,
       Pt_ARG_IS_STRING( MyWidget_t, my_string ), 0,

     MW_ARG_MY_SHORT, set_my_short, get_my_short, 0, 0,

     MW_ARG_MY_FLAGS, Pt_CHANGE_INVISIBLE, 0,
       Pt_ARG_IS_FLAGS( MyWidget_t, flags ), 0,

     MW_ARG_MY_FLAG_BIT, Pt_CHANGE_INVISIBLE, 0,
               Pt_ARG_IS_BOOLEAN ( MyWidget_t, flags ),
               MW_MY_FLAG_BIT,

     MW_ARG_MY_POINT_ARRAY, Pt_CHANGE_RESIZE_REDRAW, 0,
               Pt_ARG_IS_ARRAY( MyWidget_t, points ),
               Pt_ARG_IS_NUMBER( MyWidget_t, num_points ),

     MW_ARG_MY_TAG_DATA, Pt_CHANGE_INVISIBLE, 0,
       Pt_ARG_IS_ALLOC( MyWidget_t, tag_data ), 0,

     MW_CB_MY_CALLBACK, Pt_CHANGE_INVISIBLE, 0,
       Pt_ARG_IS_CALLBACK_LIST( MyWidget_t, my_callback ), 0,
          }
```

Pt_ARG_POS is inherited from **PtWidget**. Here we're overriding its *mod_f()* function with one of its own.

The *MW_ARG_MY_SHORT* resource and *mod_f()*/*query_f()* functions could look like this:

```
static void set_my_short( PtWidget_t *widget, PtArg_t *argt )
{
     MyWidget_t *mw = (MyWidget_t *)widget;

    if( mw->my_short == (short)argt->value )
       return; // don't do work if nothing is changing.

    mw->my_short = argt->value;

    // My widget needs to redraw when my_short changes...
    PtDamageWidget( widget );
}

static int get_my_short( PtWidget_t *widget, PtArg_t *argt )
```

```
{
    MyWidget_t *mw = (MyWidget_t *)widget;

    if( argt->value )
    // The address of a pointer to a short is in argt->value
          *(short **)argt->value = &mw->my_short;
     else
          argt->value = (long) mw->my_short;
    return Pt_TRUE;
    /* The only time one would return Pt_FALSE is if no data
       is given as a result of the query */
}
```

Defining the widget class

In Photon, a widget class is defined much a like a widget. You set up a list of arguments or class resources and call *PtCreateWidgetClass()*. This list is used to set the field members of the widget class structure that Photon uses to determine how to handle the widget.

Widget class structure

Let’s look at the general form of a **`PtWidgetClass_t`** structure:

```
struct Pt_widget_class {
        char            *description;
        struct Pt_widget_class  *superclass;
        PtWidgetClassRef_t      *class_ref;
        unsigned        class_len;
        unsigned        state_len;
        unsigned long   flags;
        void    (*dflts_f)( PtWidget_t * );
        int     (*init_f)( PtWidget_t * );
        int     (*connect_f)( PtWidget_t * );
        void    (*unrealize_f)( PtWidget_t * );
        void    (*destroy_f)( PtWidget_t * );
        void    (*realized_f)( PtWidget_t * );
        PtClassRawCallback_t const *callbacks;
        int     (*setres_f)( PtWidget_t *, int,
                            PtArg_t const *,
                            PtResourceRec_t const *rrec );
        int     (*getres_f)( PtWidget_t const *,
                            int, PtArg_t * );
        unsigned int    ex_state_len;
        struct Pt_resource_range *res_ranges;
        void    (*syncwidget_f)( PtWidget_t *widget );
        int     (*calc_region_f)( PtWidget_t *,
                                 unsigned int *,
                                 PhRegion_t *,
                                 PhRect_t * );
        PtResourceRec_t const   **res_all;
        unsigned short  res_nranges;
        unsigned char         num_actions;
        unsigned char   num_callbacks;
        PtWidgetAction_t        *actions;
        short           max_style_index;
        unsigned short  res_nall;
        PtWidgetClassStyle_t    **styles;
        unsigned        reserved[ 5 ];
};
```

Widget class structure description

Let's look at the **`PtWidgetClass_t`** structure one member at time:

`char *`*description*

The name of the widget type, for example "PtTree" if the widget is a **`PtTree`**.

`PtWidgetClass_t *`*superclass*

A pointer to the *superclass* of this widget class. This value defines the superclass this class inherits from. If a widget class is at the top of the hierarchy, this pointer is NULL.

`PtWidgetClassRef_t *`*class_ref*

A pointer to the *class_ref* structure for this widget class.

`unsigned` *class_len*

The size of this widget class (this differs from the superclass only if the class extends the superclass definition).

`unsigned` *state_len*

The size of the widget instance structure for this widget class.

`unsigned long` *flags*

A general flag field for widget classes. For valid flag bits, see the list below.

`void` (**dflts_f*)(**`PtWidget_t`** *)

Defines the Defaults method.

`int` (**init_f*)(**`PtWidget_t`**)

Defines the Initialization method.

`int` (**connect_f*)(**`PtWidget_t`** *)

Defines the Connection method.

`void` (**unrealized_f*)(**`PtWidget_t`** *)

Defines the Unrealization method.

`void` (**destroy_f*)(**`PtWidget_t`** *)

Defines the Destruction method.

`void` (**realized_f*)(**`PtWidget_t`** *)

Defines the Realization method.

`PtClassRawCallback_t *`*callbacks*

The array of widget actions (raw callbacks) for the widget class. If a function in the callback list has an event mask matching the event being handled, that function is invoked.

`int` (**setres_f*)(**`PtWidget_t *`**, **`int`**, **`PtArg_t`** *)

Defines the Set Resources method that's called when a user calls *PtSetResources()* on a widget of this class.

`int` (**getres_f*)(**`PtWidget_t`** *, **`int`**, **`PtArg_t`** *)

Defines the Get Resources method that's called when a user calls *PtGetResources()* on a widget of this class.

`unsigned int` *ex_state_len*

The length of *state_len*. Used internally.

`struct Pt_resource_range` **res_ranges*

Used internally.

`void` (**syncwidget_f*)(**`PtWidget_t`** **widget*)

Defines the Synchronize Widget method that's called when a user calls *PtSyncWidget()* on a widget of this class.

`int` (**calc_region_f*)(**`PtWidget_t`** *, **`unsigned int`** *, **`PhRegion_t`** *, **`PhRect_t`** *)

Defines the Calculate Region method that's called when the Photon library calls *PtCalcRegion()* on a widget of this class.

`PtResourceRec_t const` ***res_all*

Defines the resource manifest table for the widget class. The resource manifest table is an array of pointers to all the resource records defined or inherited by this class.

`unsigned short` *res_nranges*

The length of *res_ranges*. Used internally.

`unsigned char` *num_actions*

The number of items in the *actions* array.

`unsigned char` *num_callbacks*

The number of items in the *callbacks* array.

`PtWidgetAction_t` **actions*

A list of widget actions.

`short` *max_style_index*

The number of items in the *styles* array.

`unsigned short` *res_nall*

The number of items in the *res_all* array. Used internally

`PtWidgetClassStyle_t` ***styles*;

An array of styles for this widget class.

`unsigned` *reserved*[5]

Reserved for future use.

These are the valid flag bits for the *flags* member:

Pt_CONTAINER	The widget class is a container.
Pt_RECTANGULAR	Rectangular widgets are opaque when filled. Opaque widgets don't damage widgets below them when they're modified (unless their size or position is modified).
Pt_FORCE_UNREALIZE (set automatically when required)	The Unrealization method (*unrealize_f()*) for this class and its superclasses is called when this widget is unrealized.
Pt_DISJOINT (e.g. **`PtWindow`**, **`PtMenu`**, **`PtRegion`**)	Indicates that widgets of this class own regions that aren't children of the regions of their widget parents. This means that a disjoint widget is *not* assumed to sit inside its parent, and therefore is responsible for collecting exposes and emitting draw stream for itself and its non-disjoint descendants.
Pt_NO_INHERITED_RESOURCES	Prevents the search for a resource from walking up through superclasses. Only the resources for this class are handled; all others are ignored. This doesn't prevent resources from being propagated to procreated widgets. This is handy for allowing common resources such as *Pt_ARG_COLOR* to pass to procreated children without having to write a resource-redirector function.
Pt_OCCLUSIVE	Drawing routines skip all children of a widget derived from an occlusive class. The rendering of these children is the responsibility of the occlusive widget.
Pt_BASIC	Indicates that the widget is a PtBasic or subclass.
Pt_FORCE_SYNC	Indicates widgets must be sized if the Pt_WIDGET_RESIZE flag is set during a set resource regardless of the widgets realized state.

Widget class resource table

Not all members of the widget class structure can be set directly; some are used internally by the widget library. The members you can change using the class resource manifests are:

Member	Description	Resource manifest
state_len	Instance length	Pt_SET_STATE_LEN
flags	Flags	Pt_SET_FLAGS
dflts_f	Defaults method	Pt_SET_DFLTS_F
init_f	Initialization method	Pt_SET_INIT_F
extent_f	Extent method	Pt_SET_EXTENT_F
connect_f	Connection method	Pt_SET_CONNECT_F
draw_f	Draw method	Pt_SET_DRAW_F
unrealized_f	Unrealization method	Pt_SET_UNREALIZE_F
realized_f	Realization method	Pt_SET_REALIZED_F
destroy_f	Destruction method	Pt_SET_DESTROY_F
resources	Table of resources	Pt_SET_RESOURCES
num_resources	Number of resources	Pt_SET_NUM_RESOURCES
callbacks	Raw callbacks	Pt_SET_RAW_CALLBACKS
setres_f	Set Resources method	Pt_SET_SETRESOURCES_F
getres_f	Get Resources method	Pt_SET_GETRESOURCES_F
version	Version number	Pt_SET_VERSION
description	Textual description of the class; see below.	Pt_SET_DESCRIPTION

For the description, you might include something like this in your class definition:

```
static const PtArg_t args[] =
{
  ...

  { Pt_SET_DESCRIPTION, (long) "PtButton" },
  ...
};
```

In general, it's assumed that the description corresponds to the widget's name (i.e. applications might conceivably use this field to display the name of the widget's class) and hence it's recommended you follow this practise. If additional information is required, the convention adopted is to append a colon (`:`) followed by the text; applications that use this description field will look for the first `:` and parse based on it.

So this would translate the above example to

```
  { Pt_SET_DESCRIPTION, (long) "PtButton:dave was here" },
```

This is a convention, not a rule. You can use this field for whatever you want, as long as you realize that some applications might use this field (for informational purposes only). The most graceful way to have such applications disregard this field altogether is to precede the text with a a colon, like this:

```
{ Pt_SET_DESCRIPTION, (long) ":dave was here" },
```

in which case, the application should indicate a “value not known” state (i.e. disregard anything past the **:** in all cases).

When defining a custom widget class, you can extend the definition of its superclass with new “class-level” methods and/or callbacks. For example, the **PtWidget** class is extended by **PtBasic**, which adds new class methods for providing focus notification. This was done as shown in the following excerpt from the **PtBasic.h** header file:

```
typedef struct Pt_basic_widget_class {
     PtWidgetClass_t     core;
     void                (*got_focus_f)( PtWidget_t *,
                                        PhEvent_t * );
     void                (*lost_focus_f)( PtWidget_t *,
                                         PhEvent_t * );
     void                (*calc_opaque_f)( PtWidget_t * );
     } PtBasicWidgetClass_t;

#define Pt_SET_GOT_FOCUS_F (Pt_ARG_IS_POINTER(PtBasicWidgetClass_t,got_focus_f))
#define Pt_SET_LOST_FOCUS_F (Pt_ARG_IS_POINTER(PtBasicWidgetClass_t,lost_focus_f))
#define Pt_SET_CALC_OPAQUE_F (Pt_ARG_IS_POINTER(PtBasicWidgetClass_t,calc_opaque_f))
```

When a class definition is extended in this way, the new class structure size must be passed as the second parameter to *PtCreateWidgetClass()*:

```
PtBasic->wclass = PtCreateWidgetClass( PtWidget,
                      sizeof(PtBasicWidgetClass_t ),... );
```

If the class isn’t extended, the second parameter may be passed as 0. Also, when the class is extended, you must define new Pt_SET* manifests to provide access to the new class members from the create class function.

PtBasic class resource additions

The **PtBasic** widget class provides the following three additional structure members:

Member	Description	Resource manifest
got_focus_f	Got Focus method	Pt_SET_GOT_FOCUS_F
lost_focus_f	Lost Focus method	Pt_SET_LOST_FOCUS_F
calc_opaque_f	Calc Opaque Rect method	Pt_SET_CALC_OPAQUE_F

Let's look at the class resource table from our **ShadowedBox** example in more detail:

```
static PtArg_t args[] = {
    { Pt_SET_VERSION, 110},
    { Pt_SET_STATE_LEN, sizeof( ShadowedBoxWidget ) },
    { Pt_SET_DFLTS_F, (long)shadowedbox_dflts },
    { Pt_SET_DRAW_F, (long)shadowedbox_draw },
    { Pt_SET_FLAGS, 0, Pt_RECTANGULAR },
    { Pt_SET_NUM_RESOURCES,
      sizeof( resources ) / sizeof( resources[0] ) },
    { Pt_SET_RESOURCES, (long)resources,
      sizeof( resources ) / sizeof( resources[0] ) },
    };
```

Pt_SET_VERSION	Tells the widget library what style this widget is. For your widgets, this value is always at least 110 (110 corresponds to Photon 1.10 style).
Pt_SET_STATE_LEN	Defines the length of the widget instance structure.
Pt_SET_DFLTS_F	Defines the Defaults method, which is called to set default values for the widget when it's first created. In our example, this function is called *shadowedbox_dflts()*.
Pt_SET_DRAW_F	Defines the Draw method (e.g. *shadowedbox_draw()*), which is called when the widget needs to be drawn.
Pt_SET_FLAGS	Defines behavioral flags related to this widget class. This example turns off the Pt_RECTANGULAR flag, which indicates the widget can't take advantage of flicker-free, opaque-drawing methods.
Pt_SET_NUM_RESOURCES	Defines the number of resources in the table.
Pt_SET_RESOURCES	Defines the table of resources unique to this widget, as described above.

Class methods

This section describes the role and responsibilities of the class methods defined in the widget class structure. The fundamental methods defined by **PtWidget** are:

- Defaults
- Initialization
- Extent
- Connection

- Realization
- Draw
- Unrealization
- Destruction
- Set Resources
- Get Resources

The **PtBasic** widget extends these with three additional methods:

- Got Focus
- Lost Focus
- Calc Opaque Rect

These are the methods you write to define the functionality of your widget. Not all methods need to be defined and coded by a widget class; they can be inherited from a superclass. Almost all widgets need at least the Draw method, since the primary purpose of building a custom widget is to draw something.

Defaults method

Type: Chained down, unstoppable

This method sets the default values for all widget instance structure members. It's called during the creation of a widget instance (call to *PtCreateWidget()*). When a widget instance is first created, all members of the instance structure are zeroed out and then the Defaults method for each parent class (starting from **PtWidget** at the top) are called in sequence from top to bottom. This allows the lower-level classes to override the default values set by the parent classes in the hierarchy. Here's an example showing how to initialize **PtBasic** variables:

```
static void basic_dflts( PtWidget_t *widget )
{

PtBasicWidget_t *basic = (PtBasicWidget_t *) widget;

  widget->border_width = 2;
  widget->cursor_color = Ph_CURSOR_DEFAULT_COLOR;
  widget->resize_flags |= Pt_RESIZE_XY_AS_REQUIRED;

  basic->color = Pg_BLACK;
  basic->fill_color = Pg_GREY;
  basic->top_border_color = Pg_WHITE;
  basic->bot_border_color = Pg_DGREY;
  basic->flags = Pt_DAMAGE_ON_FOCUS;
}
```

Although the instance variables in this example are specific to **PtBasic**, the initialization technique is common to all Defaults methods.

Initialization method

Type: Chained up, stoppable

This is the first method called when a widget is realizing (call to *PtRealizeWidget()*). The Initialization method does final checks to ensure the widget is "extentable." This check ensures all members used in the subsequent Extent method are correctly assigned.

The Initialization method is also the best place to create unexported subordinate widgets. Unexported subordinate widgets are used by the widget but not available to the user. For example, a widget such as **PtPrintSel** uses other widgets (**PtText**, **PtLabel**, and **PtButton**) but doesn't allow the user to act directly on the subordinate widgets. Instead, the widget provides new unique resources used internally to set the subordinate widgets. For more information about exported subordinate widgets, see "Compound widget anatomy" later in this chapter.

Initialization is executed each time the widget is realized. The Initialization method is called first for this widget followed by its parent superclass and so on until the core widget class (**PtWidget**) is reached. Any widget class in the chain can terminate the chaining process by returning Pt_END.

Here's an example showing how a **PtContainer** widget is initialized:

```
static in PtContainerInit( PtWidget_t *widget )
{
  PtContainerRegister( widget );
  return( Pt_CONTINUE );
}
```

The Initialization method is also used to register widgets for balloon handling. All container widgets provide a default balloon-handling mechanism. If you want your widget to support popup help balloons, you must register the widget with the container in this function. Here's an excerpt from the **PtLabel** code:

```
static int label_init( PtWidget_t *widget )
{
    PtLabelWidget_t *label = (PtLabelWidget_t *) widget;
    PtBalloonCallback_t bcalls;
    PtArg_t argt;

  if( (label->flags & Pt_SHOW_BALLOON)
     && ( !( label->flags & Pt_BALLOON_REGISTERED ) ) )
  {
     bcalls.widget  = widget;
     bcalls.event_f = label_balloon_callback;
     PtSetArg( &argt, Pt_CB_BALLOONS, &bcalls, 0 );
     PtSetResources( widget->parent, 1, &argt );
     label->flags |= Pt_BALLOON_REGISTERED;

  }
  return Pt_CONTINUE;
}
```

Extent method

Type: Inherited

This is the second method called during the realization of a widget (call to *PtRealizeWidget()*). The Extent method is responsible for determining the widget's screen real estate (bounding box) with regard to its resize policy. The Extent method is called frequently during the life of a widget — whenever the widget is moved or resized, or resources marked as Pt_CHANGE_RESIZE or Pt_CHANGE_RESIZE_REDRAW are modified.

The following are examples of these types of resources, as defined by the **PtWidget** class:

```
static PtResourceRec_t resources[] = {
{  Pt_ARG_AREA, Pt_CHANGE_RESIZE, 0,
   Pt_ARG_IS_STRUCT(PtWidget_t, area) },

{  Pt_ARG_POS, Pt_CHANGE_RESIZE, 0,
   Pt_ARG_IS_STRUCT(PtWidget_t, area.pos) },

{  Pt_ARG_DIM, Pt_CHANGE_RESIZE, 0,
   Pt_ARG_IS_STRUCT(PtWidget_t, area.size) },
};
```

In addition, the Extent method is called whenever any other resource causes a widget to change size or position. The following example code is taken from **PtLabel**:

```
static PtResourceRec_t resources[] = {
{ Pt_ARG_LABEL_TYPE, Pt_CHANGE_RESIZE_REDRAW, 0,
  Pt_ARG_IS_NUMBER(PtLabelWidget_t, type), 0 },
};
```

The widget engine uses the extent calculated in this method to determine when this widget is involved in an event, when the widget needs to be repaired, and which other widgets need to be repaired when this one changes.

Every widget class inherits the Extent method of its superclass. If this method is suitable, you won't need to provide your own Extent method. If the superclass's Extent method isn't quite what your widget needs, you should provide only what the widget's superclass doesn't provide, then call the Extent method of the superclass to do the rest of the work.

It's unusual to write an Extent method that calculates the entire extent without using the superclass's method. Quite often you'll want most, but not all, of the superclass's extent behavior. There's usually a way to prevent the Extent method of the superclass from performing any set of extenting behaviors (see the "Extent method" sections in the Using Widget Superclasses chapter for details).

Extenting a widget usually involves four stages:

1. Calculate the canvas. Check the chapter on Using Widget Superclasses for canvas services. The canvas is the area within which a widget must restrict its rendering. The canvas function is *PtCalcCanvas()*.

2. Calculate the render rectangle. This is the bounding box area required for this widget to display all its data, including points, widget children, any text strings, etc.

3. Call *PtResizeCanvas()* passing to it the widget and desired size. *PtResizeCanvas()* applies the widget's resize policy automatically and modifies the widget's dimensions as required to ensure the widget conforms to its resize policy.

   If a widget's canvas can't be resized to encompass the render rectangle, *PtResizeCanvas()* sets the Pt_UCLIP bit in the widget's resize flags. The widget's Draw method should check the Pt_UCLIP bit. If this bit is set, the Draw method should apply clipping to prevent the widget from rendering outside its canvas.

4. Call:

   PtSuperClassExtent(PtBasic, *widget***)**
   to have the final extent calculation performed. The Extent method of **PtBasic** uses the widget's position, dimension, border width, and flags to determine the extent.

Here's an example showing how to apply these guidelines:

```
mywidget_extent( PtWidget_t *widget )
{
  MyWidgetUnion_t *mwu = (MyWidgetUnion_t *)widget;
  PhRect_t  canvas, render;
  PhDim_t size;

  PtCalcCanvas( widget, &canvas );
  render.ul = render.lr = canvas.ul;
  PgExtentText( &render, &render.ul, mwu->label.font,
              mwu->label.string, 0 );
  size.w = render.lr.x - render.ul.x + 1;
  size.h = render.lr.y - render.ul.y + 1;
  PtResizeCanvas( widget, &size );
  PtSuperClassExtent( PtBasic, widget );
}
```

Connection method

Type: Chained up, stoppable

This method creates Photon regions whenever a widget requires them. Generally, it isn't necessary to explicitly create your own region since the Connection method of **PtWidget** does this for you.

However, it may be beneficial to create your own region if you need to modify the region based on the current environment. For example, **PtMenu** widgets have to modify a region whenever they're displayed:

```
static int menu_connect( PtWidget_t *widget )
{
  PhRegion_t     region;
```

```
 unsigned       fields;
 PhRect_t       rect;
 PtMenuWidget_t *menu = (PtMenuWidget_t *)widget;
 PtWidget_t     *wp;

 /* calculate menu region */
 fields = UINT_MAX;
  if( !PtCalcRegion( &fields, widget, &region, &rect ) )
   return( -1 );

 /* open menu region */
 region.parent     = menu->ff_wgt->rid;
 region.events_opaque  |= Ph_EV_DRAW | Ph_EV_PTR_ALL;
 region.events_opaque  &= ~Ph_EV_KEY; region.events_sense
      |= Ph_EV_PTR_ALL; region.events_sense   &= ~Ph_EV_KEY;
 region.flags      = 0;
 fields |= Ph_REGION_PARENT | Ph_REGION_EV_SENSE |
          Ph_REGION_EV_OPAQUE;
 fields &= ~( Ph_REGION_BEHIND | Ph_REGION_IN_FRONT );
 widget->rid = PhRegionOpen( fields, &region, &rect, NULL );
 wp = widget;
while( PtWidgetIsClass( wp, PtMenu ) )
 {  menu_pdr_start( wp );
    if ( !wp->parent )
      break;
    wp = wp->parent->parent;
 }
   if( widget->parent &&
       PtWidgetIsClassMember( widget->parent, PtContainer ) )
 {  if( !( menu->flags & Pt_MENU_CHILD ) )
    {
      // If the menu is off a window, focus that window.
      PhEvent_t event;
      memset( &event, 0, sizeof( event ) );
      menu->prev_focus =
         PtContainerFindFocus( widget->parent );
      if( widget->parent->class_rec->flags & Pt_DISJOINT )
         PtContainerNullFocus( widget->parent, &event );
      else
      {
         int flags = widget->parent->flags;
         widget->parent->flags |= Pt_GETS_FOCUS;
         PtContainerGiveFocus(
         widget->parent, &event );
         widget->parent->flags = flags;
      }
    } else
      menu->flags |= Pt_MENU_SUBFOCUS;
    ((PtContainerWidget_t *)widget->parent)->focus = widget;
 }
 wp = PtFindDisjoint( widget );
 for( wp = wp->parent;
      wp && (PtWidgetIsClassMember(wp, PtMenu)
      || PtWidgetIsClassMember(wp, PtMenuButton));
      wp = wp->parent);
 if( wp )
 {
    wp = PtFindDisjoint( wp );
    if (PtWidgetIsClassMember( wp, PtWindow ))
       ((PtContainerWidget_t *)wp)->last_focus = NULL;
    if( !( PtWindowGetState( wp ) & Ph_WM_STATE_ISFOCUS ) ) {
      PtWindowFocus( wp );
    }
    }
  }

  /* stop init chaining */
  return( Pt_END );
}
```

If you create your own region, the Connection method of **`PtWidget`** won't create another region — it modifies the current region. To prevent modification of the current region, have the widget class return Pt_END.

Realization method

Type: Inherited

This method is called after a widget has been realized. Its function is similar to that of the *Pt_CB_REALIZED* callback, but unlike the *Pt_CB_REALIZED* callback, it can't be accessed by any developer using your widget.

This method is used primarily by compound widgets to perform any postrealize operations, such as realizing any subordinate widgets that couldn't be realized to this point. It's the last method to be called prior to the Draw method, and it's invoked just prior to the user's *Pt_CB_REALIZED* callbacks. For more information, see the section on "Compound widget anatomy."

Draw method

Type: Inherited

This is the last method called during the realization process. The Draw method is used to render the widget on the screen during realization and is called to redraw a widget afterwards whenever that widget is damaged.

When a widget is damaged, a pointer to the damaged widget and a list of tiles describing the damage are passed to the Draw method. The first tile in the damage list reveals the total extent of the damage (its bounding box encompasses all remaining tiles). The remaining tiles contain the actual extents damaged. Unless the widget is complex or passes a lot of draw data (large images) and can be sped up by drawing damaged areas only, you should ignore the damage list.

The widget library uses the damage list to clip parts that shouldn't be drawn. If you plan to use the damage tiles, make sure to translate the widget canvas using the widget's offset. Use *PtWidgetOffset()* to obtain the offset — the damage list is relative to the disjoint parent widget (usually a **`PtWindow`** widget).

The Draw method restricts its updates to the canvas of the damaged widget. This is done by setting a clipping rectangle if necessary. Here's a drawing example taken from the code for **`PtButton`**:

```
static void button_draw( PtWidget_t *widget, PhTile_t *damage )
{
  PtButtonWidget_t  *button = (PtButtonWidget_t *)widget;
  PgColor_t     tcolor;
  button->label.data = button->unarmed_data;
  /* set fill_color to arm_color if required */
  if ( widget->flags & Pt_SET )
  {
     if( button->arm_fill == 1 )
     {
       tcolor = button->label.basic.fill_color;
       button->label.basic.fill_color = button->arm_color;
     }
     if( button->arm_data )
       button->label.data = button->arm_data;
  }

  /* draw button - includes highlight */
  PtSuperClassDraw( PtLabel, widget, damage );

  /* restore fill_color */
  if ( widget->flags & Pt_SET )
  {
     if ( button->arm_fill == 1 )
        button->label.basic.fill_color = tcolor;
  }
}
```

The following code excerpt (from **PtArc**) shows how setting the Pt_UCLIP bit in the widget's resize flags affects clipping:

```
  PtCalcCanvas( widget, &rect );
  if ( widget->resize_flags & Pt_UCLIP )
     PtClipAdd( widget, &rect );
  PgDrawArc( &pos, &dim, start, end, arc->type | flags );
  if ( widget->resize_flags & Pt_UCLIP )
     PtClipRemove( );
```

Using the Pg library safely

You'll use the *Pg** functions in your widget's Draw method, but you need to use them safely. Here are some things to remember:

PgSetClipping()
PgSetMultiClip()
PgSetUserClip() These are used by the library. The only safe way of changing clipping in a widget's Draw method is to use *PtClipAdd()* and *PtClipRemove()* (see the Widget Building Library API chapter).

PgSetDrawMode()
PgSetPlaneMask()
PgSetStrokeCap()
PgSetTranslation()
PgSetUnderline() These aren't set by the library, but widgets assume they're set to their default values. If your Draw method changes any of them, you have to restore it.

PgSetPalette()
PgSetFillDither()
PgSetFillTransPat()
PgSetStrokeTransPat()
PgSetTextTransPat()
PgSetStrokeWidth()
PgSetStrokeDash()
PgSetStrokeDither()
PgSetStrokeJoin()

These are automatically reset to the default after a widget's Draw method returns. It's safe to change them.

PgSetFillColor()
PgSetStrokeColor()
PgSetTextColor()
PgSetFillXORColor()
PgSetStrokeXORColor()
PgSetTextXORColor()

There's no default for these. Set them as needed before drawing and don't worry about restoring them.

PgSetRegion() This is set by the library. If you change it, be sure to restore it.

For more information about these functions, see the Photon *Library Reference*.

Unrealization method

Type: Chained up

This method is called when a widget is being unrealized. The Unrealization method is responsible for removing any regions created by a widget (*widget*->*rid* is removed automatically by the **PtWidget** class's Unrealization method). The Unrealization method should free any memory that would be reallocated during the realization process.

The Unrealization method is also used to deregister widgets. For example, if a label widget registered a balloon in its Initialization method, it must deregister the balloon in the Unrealization method or the balloon will try to inflate whenever the mouse pointer pauses over the last location of the widget. Here's an example taken from the code for **PtLabel**:

```
static int label_unrealize(PtWidget_t *widget )
  { PtLabelWidget_t *label = (PtLabelWidget_t*)widget;
  PtBalloonCallback_t bcalls;
  PtArg_t arg;

  if(label->balloon_widget)
      PtDestroyWidget( label->balloon_widget );

  bcalls.widget = widget;
  bcalls.event_f = label_balloon_callback;
  if( label->flags & Pt_SHOW_BALLOON ){
     PtSetArg( &arg, Pt_CB_BALLOONS, &bcalls, Pt_LINK_DELETE );
     PtSetResources( widget->parent, 1, &arg );
  }
  label->flags &= ~Pt_BALLOON_REGISTERED;
  return Pt_CONTINUE;
}
```

Destruction method

Type: Chained up, unstoppable

This method is called when a widget is being destroyed by the application. The Destruction method is responsible for releasing all resources allocated by a widget class during its lifetime. The Destruction method doesn't deal with memory allocated by a widget's superclass, because each class is responsible for freeing its own memory. Here's an example taken from the code for **PtLabel**:

```
static int
label_destroy( PtWidget_t *widget )
  {
  PtLabelWidget_t *label = (PtLabelWidget_t *)widget;
  PtArg_t arg;
  PtBalloonCallback_t bcalls;
  if( label->flags & Pt_BALLOON_REGISTERED ) {
    bcalls.widget = widget;
    bcalls.event_f  = (void*)label_balloon_callback;
    if( label->flags & Pt_SHOW_BALLOON )
      {
      PtSetArg( &arg, Pt_CB_BALLOONS, &bcalls, Pt_LINK_DELETE );
      PtSetResources( widget->parent, 1, &arg );
    }
    label->flags &= ~Pt_BALLOON_REGISTERED;
  }
  return 0;
}
```

Set Resources method

Type: Inherited

This method is used to take over the standard resource setting process built into the Photon library. Compound widgets are the only widgets that set this method (see the section on "Compound widget anatomy").

Get Resources method

Type: Inherited

This method is used to take over the standard resource retrieval process built into the Photon library. Compound widgets are the only widgets that set this method (see the section on "Compound widget anatomy").

Got Focus method

Type: Inherited

This method is used by subclasses of **PtBasic** only. It's called when a widget gets focus. If your widget gets focus in such a way that the whole widget need not be redrawn, clear the Pt_DAMAGE_ON_FOCUS flag (from **PtBasic**) and damage the appropriate area when your widget gets focus.

This method isn't chained. If your class defines a Got Focus method, you'll have to either call *PtSuperClassLostFocus()* to preserve automatic highlighting and widget-level Got Focus method behavior or implement the behavior in the Got Focus method of your class. Here's an excerpt from the code for **PtBasic**:

```
static basic_got_focus( PtWidget_t *widget,
                        PhEvent_t *event)
{
  PtBasicWidget_t *basic =( PtBasicWidget_t *) widget;
  PtCallbackInfo_t cbinfo;
  PtArg_t arg;

  /* damage the widget so that focus rendering
     will take effect */
  if( ( widget->flags & Pt_FOCUS_RENDER ) &&
      ( basic->flags & Pt_DAMAGE_ON_FOCUS ) )
     PtDamageWidget( widget );

  /* setup callback structure */
  cbinfo.reason_subtype = 0;
  cbinfo.event = event;
  cbinfo.cbdata = NULL;

  /* an autohighlight widget with focus should invoke ARM */
  if( widget->flags & Pt_AUTOHIGHLIGHT )
  {
     PtSetArg( &arg, Pt_ARG_FLAGS,
               Pt_HIGHLIGHTED, Pt_HIGHLIGHTED);
     PtSetResources( widget, 1, &arg );
     cbinfo.reason = Pt_CB_ARM;
     PtInvokeCallbackList( basic->arm, widget, &cbinfo );
  }

  /* invoke got focus callback */
  cbinfo.reason = Pt_CB_GOT_FOCUS;
 PtInvokeCallbackList( basic->got_focus, widget, &cbinfo );
  return Pt_CONTINUE;
}
```

Lost Focus method

Type: Inherited

This method is used by subclasses of **PtBasic** only. It's called when a widget loses focus. This method isn't chained. If your class defines a Lost Focus method, you'll have to either call *PtSuperClassLostFocus()* to preserve automatic highlighting and widget-level Lost Focus method behavior or implement the behavior in the Lost Focus method of your class. Here's an excerpt from the code for **PtBasic**:

```
static basic_lost_focus( PtWidget_t *widget, PhEvent_t *event )
{
  PtBasicWidget_t *basic =( PtBasicWidget_t *) widget;
  PtCallbackInfo_t cbinfo;
  PtArg_t arg;
  PhRect_t wrect, rect = widget->extent;

  if( (widget->flags & Pt_FOCUS_RENDER) &&
      ( basic->flags & Pt_DAMAGE_ON_FOCUS )  )
     if( basic->fill_color == Pg_TRANSPARENT )
     {
       PhTranslateRect( &rect,
             (PhPoint_t*)PtCalcCanvas( widget->parent,
                                       &wrect ) );
       PtDamageExtent( widget->parent, &rect );
     }else
       PtDamageWidget( widget );
  cbinfo.reason_subtype = 0;
  cbinfo.event = event;
  cbinfo.cbdata = NULL;
  if( widget->flags & Pt_AUTOHIGHLIGHT )
  {
     PtSetArg( &arg, Pt_ARG_FLAGS, 0, Pt_HIGHLIGHTED );
     PtSetResources( widget, 1, &arg );
     cbinfo.reason = Pt_CB_DISARM;
     PtInvokeCallbackList( basic->disarm, widget, &cbinfo );
  }
  cbinfo.reason = Pt_CB_LOST_FOCUS;
  PtInvokeCallbackList( basic->lost_focus, widget, &cbinfo );
  return Pt_CONTINUE;
}
```

Calc Opaque Rect method

Type: Inherited

This method is used only by subclasses of **`PtBasic`**. It sets or clears the widget's Pt_OPAQUE flag (*Pt_ARG_FLAGS* resource) and the Pt_RECTANGULAR widget class flag.

When the Pt_OPAQUE flag is set for a widget, it means the widget draws over the entire widget extent area. This allows the widget library to be smart about redrawing the widget, because it knows that nothing beneath the widget needs to be redrawn. This flag is essential for creating flicker-free effects. If any part of the widget is transparent (i.e. any widget beneath can be seen), the Pt_OPAQUE flag must be cleared. Here's an excerpt from the code for **`PtBasic`**:

```
static void basic_calc_opaque( PtWidget_t *widget )
{
  PtBasicWidget_t *basic = (PtBasicWidget_t *) widget;

  /* if widget is transparent or round it can't be opaque */
  if ( basic->fill_color == Pg_TRANSPARENT ||
                               basic>roundness )
     widget->flags &= ~Pt_OPAQUE;
  else
     /* must have RECTANGULAR class flag set */
     if ( widget->class_rec->flags &
          Pt_RECTANGULAR ) {
```

```
        widget->flags |= Pt_OPAQUE;
        basic_opaque_rect( widget );
      }
}

static void basic_opaque_rect( PtWidget_t *widget )
{
  if( widget->flags & Pt_HIGHLIGHTED )
     memcpy( &widget->opaque_rect,
             &widget->extent, sizeof( PhRect_t ) );
  else
     PtCalcCanvas( widget, &widget->opaque_rect );
}
```

Widget actions

Widget actions are used to make a widget interactive. For example, when you click a button widget, you can see it press in and then pop out again. This is achieved by setting up raw callbacks sensitive to specific Photon events. The way a widget interacts with events defines the widget's behavior.

The *callbacks* list, Pt_SET_RAW_CALLBACKS (see the "Widget class resource table" section earlier in this chapter), defines a widget's response if it's different from the behavior of its superclasses. This method is defined in the same manner as *Pt_CB_RAW*. The primary difference is that the class's raw callback list is invoked *before* the user's raw callback list. Here's an excerpt from the code for **`PtBasic`**:

```
static const PtClassRawCallback_t callback = {

  Ph_EV_BUT_PRESS | Ph_EV_BUT_RELEASE |
  Ph_EV_BUT_REPEAT | Ph_EV_BOUNDARY,
  basic_callback
  };

static PtArg_t args[] = {
  ⋮
  { Pt_SET_RAW_CALLBACKS, &callback },
  ⋮
  };
```

In the example above, whenever the widget receives one of the four events (Ph_EV_BUT_PRESS, Ph_EV_BUT_RELEASE, Ph_EV_BUT_REPEAT, or Ph_EV_BOUNDARY), the *basic_callback()* function is invoked. This function can check the event type and act accordingly.

For clarity, let's walk through a simplified description of the "click" process of a **`PtButton`** widget.

First, **`PtButton`** receives the Ph_EV_BUT_PRESS event. The widget interprets the press event, changes the widget flags to Pt_SET (possibly causing the widget to be damaged and redrawn), and then invokes the *Pt_CB_ARM* callback.

When the user releases the mouse button, **`PtButton`** receives a Ph_EV_BUT_RELEASE release event. The widget clears the Pt_SET flag and then invokes the *Pt_CB_DISARM* and *Pt_CB_ACTIVATE* callbacks.

The action **PtButton** takes when the button is released is a little more complicated, because the widget actually doing the work is **PtBasic**, not **PtButton**. The **PtButton** class doesn't define any raw callbacks because the handling done by **PtBasic** is sufficient. The **PtBasic** class handles the common Photon arm, disarm, repeat, activate, and menu callbacks for all widgets.

Raw callback list

Type: Chained up, stoppable

The class's list of raw callbacks is used to make a widget sensitive to raw Photon event messages. This allows the widget to define a specific behavior related to external events or user interaction.

Returning Pt_HALT from a class's raw callback prevents any superclass (or the user) from processing the event. The event is propagated up through the widget hierarchy and may be handled by a parent widget.

Returning Pt_END from a class's raw callback prevents any superclass, user, or parent widget from processing the event. This is called *consuming* the event. Here's an example taken from the code for **PtTimer**:

```
static int timer_callback( PtWidget_t *widget, PhEvent_t *event )
{
  PtTimerWidget_t *timer = (PtTimerWidget_t *)widget;

  {
    PtCallbackInfo_t  cbinfo;
    cbinfo.event = event;
    cbinfo.cbdata = NULL;
     cbinfo.reason = Pt_CB_TIMER_ACTIVATE;
     if( timer->state == Pt_TIMER_INITIAL )
       cbinfo.reason_subtype = Pt_TIMER_INITIAL;
     else
       cbinfo.reason_subtype = Pt_TIMER_REPEAT;
     timer->state = Pt_TIMER_REPEAT;
     PtInvokeCallbackType( widget, Pt_CB_TIMER_ACTIVATE, &cbinfo );
     if(timer->msec_repeat && timer->state == Pt_TIMER_REPEAT)
      PtTimerArm(widget,timer->msec_repeat);
  }
  return( Pt_CONTINUE );
}
//
// PtTimer class-creation function
//
static PtWidgetClass_t *PtCreateTimerClass( void )
{
    static const PtResourceRec_t resources[] =
    {
      { Pt_ARG_TIMER_INITIAL, timer_modify, 0,
        Pt_ARG_IS_NUMBER( PtTimerWidget_t, msec_value ) },
      { Pt_ARG_TIMER_REPEAT, timer_modify, 0,
        Pt_ARG_IS_NUMBER( PtTimerWidget_t, msec_repeat ) },
      { Pt_ARG_AREA, Pt_CHANGE_PREVENT, 0,
        Pt_ARG_IS_STRUCT( PtTimerUnion_t, core.area ) },
      { Pt_ARG_DIM, Pt_CHANGE_PREVENT, 0,
        Pt_ARG_IS_STRUCT( PtTimerUnion_t, core.area.size ) },
      { Pt_ARG_POS, Pt_CHANGE_PREVENT, 0,
        Pt_ARG_IS_STRUCT( PtTimerUnion_t, core.area.pos ) },
      { Pt_CB_TIMER_ACTIVATE, Pt_CHANGE_INVISIBLE, 0,
        Pt_ARG_IS_IN_CB_LISTS( PtCallback_t ) },
    };

    static const PtClassRawCallback_t callback =
    {
      Ph_EV_TIMER, timer_callback
    };

    static const PtClassArg_t args[] = {
      { Pt_SET_DFLTS_F,  timer_dflts },
      { Pt_SET_EXTENT_F,  PtNullWidget_f },
      { Pt_SET_REALIZED_F,  timer_realized },
      { Pt_SET_RAW_CALLBACKS,  &callback },
      { Pt_SET_RESOURCES,  resources },
      { Pt_SET_DESCRIPTION,  "PtTimer" },
      { Pt_SET_VERSION, 200},
      { Pt_SET_STATE_LEN, sizeof( PtTimerWidget_t ) },
      { Pt_SET_FLAGS, Pt_FORCE_UNREALIZE, Pt_FORCE_UNREALIZE },
      { Pt_SET_NUM_RESOURCES, sizeof( resources )/sizeof( resources[0] ) },

    };
    return( PtTimer->wclass = PtCreateWidgetClass(
      PtWidget, 0, sizeof( args )/sizeof( args[0] ), args) );
}
```

The example code above is similar but not identical to the Photon library code; some optimizations have been removed for clarity.

Container widget anatomy

This section applies to creating **PtContainer** class widgets:

PtWidget → **PtBasic** → **PtContainer** → **MyContainer**

Child-constraint support

Container widgets extend the **PtBasic** widget class definition with a number of constraint methods. These methods allow the container to adjust itself automatically according to changes made to its children.

The container class extension is shown in the example code below (taken from the **PtContainer.h** header file):

```
typedef struct Pt_container_widget_class {
  PtBasicWidgetClass_t basic;
  void (*child_created_f)( ... );
  int  (*child_settingresource_f)( ... );
  int  (*child_gettingresource_f)( ... );
  int  (*child_realizing_f)( ... );
  void (*child_realized_f)( ... );
  void (*child_unrealizing_f)( ... );
  void (*child_unrealized_f)( ... );
  void (*child_destroyed_f)( ... );
  void (*child_move_resize_f)( ... );
  int  (*child_getting_focus_f)( ... );
  int  (*child_losing_focus_f)( ... );
  PtWidget_t * (*child_redirect_f)( ... );
} PtContainerClass_t;
```

Constraint methods can be individually enabled or disabled by setting or clearing the appropriate *container->flags* bits. You can enable or disable all the constraint methods at once by setting or clearing Pt_IGNORE_CONSTRAINTS.

Method	Description	Resource manifest
child_created_f	Child Created	Pt_SET_CHILD_CREATED_F
child_settingresource_f	Child Setting Resource	Pt_SET_CHILD_SETTINGRESOURCE_F
child_gettingresource_f	Child Getting Resource	Pt_SET_CHILD_GETTINGRESOURCE_F
child_realizing_f	Child Realizing	Pt_SET_CHILD_REALIZING_F
child_realized_f	Child Realized	Pt_SET_CHILD_REALIZED_F
child_unrealizing_f	Child Unrealizing	Pt_SET_CHILD_UNREALIZING_F
child_unrealized_f	Child Unrealized	Pt_SET_CHILD_UNREALIZED_F
child_destroyed_f	Child Destroyed	Pt_SET_CHILD_DESTROYED_F
child_move_resize_f	Child Moved/Resized	Pt_SET_CHILD_MOVED_RESIZED_F
child_getting_focus_f	Child Getting Focus	Pt_SET_CHILD_GETTING_FOCUS_F
child_losing_focus_f	Child Losing Focus	Pt_SET_CHILD_LOSING_FOCUS_F
child_redirect_f	Child Redirection	Pt_SET_CHILD_REDIRECT_F

For convenience, the Photon widget building library lets you call these methods from a superclass using the provided functions. For more information, see the Widget Building Library API chapter.

Child Created method

Type: Inherited
Constraint flag: Pt_CHILD_CREATED

Called whenever a new child is being created in this widget or one of its subordinate widgets. Here's an excerpt taken from the code for **PtGroup**:

```
static void child_created( PtWidget_t *widget,
                           PtWidget_t *child )
{
  PtCallback_t callback = { group_exclusive_callback,
                            NULL };
  PtGroupUnion_t *group = (PtGroupUnion_t *)widget;
  PtArg_t argt[2];
  int n = 0;

  callback.data = widget;

  if( group->basic.activate ) {
     PtSetArg( &argt[n++], Pt_CB_ACTIVATE,
               &group->basic.activate->cb, 0 );
  }
  if( group->group.group_flags & Pt_GROUP_EXCLUSIVE ) {
     PtSetArg( &argt[n++], Pt_CB_ACTIVATE, &callback, 0 );
  }
  if( n )
     PtSetResources( child, n, argt );
}
```

Child Realizing method

Type: Inherited
Constraint flag: Pt_CHILD_REALIZING

Called whenever a child is in the process of being realized below this container in the hierarchy.

Child Realized method

Type: Inherited
Constraint flag: Pt_CHILD_REALIZED

Called whenever a child is realized below this container in the hierarchy.

Child Moved/Resized method

Type: Inherited
Constraint flag: Pt_CHILD_MOVED_RESIZED

Called whenever a child is moved or resized below this container in the hierarchy.

Child Unrealizing method

Type: Inherited
Constraint flag: Pt_CHILD_UNREALIZING

Called whenever a child is in the process of being unrealized below this container in the hierarchy.

Child Unrealized method

Type: Inherited
Constraint flag: Pt_CHILD_UNREALIZED

Called whenever a child is unrealized below this container in the hierarchy.

Child Destroyed method

Type: Inherited
Constraint flag: Pt_CHILD_DESTROYED

Called whenever a direct child of this widget or a direct child of one of its subordinates is destroyed.

Child Setting Resource method

Type: Inherited
Constraint flag: Pt_CHILD_SETTING_RESOURCE

Called whenever a resource is being set on a direct child of this widget or one of its subordinates.

Child Getting Resource method

Type: Inherited
Constraint flag: Pt_CHILD_GETTING_RESOURCE

Called whenever a resource is being retrieved from a direct child of this widget or one of its subordinates.

Child Getting Focus method

Type: Inherited
Constraint flag: Pt_CHILD_GETTING_FOCUS

Called whenever a child of this widget or one of its subordinates is about to be given focus.

Child Losing Focus method

Type: Inherited
Constraint flag: Pt_CHILD_LOSING_FOCUS

Called whenever a child of this widget or one of its subordinates is about to lose focus.

Child Redirection method

Type: Inherited
Constraint flag: Pt_CHILD_REDIRECTOR

Container widgets provide a mechanism for redirecting child widgets as they're added to a container. You can use this mechanism to prevent certain widget classes from being added as direct children or redirect those children to other containers within the container (this feature is typically used by **`PtCompound`** widgets).

The child-redirector function is specified in the class-creation function and indicates where children should be attached in the widget hierarchy. Redirection is achieved by setting the *child_redirect_f* member of the **`Pt_container_widget_class`** structure to the child-redirector function.

The arguments to the child-redirector function are a widget pointer and the class type of the widget being added to the container. Using this information, the child-redirector function determines whether to accept the widget into the container or redirect the widget to another container, such as the parent of the container widget.

A good example is the **`PtMenuBar`** widget. This widget accepts only **`PtMenuButton`** widgets. Its class-creation function includes this:

```
{ Pt_SET_CHILD_REDIRECT_F, (long)menubar_redirect },
```

The *menubar_redirect()* function would look like this:

```
static PtWidget_t *menubar_redirect(
                       PtWidget_t *menubar,
                       PtWidgetClassRef_t *cref )
{
  if (cref != PtMenuButton )
     return menubar->parent;
  return menubar;
}
```

The widget returned by the function becomes the parent for the widget being added.

You can use *PtCompoundRedirect()* as the default child-redirector function for any containers that won't accept other widgets. *PtCompoundRedirect()* redirects child creation to the parent of the container widget. This causes a new widget to become a sibling of the container widget rather than a child of the container widget.

If you set up a child-redirector function in your widget class, Pt_CHILD_REDIRECTOR is set. When you create an instance, this bit is automatically turned off before Defaults method is called. It's turned back on after the Defaults chaining is complete. This lets you create subordinate children in your Defaults method without having to clear and set this bit yourself.

Fundamental methods

When using container widgets, you must provide a number of container-specific processes within the fundamental methods in addition to those common to every widget.

Defaults method

To enable the container-constraint methods, set the appropriate bits in *container*->*flags*. You can turn on all bits as follows:

```
ctnr->flags |= Pt_CONTAINER_CONSTRAINT_BITS;
```

Only the constraint methods whose bits are on are invoked. If you turn a bit on and the corresponding constraint method is undefined, the bit is ignored. For example:

```
ctnr->flags |= Pt_CHILD_CREATED;
```

For each bit set in the flag, you should provide a constraint method in the argument list of the class-creation function:

```
static PtArg_t args[] = {
  :
  { Pt_SET_CHILD_CREATED_F, child_created },
  :
  };
```

The *child_created()* function should modify the child or container as required to suit the situation.

The Common User Access (CUA) mechanism built into the Photon library automatically passes focus around the application. If you want to prevent widgets inside the container from getting focus, set the Pt_BLOCK_CUA_FOCUS flag. The **PtMenuBar** widget does this (i.e. you can't press the Tab key to move the focus from a widget outside a menubar to a widget inside a menubar).

Extent method

This method is responsible for determining the "screen real estate" of a widget. Anchoring is applied in this method. Widgets subclassed under **PtContainer** normally call the Extent method of **PtContainer** to do the final extent calculation and anchor the widget according to its anchor flags. When a widget's extent has been calculated, its *widget->* *extent_valid* flag should be set to Pt_TRUE.

The following example demonstrates how to handle anchoring if you choose *not* to let the **PtContainer** class do it for you (see also *PtSuperClassExtent()*):

```
mycontainerwidget_extent( PtWidget_t *widget )
{
  PtWidget_t *widget
  PhRect_t canvas, old_extent;
  PhArea_t area;

  // Store the old size for comparison later.
  old_extent = widget->extent;
  PhRectToArea( &old_extent, &area );

  if( PtResizePolicy( widget ) )
  {
     PhRect_t render;
     render.lr.x = render.lr.y = SHRT_MIN;
     render.ul.x = render.ul.y = SHRT_MAX;
     PtChildBoundingBox( widget, &canvas, &render );
     PhTranslateRect( &render, &canvas.ul );
     PtAttemptResize( widget, &render, &canvas );
  }
  PtSuperClassExtent( PtBasic, widget );
  widget->extent_valid = Pt_TRUE;

  // Containers must anchor their children. Flux to
  // minimize flicker.

  PtStartFlux( widget );
  if( widget->parent && widget->parent->extent_valid
      && (ctnr->anchor_flags & Pt_IS_ANCHORED ) &&
      !( widget->class_rec->flags &
      (Pt_DISJOINT|Pt_DISCONTINUOUS) ) )
    PtAnchorWidget( widget );
  else
    if( !(ctnr->anchor_flags & Pt_ANCHORS_LOCKED ) &&
        memcmp( &widget->area.size, &area.size,
                sizeof(PhDim_t) ) )
     for( wlp = ctnr->ctnrs; wlp; wlp = next )
     {
       next = wlp->next;
       if( ((PtContainerWidget_t *)wlp->widget)->anchor_flags &
                      Pt_IS_ANCHORED )
```

```
            PtAnchorWidget( wlp->widget );
        }
    PtEndFlux( widget );

    // If the size changes, accommodate the new size.
    if( memcmp( &old_extent, &widget->extent,
                sizeof( old_extent ) ) )
    {
        if( ( widget->flags & Pt_REALIZED ) && (widget->rid) )
          PtCoreChangeRegion( Ph_REGION_ORIGIN | Ph_REGION_RECT,
                              widget );
        if( !(ctnr->anchor_flags & Pt_ANCHORS_LOCKED)
            && memcmp( &widget->area.size,
            &area.size, sizeof(PhDim_t) ) )
          PtInvokeResizeCallbacks( widget );
    }
}
```

Realization method

If your container creates any subordinate widgets with the Pt_DELAY_REALIZE flag set, they can be realized in the Realization method.

Compound widget anatomy

This section applies to creating **PtCompound** class widgets:

PtWidget → **PtBasic** → **PtContainer** → **PtCompound** → **MyCompound**

The **PtCompound** superclass supports extended functionality provided by "exported" subordinate children. The export mechanism allows users to set/get the resources of subordinate children through a compound widget without defining any of these resources in the compound widget. Compound widgets can modify or block the default resources inherited by their exported subordinate children.

Widgets don't have to be a subclass of **PtCompound** to export subordinate widgets. However, because **PtContainer** provides powerful child-constraint and child-redirector mechanisms, we recommend that if you're building a widget that creates subordinate children, you should subclass that widget to **PtContainer** (if not **PtCompound**). This greatly simplifies the management of subordinate children. It also makes the widget easier to use since new resources don't have to be learned.

To achieve this exporting mechanism, the compound class extends the **PtContainer** widget class definition as shown below:

```
typedef struct Pt_compound_class {
    PtContainerClass_t  container;
    unsigned short            num_subordinates;
    unsigned short            *subordinates;
    unsigned short            num_blocked_resources;
    unsigned long             *blocked_resources;
} PtCompoundClass_t;
```

The members of this structure are:

num_subordinates (Resource manifest Pt_SET_NUM_SUBORDINATES)

The number of subordinate widgets (in the subordinate offset array) to be exported. This value must be supplied when defining an array of offsets.

subordinates (Resource manifest Pt_SET_SUBORDINATES)

An array of offsets to widget pointers to subordinate widgets. Every widget defined in the array of offsets must be created in the Defaults method of the compound widget.

num_blocked_resources (Resource manifest Pt_SET_NUM_BLOCKED_RESOURCES)

The number of resources in the array of blocked resources.

blocked_resources (Resource manifest Pt_SET_BLOCKED_RESOURCES)

An array of resources to be blocked.

Here's a sample class-creation function from **PtComboBox**:

```
//
// PtComboBox class creation function
//

static PtWidgetClass_t *PtCreateComboBoxClass( void )
{
    static const PtResourceRec_t resources[] = {

        { Pt_ARG_CURSOR_TYPE, combobox_modify, 0,
                Pt_ARG_IS_NUMBER( PtWidget_t, cursor_type ) },

        { Pt_ARG_CURSOR_COLOR, combobox_modify, 0,
                Pt_ARG_IS_NUMBER( PtWidget_t, cursor_color ) },

        { Pt_ARG_BORDER_WIDTH, combobox_modify, 0,
                Pt_ARG_IS_NUMBER( PtComboBoxWidget_t, border_width ) },

        { Pt_ARG_FLAGS, combobox_modify, get_text_res,
                Pt_ARG_IS_FLAGS( PtWidget_t, flags ) },

        { Pt_ARG_TOP_BORDER_COLOR, set_border_color, 0,
                Pt_ARG_IS_NUMBER( PtBasicWidget_t, top_border_color ) },

        { Pt_ARG_HORIZONTAL_ALIGNMENT, combobox_modify, 0,
                Pt_ARG_IS_NUMBER( PtLabelWidget_t, h_alignment ) },
        { Pt_ARG_VERTICAL_ALIGNMENT, combobox_modify, 0,
                Pt_ARG_IS_NUMBER( PtLabelWidget_t, v_alignment ) },
        { Pt_ARG_MARGIN_HEIGHT, combobox_modify, 0,
                Pt_ARG_IS_NUMBER( PtBasicWidget_t, margin_height ) },
        { Pt_ARG_MARGIN_WIDTH, combobox_modify, 0,
                Pt_ARG_IS_NUMBER( PtBasicWidget_t, margin_width ) },
        { Pt_ARG_MARGIN_TOP, combobox_modify, 0,
                Pt_ARG_IS_NUMBER( PtLabelWidget_t, margin_top ) },
        { Pt_ARG_MARGIN_BOTTOM, combobox_modify, 0,
                Pt_ARG_IS_NUMBER( PtLabelWidget_t, margin_bottom ) },
        { Pt_ARG_MARGIN_LEFT, combobox_modify, 0,
                Pt_ARG_IS_NUMBER( PtLabelWidget_t, margin_left ) },
        { Pt_ARG_MARGIN_RIGHT, combobox_modify, 0,
                Pt_ARG_IS_NUMBER( PtLabelWidget_t, margin_right ) },

        { Pt_ARG_COLOR, set_all_same_res, get_text_res,
                Pt_ARG_IS_NUMBER( PtComboBoxUnion_t, basic.color ) },

        { Pt_ARG_FILL_COLOR, combobox_modify, 0,
                Pt_ARG_IS_COLOR( PtBasicWidget_t, fill_color ) },

        { Pt_ARG_BOT_BORDER_COLOR, set_border_color, 0,
                Pt_ARG_IS_NUMBER( PtBasicWidget_t, bot_border_color ) },
        { Pt_ARG_TEXT_STRING, set_text_res, get_text_res },
        { Pt_ARG_TEXT_FLAGS, combobox_modify, get_text_res,
                Pt_ARG_IS_FLAGS( PtComboBoxWidget_t, flags ) },
        { Pt_ARG_CBOX_FLAGS, combobox_modify, 0,
                Pt_ARG_IS_FLAGS( PtComboBoxWidget_t, flags ) },
        { Pt_ARG_CBOX_SEL_ITEM, combobox_modify, 0,
                Pt_ARG_IS_NUMBER( PtComboBoxWidget_t, sel_item ) },
        { Pt_ARG_ITEMS, set_list_res, get_list_res },
        { Pt_ARG_CBOX_ITEMS, set_list_res, get_list_res },
        { Pt_ARG_CBOX_SPACING, set_list_res, get_list_res },
        { Pt_ARG_CBOX_VISIBLE_COUNT, set_list_res, get_list_res },
        { Pt_ARG_CBOX_BUTTON_WIDTH, combobox_modify, 0,
                Pt_ARG_IS_NUMBER( PtComboBoxWidget_t, butn_size.w ) },
        { Pt_ARG_CBOX_MAX_LENGTH, set_text_res, get_text_res },
        { Pt_ARG_CBOX_CURSOR_POSITION, set_text_res, get_text_res },
        { Pt_ARG_CBOX_SELECTION_FILL_COLOR, set_list_res, get_list_res },
        { Pt_ARG_CBOX_EDIT_MASK, set_text_res, get_text_res },
        { Pt_ARG_CBOX_SELECTION_TEXT_COLOR, set_list_res, get_list_res },
        { Pt_ARG_CBOX_TEXT_FONT, set_text_res, get_text_res },
        { Pt_ARG_CBOX_TEXT_STRING, set_text_res, get_text_res },
        { Pt_ARG_CBOX_TEXT_FILL_COLOR, set_text_res, get_text_res },
        { Pt_CB_SELECTION, (long) Pt_CHANGE_INVISIBLE, 0,
                Pt_ARG_IS_IN_CB_LISTS( PtCallback_t ) },
        { Pt_CB_LIST_INPUT, (long) Pt_CHANGE_INVISIBLE, 0,
                Pt_ARG_IS_IN_CB_LISTS( PtCallback_t ) },
        { Pt_CB_CBOX_ACTIVATE, (long) Pt_CHANGE_INVISIBLE, 0,
                Pt_ARG_IS_IN_CB_LISTS( PtCallback_t ) },
        { Pt_ARG_CBOX_BUTTON_BORDER_WIDTH, (long) Pt_CHANGE_RESIZE_REDRAW, 0,
                Pt_ARG_IS_NUMBER( PtComboBoxWidget_t, butn_border_width ) },
        { Pt_ARG_CBOX_BUTTON_TOP_BORDER_COLOR, (long) Pt_CHANGE_REDRAW, 0,
                Pt_ARG_IS_NUMBER( PtComboBoxWidget_t, butn_top_border_color ) },
        { Pt_ARG_CBOX_BUTTON_BOT_BORDER_COLOR, (long) Pt_CHANGE_REDRAW, 0,
                Pt_ARG_IS_NUMBER( PtComboBoxWidget_t, butn_bot_border_color ) },
        { Pt_ARG_CBOX_BUTTON_COLOR, (long) Pt_CHANGE_REDRAW, 0,
                Pt_ARG_IS_NUMBER( PtComboBoxWidget_t, butn_color ) },
        { Pt_ARG_CBOX_MAX_VISIBLE_COUNT, (long) Pt_CHANGE_INVISIBLE, 0,
                Pt_ARG_IS_NUMBER( PtComboBoxWidget_t, max_visible ) },
        { Pt_CB_CBOX_CLOSE, (long) Pt_CHANGE_INVISIBLE, 0,
                Pt_ARG_IS_IN_CB_LISTS( PtCallback_t ) },
    };

    static const unsigned short subs[] =
    {
        offsetof( PtComboBoxWidget_t, text_wgt ),
        offsetof( PtComboBoxWidget_t, list_wgt ),
    };

    static const PtClassRawCallback_t callback = {
        Ph_EV_KEY, combobox_callback
    };

    static const unsigned long blocked[] = {
        Pt_ARG_SELECTION_MODE,
        Pt_ARG_SEL_INDEXES,
        Pt_ARG_COLUMNS,
    };

    static const PtWidgetAction_t actions[] =
    {
        { Ph_EV_BUT_PRESS | Ph_EV_BUT_RELEASE | Ph_EV_BUT_REPEAT,
          { combobox_but_action } },
    };

    static const PtClassArg_t args[] = {
        { Pt_SET_DFLTS_F, (void*) combobox_dflts },
        { Pt_SET_RAW_CALLBACKS, (void*) &callback },
        { Pt_SET_RESOURCES, (void*) resources },
        { Pt_SET_EXTENT_F, (void*) combobox_extent },

        { Pt_SET_CONNECT_F, (void*) combobox_init },
        { Pt_SET_REALIZED_F, (void*) combobox_realized },
        { Pt_SET_SUBORDINATES, (void*) subs },
        { Pt_SET_BLOCKED_RESOURCES, (void*) blocked },
        { Pt_SET_CHILD_MOVED_RESIZED_F, (void*) combobox_child_resize },
        { Pt_SET_GOT_FOCUS_F, (void*) combobox_got_focus },
        { Pt_SET_LOST_FOCUS_F, (void*) combobox_lost_focus },
        { Pt_SET_DESCRIPTION, (void*) "PtComboBox" },
        { Pt_SET_CHILD_REDIRECT_F, (void*) PtCompoundRedirect },
        { Pt_SET_ACTIONS, (void*) actions },
        { Pt_SET_DRAW_F, (void*) combobox_draw },
        { Pt_SET_CALC_BORDER_F, (void*) combobox_calc_border },
        { Pt_SET_VERSION, 200},
        { Pt_SET_STATE_LEN, sizeof( PtComboBoxWidget_t ) },
        { Pt_SET_NUM_RESOURCES, (sizeof( resources )
          /sizeof( resources[0] )) },
        { Pt_SET_NUM_SUBORDINATES, (sizeof( subs )
          / sizeof( subs[0] )) },
        { Pt_SET_NUM_BLOCKED_RESOURCES, (sizeof( blocked )
          / sizeof( blocked[0] )) },
        { Pt_SET_NUM_ACTIONS, (sizeof( actions )
          /sizeof( actions[0] )) },
    };
    return( PtComboBox->wclass = PtCreateWidgetClass(
            PtCompound, 0, sizeof( args )/sizeof( args[0] ),
            args ) );
}
```

- The example code above is similar but not identical to the Photon library code; some optimizations have been removed for clarity.
- In the example code shown above, the **`PtComboBox`** widget creates subordinate widgets and sets the pointers *text_wgt* and *list_wgt* in the Defaults method to the appropriate widget pointer.

In the following example, the widget class **`MyCompound`** creates subordinate widgets **`PtText`**, **`PtProgress`**, **`PtScrollArea`**, and a few **`PtLabel`**s. The **`PtText`**, **`PtProgress`**, and **`PtScrollArea`** widgets are exported, but the **`PtLabel`** widgets aren't. All resources are applied to the subordinate widgets. No extra code is required for **`MyCompound`**:

```
⋮
n = 0;
PtSetArg( &argt[n], Pt_ARG_POS, &pos, 0 ); n++;
PtSetArg( &argt[n], Pt_ARG_TEXT_STRING, "A text field",
          0 ); n++;
PtSetArg( &argt[n], Pt_ARG_SCROLL_AREA_MAX_X, 1000, 0 ); n++;
PtSetArg( &argt[n], Pt_CB_SCROLLED_X, &callback, 1 ); n++;
PtSetResources( MyCompound, n, argt );
⋮
n = 0;
```

To get the resources afterwards:

```
⋮
n = 0;
n = 0;
PtSetArg( &argt[n], Pt_ARG_POS, &phpoint_ptr, 0 ); n++;
PtSetArg( &argt[n], Pt_ARG_TEXT_STRING, &char_ptr, 0 ); n++;
PtSetArg( &argt[n], Pt_ARG_SCROLL_AREA_MAX_X, &short_ptr,
          0 ); n++;
PtGetResources( MyCompound, n, argt );
⋮
n = 0;
```

When the *Pt_CB_SCROLLED_X* callback is invoked, the first parameter *widget* is a pointer to **`MyCompound`**, not to the subordinate. The **`PtCompound`** class also makes it easy to block specific resources from hitting any subordinate.

What happens when you export two or more subordinate widgets supporting the same resource? For example, both a button and a text field accept the resource *Pt_ARG_TEXT_STRING*; if they're exported with no supporting code, then setting the resource on the compound widget will set the resource on both subordinates.

When getting the resource, the value is retrieved from the first exported widget supporting the resource. If you don't want this to happen, set up a resource-redirector function at the end of the compound widget's Defaults method.

You can have a compound widget override the resource (see *Pt_ARG_TEXT_STRING* in the example above) by defining it, then using the *mod_f()* function (named in the *mod_f* field member of the **`PtResourceRec_t`** structure) to apply the resource to the appropriate subordinate.

Any resources defined for a subclass of a **`PtCompound`** widget *won't* automatically be applied to a subordinate widget, exported or otherwise. If you define resource-redirector functions for all user-modified resources of subordinates, consider subclassing your widget below **`PtContainer`** instead of **`PtCompound`**.

Blocking resources

The exporting mechanism provides a resource-blocking mechanism. You can selectively block resources, making them inaccessible to subordinate widgets.

Suppose you've built a compound widget comprising an exported **`PtSlider`** widget, and you want the slider thumb to stay the same size always — blocking access to the *Pt_ARG_SLIDER_SIZE* resource would prevent the slider from being resized.

You may also find that you have more than one occurrence of a single type of widget as subordinate widget. For example, your widget might have a vertical and a horizontal scrollbar. In this case, you should block *Pt_ARG_SCROLL_POSITION* and create two new resources: *Pt_ARG_X_SCROLL_POSITION* and *Pt_ARG_Y_SCROLL_POSITION*. The Set Resources method for each would set the *Pt_ARG_SCROLL_POSITION* resource of the appropriate subordinate scrollbar widget.

Compound redirection

The **`PtCompound`** class provides a standard child-redirector function called *PtCompoundRedirect()*. This function prevents the user from creating widgets in your compound widget and redirects the user's widget to another container instead. To target another widget, redirect child creation in the class-creation function:

```
{ Pt_SET_CHILD_REDIRECT_F, (long)PtCompoundRedirect },
```

In the template for the **`PtSampCompound`** widget, new children are redirected to one of the procreated subordinate widgets, *scroll_area*, by calling *PtValidParent()* (described in the Photon *Library Reference*):

```
PtWidget_t * PtSampContainerRedirect( PtWidget_t *widget )
{
  PtWidget_t *parent;

  if( ( parent =
        PtValidParent( samp->scroll_area,
                       widget->class_ref ) ) == widget )
     return PtWidgetParent( widget );
  return( parent );

  /*
  * Returning samp->scroll_area would allow the child
  * to be created as a direct child of samp->scroll_area.
  * This may be undesirable, as scroll_area is a container
  * widget that redirects its children.
  */
}
```

PtValidParent() honors any child-redirector functions existing in subordinate widgets and their subordinates. *PtValidParent()* should be used only to redirect parentage to a subordinate child. This prevents infinite loops when the child's redirector function returns control.

Fundamental methods

Compound widgets require a few fundamental methods in addition to those common to every widget.

Defaults method

For compound widgets, all exported subordinate widgets *must* be created in the Defaults method. To export widgets, set the following in the class-creation function:

Pt_SET_SUBORDINATES

  An array of offsets to the subordinate widget pointers.

Pt_SET_NUM_SUBORDINATES

  The number of entries in the array.

Resources of subordinate widgets may be overridden, overloaded, or blocked. Subordinate widgets can be created but not realized in the Defaults method.

For the container-constraint mechanisms to work correctly, the Pt_PROCREATED flag has to be set in each subordinate widget, and the *Pt_ARG_DATA* (*not Pt_ARG_USER_DATA*) resource has to point back to the parent widget.

- For each subordinate widget, you must set the *Pt_ARG_DATA* resource before setting the Pt_PROCREATED flag, or a SIGSEGV error will result.
- Your custom widget shouldn't set its own *Pt_ARG_DATA* resource because this resource is used internally by the Photon libraries. It *is* safe to set it in your widget's subordinate children.

Here's an example from **PtComboBox**:

```
static void combobox_dflts( PtWidget_t *widget )
{
  PtComboBoxUnion_t   *combobox = (PtComboBoxUnion_t *)widget;
  PtArg_t       args[13];
  int         n = 0;
  PtCallback_t    callback;
  PtRawCallback_t   raw_cb;

  combobox->core.flags |= Pt_HIGHLIGHTED | Pt_SET;
  combobox->core.flags &= ~Pt_GETS_FOCUS;
  combobox->core.resize_flags = Pt_RESIZE_XY_ALWAYS;
  combobox->basic.fill_color = Pg_LGREY;
  combobox->basic.margin_height = 0;
  combobox->basic.margin_width = 0;
  combobox->basic.flags = Pt_STATIC_GRADIENT | Pt_ALL_ETCHES | Pt_ALL_OUTLINES;
  widget->border_width = combobox->combobox.border_width = 2;
  combobox->combobox.butn_size.w = 13;
  combobox->combobox.butn_border_width = 2;
  combobox->combobox.butn_bot_border_color = Pg_DGREY;
  combobox->combobox.butn_top_border_color = Pg_WHITE;
  combobox->combobox.butn_color = Pg_GREY;
  combobox->combobox.flags = Pt_COMBOBOX_DAMAGE_BUTTON;
  callback.event_f = combobox_text_callback;
  callback.data = (void*)widget;

  n = 0;
  PtSetArg( &args[n], Pt_ARG_BEVEL_WIDTH, 0, 0 );
  n++;
  PtSetArg( &args[n], Pt_ARG_MARGIN_HEIGHT, 2, 0 );
  n++;
  PtSetArg( &args[n], Pt_ARG_MARGIN_WIDTH, 2, 0 );
  n++;
  PtSetArg( &args[n], Pt_ARG_DATA, &widget, sizeof( widget ) );
  n++;
  PtSetArg( &args[n], Pt_ARG_FLAGS, Pt_PROCREATED, Pt_PROCREATED);
  n++;
  PtSetArg( &args[n], Pt_CB_MODIFY_VERIFY, &callback, 1);
  n++;
  PtSetArg( &args[n], Pt_CB_MOTION_VERIFY, &callback,1);
  n++;
  PtSetArg( &args[n], Pt_CB_ACTIVATE, &callback, 1);
  n++;
  PtSetArg( &args[n], Pt_CB_GOT_FOCUS, &callback, 1);
  n++;
  PtSetArg( &args[n], Pt_CB_LOST_FOCUS, &callback, 1);
  n++;
  PtSetArg( &args[n], Pt_ARG_RESIZE_FLAGS, Pt_RESIZE_Y_AS_REQUIRED,
    Pt_RESIZE_XY_BITS );
  n++;
  PtSetArg( &args[n], Pt_ARG_BASIC_FLAGS, Pt_TOP_LEFT_INLINE |
    Pt_RIGHT_OUTLINE | Pt_FLAT_FILL, ~0 );
  n++;
  combobox->combobox.text_wgt =
    PtCreateWidget( PtText, widget, n, args );

  n = 0;
  callback.event_f = combobox_list_callback;
  callback.data = (void*)widget;
  raw_cb.event_f = combobox_action;
  raw_cb.event_mask = Ph_EV_BOUNDARY;
  raw_cb.data = combobox;
  PtSetArg( &args[n], Pt_ARG_BEVEL_WIDTH, 1, 0 );
  n++;
  PtSetArg( &args[n], Pt_ARG_SCROLLBAR_WIDTH,
            combobox->combobox.butn_size.w +3, 0 );
  n++;
  PtSetArg( &args[n], Pt_ARG_SEL_MODE, Pt_SELECTION_MODE_SINGLE
            | Pt_SELECTION_MODE_AUTO, 0 );
  n++;
  PtSetArg( &args[n], Pt_ARG_FLAGS, Pt_PROCREATED | Pt_DELAY_REALIZE,
            Pt_GETS_FOCUS | Pt_ETCH_HIGHLIGHT
            | Pt_PROCREATED | Pt_DELAY_REALIZE | Pt_ETCH_HIGHLIGHT);
  n++;
  PtSetArg( &args[n], Pt_CB_SELECTION, &callback, 1 );
  n++;
  PtSetArg( &args[n], Pt_CB_LIST_INPUT, &callback, 1 );
  n++;
  PtSetArg( &args[n], Pt_CB_RAW, &raw_cb, 1 );
  n++;
  PtSetArg( &args[n], Pt_ARG_DATA, &widget,
            sizeof( widget ) );
  n++;
  PtSetArg( &args[n++], Pt_ARG_BASIC_FLAGS, 0, Pt_ALL_ETCHES
            | Pt_ALL_INLINES );
  combobox->combobox.list_wgt = PtCreateWidget( PtList, widget,
                                                n, args );

  n = 0;
  callback.event_f = combobox_action;
  callback.data = (void*)widget;
  PtSetArg( &args[n], Pt_CB_ARM, &callback, 1 );
  n++;
  PtSetArg( &args[n], Pt_CB_REPEAT, &callback, 1 );
  n++;
  PtSetResources( combobox->combobox.text_wgt, n, args );

  combobox->container.flags |= Pt_AUTO_EXTENT | Pt_CHILD_MOVED_RESIZED;
}
```

Realization method

The Realization method is the last class-member function called before the Draw method. It's where you realize subordinate widgets created in the Defaults method. Here's an example from **PtComboBox**:

```
static int combobox_realized( PtWidget_t *widget )
{
  PtComboBoxWidget_t *combobox = (PtComboBoxWidget_t *)widget;
  long flags;

  if ( combobox->flags & Pt_COMBOBOX_STATIC )
     PtRealizeWidget( combobox->list_wgt );
  else {
     PtRealizeWidget( combobox->butn_wgt );
  }
  return Pt_CONTINUE;
}
```

Get Resources and Set Resources methods

To date, the **PtCompound** widget class is the only class to redefine the Get Resources and Set Resources methods, which are used internally. You don't have to set a function for this method unless you intend to duplicate the behavior of **PtCompound**.

Destruction method

The Destruction method must destroy any redirected callback lists of exported subordinates having callback resources set on them.

Chapter 4

Using Widget Superclasses

In this chapter. . .

This chapter describes the common widget superclasses. Use this information to determine whether a superclass's method does what you need for your widget. With this knowledge you can decide whether to take over the method (override inheritance), add a method to the chain, or use the *PtSuperClass** functions.

It's important to read the specifications of each of your widget's superclasses before using any of the *PtSuperClass*()* functions.

PtWidget

The **PtWidget** superclass provides the fundamental functionality of all Photon widgets.

Class hierarchy

PtWidget

Class flags

Pt_RECTANGULAR

Methods

PtWidget defines the class methods described below.

Defaults method

None.

Initialization method

None.

Extent method

Calculates the extent of the widget without accounting for borders or margins. The extent is calculated based on the widget's position (*Pt_ARG_POS*) and dimension (*Pt_ARG_DIM*). For disjoint widgets (e.g. **PtWindow** widgets), the position is assumed to be (0, 0).

Connection method

Determines if the widget needs a region, and if so, what events the region should be opaque and/or sensitive to.

If the widget has a bitmap cursor defined, it's set up as region data. If the widget already has a region, that region is updated with the opaque/sense and region data. This is done through *PhRegionChange()*.

If the widget doesn't have a region but one is required, it's created through *PhRegionOpen()*.

Finally, if the widget isn't a window, any hotkey callbacks attached to the widget are registered with the nearest disjoint parent (of **PtWindow** class). This is done through *PtSetResources()*.

Realization method

None.

Unrealization method

If the widget has a region, the region is closed. All descendants (*widget*->*rid* members) are set to 0. If the widget isn't a window, any attached hotkey callbacks are detached from its disjoint parent.

The extent of this widget is damaged on the parent. All children of this widget are unrealized. Any of these widgets having a constraining parent with Pt_SET_CHILD_UNREALIZED_F defined has that function invoked. Any of these having a *Pt_CB_UNREALIZED* callback chain has that callback chain invoked (from the top down).

Destruction method

Called when a widget instance is being removed. Frees *widget*->*widget_data*. Any memory automatically allocated by a resource is released (this memory shouldn't be freed in the Destruction method). Any resources you free must have the pointer set to NULL to prevent the widget engine from freeing the memory a second time. The following resource types automatically allocate and release memory:

- Pt_ARG_IS_ALLOC
- Pt_ARG_IS_ARRAY
- Pt_ARG_IS_CALLBACK_LIST
- Pt_ARG_IS_LINK
- Pt_ARG_IS_STRING

Widget actions

Raw callbacks are supported for Ph_EV_BUT_PRESS, Ph_EV_BUT_RELEASE, Ph_EV_BUT_REPEAT, and Ph_EV_KEY events.

If there are callbacks in the *Pt_CB_FILTER* callback chain having an event mask that matches the current event type, those callbacks are invoked. If the value returned by a filter callback is greater than 0, that value is returned. If there are balloons registered with this widget, the balloon list is checked to determine if a balloon needs to be inflated and/or deflated.

If the event is a Ph_EV_KEY event, the event is given to the focused child of the widget, if there is one. If the event isn't consumed by the widget, the hotkey chain of the nearest disjoint parent is processed to see if the key is a hotkey. If a matching hotkey definition is found, the hotkey callback is invoked and the event is consumed (by returning Pt_END).

If the event is a button press, release, or repeat, each child widget intersecting the event is found via *PtContainerHit()* until one of these widgets consumes the event.

When an intersecting widget is found, the event rectangle is translated relative to the upper-left corner of the intersecting widget's canvas. Once translation has been performed, the event is given to the intersecting widget via *absorbed = PtEventHandler()*. Upon return, the event rectangle is detranslated by the same amount.

If all the following are true:

- the event was a button press
- the event hasn't yet directed focus
- the current intersecting widget has the Pt_GETS_FOCUS flag set

then focus is given to that widget and *event*->*processing_flags* has its Ph_DIRECTED_FOCUS bit set. If the return from *PtEventHandler()* was Pt_END, the event is considered consumed and Pt_END is returned.

An extra step is performed if the event is a press and *_Pt_*->*current* is NULL: the absorbing widget is recorded for the purposes of delivering phantom releases to the appropriate widget at a later time.

```
if( widget->rid )
    //if the event was not absorbed, take it back.
    cbinfo->event->collector.rid = widget->rid;

if( ( ( absorbed != Pt_CONTINUE ) ||
      ( cbinfo->event->processing_flags & Ph_BACK_EVENT ) )
      &&  wp && cbinfo->event->type == Ph_EV_BUT_PRESS
      && ( !_Pt_->current || _Pt_->current == wp ) )
    {
    if ( wp->flags & Pt_DESTROYED )
        _Pt_->current = (PtWidget_t *)Pt_END;
    else
        _Pt_->current = wp;
    }
```

Once the event has been consumed or there are no more intersecting events, Pt_END is returned. Otherwise, *absorbed* is returned.

Resource definitions

```
static const PtResourceRec_t resources[] = {
    { Pt_ARG_AREA,          Pt_CHANGE_CANVAS, 0,
        Pt_ARG_IS_STRUCT( PtWidget_t, area )},
    { Pt_ARG_BEVEL_WIDTH,   Pt_CHANGE_CANVAS_REDRAW, 0,
        Pt_ARG_IS_NUMBER( PtWidget_t, border_width ) },
    { Pt_ARG_CURSOR_TYPE,       core_modify_cursor, 0,
        Pt_ARG_IS_NUMBER( PtWidget_t, cursor_type )},
    { Pt_ARG_CURSOR_COLOR,  core_modify_cursor, 0,
        Pt_ARG_IS_NUMBER( PtWidget_t, cursor_color )},
    { Pt_ARG_DATA,          Pt_CHANGE_INVISIBLE, 0,
        Pt_ARG_IS_ALLOC( PtWidget_t, data )},
    { Pt_ARG_DIM,               Pt_CHANGE_CANVAS, 0,
        Pt_ARG_IS_STRUCT( PtWidget_t, area.size )},
    { Pt_ARG_FLAGS,         PtModifyFlags, 0,
        Pt_ARG_IS_FLAGS( PtWidget_t, flags )},
    { Pt_ARG_POS,               Pt_CHANGE_CANVAS, 0,
        Pt_ARG_IS_STRUCT( PtWidget_t, area.pos ) },
    { Pt_ARG_RESIZE_FLAGS,      Pt_CHANGE_RESIZE, 0,
        Pt_ARG_IS_FLAGS( PtWidget_t, resize_flags )},
    { Pt_CB_DESTROYED,      Pt_CHANGE_INVISIBLE, 0,
        Pt_ARG_IS_CALLBACK_LIST( PtWidget_t, destroyed )},
    { Pt_CB_HOTKEY,         core_modify_hotkey_callbacks, 0,
        Pt_ARG_IS_CALLBACK_LIST( PtWidget_t, hotkeys )},
    { Pt_CB_RAW_EVENT,      core_modify_raw_callbacks, 0,
        Pt_ARG_IS_LINK( PtWidget_t, callbacks )},
    { Pt_CB_REALIZED,           Pt_CHANGE_INVISIBLE, 0,
        Pt_ARG_IS_CALLBACK_LIST( PtWidget_t, realized )},
    { Pt_CB_UNREALIZED,     Pt_CHANGE_INVISIBLE, 0,
        Pt_ARG_IS_CALLBACK_LIST( PtWidget_t, unrealized )},
    { Pt_ARG_USER_DATA,     Pt_CHANGE_INVISIBLE, 0,
        Pt_ARG_IS_ALLOC( PtWidget_t, user_data )},
    { Pt_ARG_HELP_TOPIC,        Pt_CHANGE_INVISIBLE, 0,
        Pt_ARG_IS_STRING( PtWidget_t, help_topic )
    },
    { Pt_CB_BLOCKED,            Pt_CHANGE_INVISIBLE, 0,
        Pt_ARG_IS_CALLBACK_LIST( PtWidget_t, blocked )},
    { Pt_ARG_BITMAP_CURSOR, bitmap_cursor_change, 0,
        Pt_ARG_IS_ALLOC( PtWidget_t, bitmap_cursor )
    },
    { Pt_ARG_EFLAGS,    PtModifyEFlags, 0,
        Pt_ARG_IS_FLAGS( PtWidget_t, eflags )},
    { Pt_CB_IS_DESTROYED, Pt_CHANGE_INVISIBLE, 0,
        Pt_ARG_IS_CALLBACK_LIST( PtWidget_t, is_destroyed ) },
    { Pt_CB_DND, Pt_CHANGE_INVISIBLE, 0,
        Pt_ARG_IS_CALLBACK_LIST( PtWidget_t, dnd ) },
    { Pt_ARG_EXTENT,    core_modify_extent, 0,
        Pt_ARG_IS_STRUCT( PtWidget_t, extent ) },
    { Pt_CB_OUTBOUND, Pt_CHANGE_INVISIBLE, 0,
        Pt_ARG_IS_CALLBACK_LIST( PtWidget_t, outbound ) },
    { Pt_ARG_WIDTH,             Pt_CHANGE_CANVAS, 0,
        Pt_ARG_IS_NUMBER( PtWidget_t, area.size.w )},
    { Pt_ARG_HEIGHT,                Pt_CHANGE_CANVAS, 0,
        Pt_ARG_IS_NUMBER( PtWidget_t, area.size.h )},
    { Pt_ARG_MINIMUM_DIM,           Pt_CHANGE_RESIZE, 0,
        Pt_ARG_IS_STRUCT( PtWidget_t, min_dim )},
    { Pt_CB_FILTER, Pt_CHANGE_INVISIBLE, NULL,
        Pt_ARG_IS_LINK( PtWidget_t, filter ) },
    { Pt_ARG_POINTER, Pt_CHANGE_INVISIBLE, NULL,
        Pt_ARG_IS_POINTER( PtWidget_t, ptr ) },
};
```

Functions

static *core_modify_cursor()*

Sets the resource via direct assignment and if realized, sets the Ph_REGION_CURSOR bit in *widget*->*flags*. If this flag is on when the *PtUpdate()* function is called (see the Photon *Library Reference*), a *PhRegionChange()* will be performed to change the region's cursor or create a region if one doesn't exist.

static *core_modify_raw_callbacks()*

Sets the resource via *PtSetStruct()* and adjusts the widget's region sensitivity.

static *core_modify_hotkey_callbacks()*

Sets the resource via *PtSetStruct()* and if realized, attaches any hotkey callbacks of a nonwindow widget to its disjoint parent.

int *PtModifyFlags()*

Knocks down the read-only flag bits from the mask and applies the remaining flag to *widget*->*flags*. A change in the following flag bits may cause the widget to change:

Pt_AUTOHIGHLIGHT	Requires a region and sensitivity to Ph_EV_BOUNDARY events via *PhRegionChange()* or the Connection method of **PtWidget**.
Pt_ETCH_HIGHLIGHT	Resize by setting the Pt_WIDGET_RESIZE bit in *widget*->*flags*.
Pt_SET	If Pt_SELECT_NOREDRAW isn't set in the widget flags, the widget will force a redraw by calling *PtDamageWidget()*.
Pt_HIGHLIGHTED	The widget will force a redraw by calling *PtDamageWidget()*.

PtBasic

Provides fundamental Photon widget behavior and callbacks.

Class hierarchy

PtWidget → **PtBasic**

Class extensions

The **PtBasic** widget adds three class-level methods to fundamental widget functionality. For complete descriptions, see "Class methods" in the Anatomy of a Widget chapter.

```
typedef struct Pt_basic_widget_class {
     PtWidgetClass_t   core;
     void  (*got_focus_f)( PtWidget_t *, PhEvent_t * );
     void  (*lost_focus_f)( PtWidget_t *, PhEvent_t * );
     void  (*calc_opaque_f)( PtWidget_t * );
     } PtBasicWidgetClass_t;

#define Pt_SET_GOT_FOCUS_F (Pt_ARG_IS_POINTER(PtBasicWidgetClass_t,got_focus_f))
#define Pt_SET_LOST_FOCUS_F (Pt_ARG_IS_POINTER(PtBasicWidgetClass_t,lost_focus_f))
#define Pt_SET_CALC_OPAQUE_F (Pt_ARG_IS_POINTER(PtBasicWidgetClass_t,calc_opaque_f))
```

Methods

PtBasic defines the class methods described below.

Defaults method

```
widget->border_width = 1;
widget->cursor_color = Ph_CURSOR_DEFAULT_COLOR;
widget->resize_flags |= Pt_RESIZE_XY_AS_REQUIRED;
widget->eflags = Pt_DAMAGE_ON_FOCUS;

basic->border_color = basic->fill_color = Pg_LGREY;
basic->flags = Pt_ALL_ETCHES | Pt_ALL_BEVELS |
                  Pt_ALL_OUTLINES | Pt_FLAT_FILL;
basic->inline_color = basic->outline_color = PgGrey( 0x4b );
```

Initialization method

None.

Extent method

Invokes the Extent method of **PtWidget** via *PtSuperClassExtent()*. The resulting extent is then adjusted to account for borders and margins.

The Extent method calculates the widget's opaque rectangle and determines whether the widget's Pt_OPAQUE flag is set. The opaque rectangle, *widget*->*opaque*, indicates:

- the rectangle under which damage needn't occur if this widget is damaged
- what should be damaged if this widget changes position or dimension

This rectangle is the area capable of obscuring any widgets beneath. Widgets completely obscured by another widget aren't drawn.

Connection method

Checks the **PtBasic** class structure member *calc_opaque_f*. If not NULL, the function is invoked. The *calc_opaque_f()* function is responsible for setting or clearing a widget's Pt_OPAQUE flag. If the widget has a rectangular area blocking anything beneath, the Pt_OPAQUE flag should be set and *widget*->*opaque_rect* should identify that rectangular area. Otherwise, the Pt_OPAQUE flag should be cleared.

If a widget's fill color is Pg_TRANSPARENT or has a *basic*->*roundness* that's greater than 0, the widget shouldn't be flagged as opaque.

Realization method

Inherited from **PtWidget**.

Draw method

`PtBasic`'s Draw method draws a rectangle filled with the current fill color. The widget's border is rendered if the Pt_HIGHLIGHTED bit of the widget flags is set and the border width is greater than 0.

If the Pt_SET bit is set, the border is rendered inverted (i.e. the top border color is used to draw the bottom border and vice versa). **`PtBasic`**'s Draw method also handles focus rendering.

Unrealization method

None.

Destruction method

None.

Got Focus method

Damages widgets having both the Pt_FOCUS_RENDER and Pt_DAMAGE_ON_FOCUS flags set. Highlights and invokes the *basic*->*arm* (*Pt_CB_ARM*) callback list if this widget has the Pt_AUTOHIGHLIGHT flag set. Invokes the *basic*->*got_focus* (*Pt_CB_GOT_FOCUS*) callback list using *PtInvokeCallbackList()*.

Lost Focus method

Damages widgets having both the Pt_FOCUS_RENDER and Pt_DAMAGE_ON_FOCUS flags set. Unhighlights and invokes the *basic*->*disarm* (*Pt_CB_DISARM*) callback list if this widget has the Pt_AUTOHIGHLIGHT flag set. Invokes the *basic*->*got_focus* (*Pt_CB_LOST_FOCUS*) callback list via *PtInvokeCallbackList()*.

Calc Opaque Rect method

Sets or clears the widget's Pt_OPAQUE flag (*Pt_ARG_FLAGS* resource) based on the widget's fill color, roundness, and current value of the Pt_RECTANGULAR flag in the widget class structure.

Widget actions

`PtBasic` is sensitive to the following events:

Ph_EV_BUT_PRESS

: The widget sets/clears Pt_SET flags, invokes *Pt_CB_ARM* (and possibly *Pt_CB_ACTIVATE* if a toggle button is selected) and *Pt_CB_MENU* (if the right mouse button is pressed).

Ph_EV_BUT_REPEAT

: The widget invokes the *Pt_CB_REPEAT* callbacks.

Ph_EV_BUT_RELEASE

The widget invokes the *Pt_CB_DISARM* callbacks. If a real release (as opposed to a phantom release) is received, the widget also invokes *Pt_CB_ACTIVATE*.

Ph_EV_BOUNDARY

The widget manages highlighting of widgets with the Pt_AUTOHIGHLIGHT flag set.

The raw callbacks return Pt_CONTINUE to allow chaining to continue.

If your widget class defines Pt_SET_RAW_CALLBACKS, keep this in mind: if your raw callback is sensitive to one of the events listed above and the callback returns Pt_END or Pt_HALT, **PtBasic** behavior for that event won't occur unless you invoke **PtBasic**'s raw handlers within the callback prior to returning. This can be done via *PtSuperClassRawEvent()*.

Resource definitions

```
static const PtResourceRec_t resources[] =
{
    { Pt_ARG_FLAGS, basic_modify_flags, NULL,
      Pt_ARG_IS_FLAGS( PtWidget_t, flags ) },
    { Pt_ARG_INLINE_COLOR, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_COLOR( PtBasicWidget_t, inline_color ) },
    { Pt_ARG_COLOR, Pt_CHANGE_REDRAW, NULL,
      Pt_ARG_IS_COLOR( PtBasicWidget_t, color ) },
    { Pt_ARG_FILL_COLOR, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_COLOR( PtBasicWidget_t, fill_color ) },
    { Pt_ARG_FILL_PATTERN, Pt_CHANGE_REDRAW, NULL,
      Pt_ARG_IS_STRUCT( PtBasicWidget_t, fill_pattern ) },
    { Pt_ARG_MARGIN_HEIGHT, Pt_CHANGE_CANVAS, NULL,
      Pt_ARG_IS_NUMBER( PtBasicWidget_t, margin_height ) },
    { Pt_ARG_MARGIN_WIDTH, Pt_CHANGE_CANVAS, NULL,
      Pt_ARG_IS_NUMBER( PtBasicWidget_t, margin_width ) },
    { Pt_ARG_OUTLINE_COLOR, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_COLOR( PtBasicWidget_t, outline_color ) },
    { Pt_CB_ARM, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_CALLBACK_LIST( PtBasicWidget_t, arm ) },
    { Pt_CB_DISARM, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_CALLBACK_LIST( PtBasicWidget_t, disarm ) },
    { Pt_CB_ACTIVATE, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_CALLBACK_LIST( PtBasicWidget_t, activate ) },
    { Pt_CB_GOT_FOCUS, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_CALLBACK_LIST( PtBasicWidget_t, got_focus ) },
    { Pt_CB_LOST_FOCUS, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_CALLBACK_LIST( PtBasicWidget_t, lost_focus ) },
    { Pt_CB_REPEAT, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_CALLBACK_LIST( PtBasicWidget_t, repeat ) },
    { Pt_ARG_TRANS_PATTERN, Pt_CHANGE_RESIZE_REDRAW, NULL,
      Pt_ARG_IS_STRUCT( PtBasicWidget_t, trans_pattern ) },
    { Pt_ARG_BASIC_FLAGS, basic_modify_flags, NULL,
      Pt_ARG_IS_FLAGS( PtBasicWidget_t, flags ) },
    { Pt_CB_MENU, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_CALLBACK_LIST( PtBasicWidget_t, menu ) },
    { Pt_ARG_CONTRAST, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_NUMBER( PtBasicWidget_t, contrast ) },
    { Pt_ARG_BEVEL_CONTRAST, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_NUMBER( PtBasicWidget_t, border_contrast ) },
    { Pt_ARG_BEVEL_COLOR, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_COLOR( PtBasicWidget_t, border_color ) },
    { Pt_ARG_LIGHT_FILL_COLOR, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_COLOR( PtBasicWidget_t, top_flat_color ) },
    { Pt_ARG_DARK_FILL_COLOR, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_COLOR( PtBasicWidget_t, bot_flat_color ) },
    { Pt_ARG_DARK_BEVEL_COLOR, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_COLOR( PtBasicWidget_t, bot_border_color ) },
    { Pt_ARG_LIGHT_BEVEL_COLOR, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_COLOR( PtBasicWidget_t, top_border_color ) },
};
```

Functions

`static void` *basic_modify_flags()*

For *Pt_ARG_FLAGS*, this function:

- recalculates the opaque rectangle if a highlighting flag is changing
- damages the widget if the Pt_GHOST flag is changing
- lets any other flag changes be handled via *PtSuperClassSetResources()*

`void` *basic_modify()*

Sets the fill color and roundness values. Invokes the Connection method of **`PtBasic`** (which invokes the Calc Opaque Rect method), and reexamines the widget's clear/opaque status via *PtUpdateVisibility()*.

Setting the Pt_CONSUME_EVENTS bit of **`PtWidget`**'s *eflags* resource controls whether a widget consumes any event it's given. Container widgets set this bit by default to prevent events from passing through to the subclassed widgets beneath them.

PtContainer

This superclass provides a new origin, clipping, and constraints for widget children. If you're creating a widget with children, we recommend you make your widget a subclass of **`PtContainer`** or one of its subclasses.

A container can have its own Draw method to render any widget-specific data (other than children).

Class hierarchy

`PtWidget` → **`PtBasic`** → **`PtContainer`**

Class extensions

```
typedef struct Pt_container_widget_class {
    PtBasicWidgetClass_t    basic;
    void    (*child_created_f)( PtWidget_t *widget,
                                PtWidget_t *child );
    int     (*child_settingresource_f)(PtWidget_t *widget,
                                       PtWidget_t *child,
                                       PtArg_t const *argt);
    int     (*child_gettingresource_f)(PtWidget_t *widget,
                                       PtWidget_t *child,
                                       PtArg_t *argt );
    int     (*child_realizing_f)( PtWidget_t *widget,
                                  PtWidget_t *child );
    void    (*child_realized_f)( PtWidget_t *widget,
                                 PtWidget_t *child );
    void    (*child_unrealizing_f)( PtWidget_t *widget,
                                    PtWidget_t *child );
    void    (*child_unrealized_f)( PtWidget_t *widget,
                                   PtWidget_t *child );
    void    (*child_destroyed_f)( PtWidget_t *widget,
                                  PtWidget_t *child );
    void    (*child_move_resize_f)( PtWidget_t *widget,
                                    PtWidget_t *child,
                                    PhArea_t *current_area,
                                    PhRect_t *current_extent,
                                    PhArea_t *old_area,
                                    PhRect_t *old_extent );
    int     (*child_getting_focus_f)( PtWidget_t *widget,
                                      PtWidget_t *child,
                                      PhEvent_t *event );
    int     (*child_losing_focus_f)( PtWidget_t *widget,
                                     PtWidget_t *child,
                                     PhEvent_t *event );
    PtWidget_t * (*child_redirect_f)( PtWidget_t *,
                                      PtWidgetClassRef_t *);

} PtContainerClass_t;

#define Pt_SET_CHILD_SETTINGRESOURCE_F \
        (Pt_ARG_MODE_PTR|offsetof(PtContainerClass_t, \
                                  child_settingresource_f))
#define Pt_SET_CHILD_GETTINGRESOURCE_F \
        (Pt_ARG_MODE_PTR|offsetof(PtContainerClass_t, \
                                  child_gettingresource_f))
#define Pt_SET_CHILD_REALIZING_F \
        (Pt_ARG_MODE_PTR|offsetof(PtContainerClass_t, \
                                  child_realizing_f))
#define Pt_SET_CHILD_REALIZED_F \
        (Pt_ARG_MODE_PTR|offsetof(PtContainerClass_t, \
                                  child_realized_f))
#define Pt_SET_CHILD_UNREALIZING_F \
        (Pt_ARG_MODE_PTR|offsetof(PtContainerClass_t, \
                                  child_unrealizing_f))
#define Pt_SET_CHILD_UNREALIZED_F \
        (Pt_ARG_MODE_PTR|offsetof(PtContainerClass_t, \
                                  child_unrealized_f))
#define Pt_SET_CHILD_CREATED_F \
        (Pt_ARG_MODE_PTR|offsetof(PtContainerClass_t, \
                                  child_created_f))
#define Pt_SET_CHILD_DESTROYED_F \
        (Pt_ARG_MODE_PTR|offsetof(PtContainerClass_t, \
                                  child_destroyed_f))
#define Pt_SET_CHILD_MOVED_RESIZED_F \
        (Pt_ARG_MODE_PTR|offsetof(PtContainerClass_t, \
                                  child_move_resize_f))
#define Pt_SET_CHILD_GETTING_FOCUS_F \
        (Pt_ARG_MODE_PTR|offsetof(PtContainerClass_t, \
                                  child_getting_focus_f))
#define Pt_SET_CHILD_LOSING_FOCUS_F \
        (Pt_ARG_MODE_PTR|offsetof(PtContainerClass_t, \
                                  child_losing_focus_f))
#define Pt_SET_CHILD_REDIRECT_F \
        (Pt_ARG_MODE_PTR|offsetof(PtContainerClass_t, \
                                  child_redirect_f))
```

Methods

PtContainer defines the class methods described below.

Defaults method

```
PtContainerWidget_t *ctnr =(PtContainerWidget_t *)widget;
PtBasicWidget_t *basic = (void *)widget;

widget->eflags |= Pt_CONSUME_EVENTS;
widget->border_width = 0;
widget->resize_flags &= ~Pt_RESIZE_XY_BITS;
basic->flags = Pt_ALL_BEVELS | Pt_FLAT_FILL;
ctnr->flags = Pt_ANCHOR_CHILD_HORIZONTAL |
                 Pt_ANCHOR_CHILD_VERTICAL |
                 Pt_CANVAS_INVALID | Pt_ENABLE_CUA |
                 Pt_ENABLE_CUA_ARROWS;

ctnr->title_font = strdup("TextFont09");

PtSetParentWidget( widget );
```

Initialization method

Registers with its parent for anchoring services.

Extent method

Finds the bounding box of widget children and applies its resize policy. The extent is calculated, and if the canvas is different as a result, all registered child containers are anchored. If the extent or canvas is different, the resize callback list of the widget is invoked. See *PtSuperClassExtent()* for a sample Extent method of a container.

Connection method

None.

Realization method

None.

Draw method

Inherited from **PtBasic**.

Unrealization method

Deregisters a widget from its parent. Destroys the *current_balloon* and sets it to NULL (if not NULL already).

Destruction method

Deregisters a widget from its parent.

Got Focus method

Inherited from **PtBasic**.

Lost Focus method

Inherited from **PtBasic**.

Calc Opaque Rect method

Inherited from **PtBasic**.

Child Created method

None.

Child Realized/Unrealized method

```
static void container_child_realized_unrealized(
    PtWidget_t *widget, PtWidget_t *child )
{
    PtContainerWidget_t *ctnr =
       (PtContainerWidget_t *)widget;
    if( child->flags & Pt_PROCREATED )
    // || !PtResizePolicy( widget ) )
        return;

    if ( ( widget->flags & Pt_REALIZED ) &&
         ( ctnr->flags & Pt_AUTO_EXTENT ) )
    {
        ctnr->flags |= Pt_IGNORE_CONSTRAINTS;
        PtMoveResizeWidget( widget, 0 );
        ctnr->flags &= ~Pt_IGNORE_CONSTRAINTS;
    }
}
```

Child Moved/Resized method

Calls the Child Realized/Unrealized method with the correct parameters:

```
static void container_child_moved_resized(
     PtWidget_t *widget, PtWidget_t *child,
     PhArea_t *area, PhRect_t *rect,
     PhArea_t *oarea, PhRect_t *orect )
{
    container_child_realized_unrealized( widget, child );
}
```

Child Destroyed method

None.

Child Setting Resources method

None.

Child Getting Resources method

None.

Child Getting Focus method

None.

Child Losing Focus method

None.

Widget actions

None.

Resource definitions

```
static const PtRawCallback_t callback =
{
    Pt_EV_REDIRECTED,   container_callback, NULL
};

static const PtResourceRec_t resources[] =
{
    { Pt_ARG_AREA, container_modify_area, NULL,
      Pt_ARG_IS_STRUCT( PtWidget_t, area ) },
    { Pt_ARG_DIM, container_modify_area, NULL,
      Pt_ARG_IS_STRUCT( PtWidget_t, area.size ) },
    { Pt_ARG_POS, container_modify_area, NULL,
      Pt_ARG_IS_STRUCT( PtWidget_t, area.pos ) },
    { Pt_ARG_RESIZE_FLAGS, container_modify_area, NULL,
      Pt_ARG_IS_FLAGS( PtWidget_t, resize_flags ) },
    { Pt_ARG_ANCHOR_OFFSETS, container_modify_area, NULL,
      Pt_ARG_IS_STRUCT( PtContainerWidget_t, anchor_offset) },
    { Pt_ARG_ANCHOR_FLAGS, container_modify_area, NULL,
      Pt_ARG_IS_FLAGS( PtContainerWidget_t, anchor_flags ) },
    { Pt_ARG_FOCUS, container_modify, NULL,
      Pt_ARG_IS_POINTER( PtContainerWidget_t, focus ) },
    { Pt_CB_RESIZE, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_CALLBACK_LIST( PtContainerWidget_t, resize ) },
    { Pt_CB_BALLOONS, container_set_balloons, NULL,
      Pt_ARG_IS_LINK( PtContainerWidget_t, balloons ) },
    { Pt_ARG_CONTAINER_FLAGS, container_modify_flags, NULL,
      Pt_ARG_IS_FLAGS( PtContainerWidget_t, flags ) },
    { Pt_ARG_TITLE, container_set_title, NULL,
      Pt_ARG_IS_STRING( PtContainerWidget_t, title ) },
    { Pt_ARG_TITLE_FONT, container_set_title, NULL,
      Pt_ARG_IS_STRING( PtContainerWidget_t, title_font ) },
    { Pt_CB_CHILD_ADDED_REMOVED,Pt_CHANGE_INVISIBLE,NULL,
      Pt_ARG_IS_LINK(PtContainerWidget_t,child_added_removed ) },
};
```

Functions

container_modify_area()

If *area*, *pos*, or *dim* is being modified, the container's anchors are invalidated and unlocked:

```
container->flags |= Pt_ANCHORS_INVALID;
container->flags &= ~Pt_ANCHORS_LOCKED;
```

The Pt_ANCHORS_INVALID bit indicates that the widget can't be anchored using the values in the anchor offsets member until these values are recalculated.

The Pt_ANCHORS_LOCKED bit indicates that the anchor offsets for the container are valid and shouldn't be recalculated due to the change that just occurred. This bit is set when *Pt_ARG_ANCHOR_OFFSETS* is set. If *Pt_ARG_ANCHOR_OFFSETS* is set, the anchors are validated and locked. If *Pt_ARG_RESIZE_FLAGS* is being modified, the anchors are invalidated and the widget is flagged for resize:

```
widget->flags |= Pt_WIDGET_RESIZE;
```

container_modify()

```
static void container_modify( PtWidget_t *widget,
                              PtArg_t *arg )
{
   PtContainerWidget_t *container =
       (PtContainerWidget_t *)widget;
   PhEvent_t event;

   memset( &event, 0, sizeof( event ) );
   switch( arg->type )
   {
      case Pt_ARG_FOCUS:
         // If the widget is already focused or isn't
         // the immediate child of this container,
         // do nothing.

         if (( container->focus ==
               (PtWidget_t *)arg->value )
            || ( !arg->value )
            || (((PtWidget_t *)arg->value)->parent !=
                 widget))
               return;

         // otherwise, give the target widget focus.
         PtContainerGiveFocus( (PtWidget_t *)arg->value,
                               &event );
        if( container->focus && container->focus->flags & Pt_REALIZED )
            PtDamageWidget( container->focus );
   }
}
```

container_set_balloons()

Registers/deregisters balloons with the container and increments/decrements the container's balloon count (*container*->*balloon_count*). If the balloon count is nonzero, the *balloons_active* bit located in *container*->*anchor_flags* is set; otherwise, it's cleared.

A raw callback function to check the balloon list is added if the balloon count is nonzero and the *balloons_active* bit was not set. The callback is removed if the balloon count goes to zero and the *balloons_active* bit was set.

container_modify_flags()

Container flags are set/cleared. If one of the bits affected was the Pt_AUTO_EXTENT bit, several constraint functions are enabled or disabled and the widget is (potentially) scheduled to have its Extent method executed.

```
static void
container_modify_flags( PtWidget_t *widget,
                        PtArg_t const *argt )
    {
    PtContainerWidget_t *ctnr =
       (PtContainerWidget_t *)widget;
    int changed;
    unsigned long mask =
       argt->len & ~Pt_CONTAINER_RO_FLAGS;
    changed = ctnr->flags;
    changed ^= ctnr->flags =
       ( ctnr->flags & ~mask ) |
       ( argt->value & mask );

    if( changed & Pt_AUTO_EXTENT )
        {
        if( ctnr->flags & Pt_AUTO_EXTENT )
            {
            ctnr->flags |= Pt_CHILD_REALIZED |
                           Pt_CHILD_UNREALIZED |
                           Pt_CHILD_MOVED_RESIZED;
            widget->flags |= Pt_WIDGET_RESIZE;
            PtSyncWidget( widget );
            }
        }
    }
```

PtCompound

This class is used for creating widgets whose functionality (in part) is derived from exported subordinate widgets.

Class hierarchy

PtWidget → **PtBasic** → **PtContainer** → **PtCompound**

Class extensions

```
typedef struct Pt_compound_class {
    PtContainerClass_t      container;
    unsigned short          num_subordinates;
    unsigned short          num_blocked_resources;
    unsigned short          *subordinates;
    unsigned long           *blocked_resources;
```

```
} PtCompoundClass_t;

#define Pt_SET_NUM_SUBORDINATES \
    (Pt_ARG_IS_NUMBER(PtCompoundClass_t,num_subordinates))

#define Pt_SET_SUBORDINATES \
    (Pt_ARG_IS_POINTER(PtCompoundClass_t,subordinates)

#define Pt_SET_NUM_BLOCKED_RESOURCES \
    (Pt_ARG_IS_NUMBER(PtCompoundClass_t,num_blocked_resources))

#define Pt_SET_BLOCKED_RESOURCES \
    (Pt_ARG_IS_POINTER(PtCompoundClass_t,blocked_resources)
```

Pt_SET_NUM_SUBORDINATES

Indicates the number of subordinate widgets to be exported.

Pt_SET_SUBORDINATES

An array of offsets to widget pointers to subordinate widgets. These widgets must be created in the compound widget's Defaults method.

Pt_SET_NUM_BLOCKED_RESOURCES

Indicates the number of resources to block.

Pt_SET_BLOCKED_RESOURCES

An array of resources to block.

Methods

PtCompound defines the class methods described below.

Defaults method

Inherits all defaults from **PtContainer**.

Initialization method

None.

Extent method

Inherited from **PtContainer**.

Connection method

None.

Realization method

None.

Draw method

Inherited from **PtContainer**.

Unrealization method

None.

Destruction method

Destroys the redirected callback lists of exported subordinates having callback resources set on them.

Got Focus method

Inherited from **PtBasic**.

Lost Focus method

Inherited from **PtContainer**.

Calc Opaque Rect method

Inherited from **PtBasic**.

Widget actions

None.

Resource definitions

None.

Functions

None.

PtGenList

This class is used for creating list widgets.

Class hierarchy

PtWidget → **PtBasic** → **PtContainer** → **PtCompound** → **PtGenList**

Class extensions

```
typedef void PtGenListDrawF_t(
        PtWidget_t *widget,
        PtGenListItem_t *item, unsigned index,
        unsigned nitems,
        PhRect_t *where /* Modify *where if needed */
        );

typedef int PtGenListMouseF_t(
        PtWidget_t *wgt,
        PtGenListItem_t *item,
        unsigned index,
        PhPoint_t *where, /* relative to the item, can modify */
        int column,
        PhEvent_t *ev
        );

typedef int PtGenListKeyF_t(
        PtWidget_t *wgt,
        PhEvent_t *ev, PhKeyEvent_t *kev,
        PtGenListItem_t *newcur, unsigned newpos
        );

typedef void PtGenListSelectF_t(
        PtWidget_t *wgt, PtGenListItem_t *item, int pos, int column,
        int nitems, int subtype, PhEvent_t *ev
        );

typedef PtWidget_t *PtGenListInflateF_t(
        PtWidget_t *widget, PtWidget_t *parent,
        PtGenListItem_t *item, unsigned index,
        int column, PhArea_t *area
        );

typedef void PtGenListDrawBackgroundF_t(
        PtWidget_t *widget,
        PhRect_t const *canvas, PhRect_t const *empty
        );

typedef int PtGenListDndCallbackF_t(
        PtWidget_t *widget,
        PtGenListItem_t const *item, int index, PhEvent_t *event,
        unsigned long *pflags, unsigned int *action
        );

typedef const PtGenListItemAttrs_t *PtGenListGetItemAttrsF_t(
        PtWidget_t *widget, PtGenListItem_t const *item
        );

typedef struct Pt_gen_list_widget_class {
    PtCompoundClass_t   compound;
        PtGenListDrawF_t        *list_draw_f;
        PtGenListMouseF_t        *list_mouse_f;
        PtGenListKeyF_t                *list_key_f;
        PtGenListSelectF_t        *list_select_f;
        PtGenListInflateF_t        *list_inflate_f;
        PtGenListDrawBackgroundF_t *list_draw_background_f;
        PtGenListDndCallbackF_t *list_dnd_callback_f;
        PtGenListGetItemAttrsF_t *list_itemattrs_f;
        }
                PtGenListClass_t;

#define Pt_SET_LIST_DRAW_F \
        Pt_ARG_IS_POINTER( PtGenListClass_t, list_draw_f )
#define Pt_SET_LIST_MOUSE_F \
        Pt_ARG_IS_POINTER( PtGenListClass_t, list_mouse_f )
#define Pt_SET_LIST_KEY_F \
        Pt_ARG_IS_POINTER( PtGenListClass_t, list_key_f )
#define Pt_SET_LIST_SELECT_F \
        Pt_ARG_IS_POINTER( PtGenListClass_t, list_select_f )
#define Pt_SET_LIST_INFLATE_F \
        Pt_ARG_IS_POINTER( PtGenListClass_t, list_inflate_f )
#define Pt_SET_LIST_DRAW_BACKGROUND_F \
        Pt_ARG_IS_POINTER( PtGenListClass_t, list_draw_background_f )
#define Pt_SET_LIST_DND_CALLBACK_F \
        Pt_ARG_IS_POINTER( PtGenListClass_t, list_dnd_callback_f )
#define Pt_SET_LIST_ITEMATTRS_F \
        Pt_ARG_IS_POINTER( PtGenListClass_t, list_itemattrs_f )
```

Methods

PtGenList defines the class methods described below.

Defaults method

```
widget->flags |= Pt_HIGHLIGHTED | Pt_ETCH_HIGHLIGHT |
                 Pt_SET | Pt_GETS_FOCUS | Pt_FOCUS_RENDER;
widget->eflags &= ~Pt_DAMAGE_ON_FOCUS;
widget->resize_flags &= ~Pt_RESIZE_XY_BITS;
widget->border_width = 1; //2;
list->columns = & list->dfltcol;
list->ncolumns = 1;
list->flags = Pt_LIST_SCROLLBAR_AUTORESIZE |
              Pt_LIST_VSCROLLBAR_AS_REQUIRED |
              Pt_LIST_BALLOONS_IN_COLUMNS;
set_selmode( list, list->sel_mode = Pt_BROWSE_MODE );
list->scroll_rate = 2;
list->selection_fill_color = PgRGB( 142, 162, 155 );
list->selection_text_color = Pg_WHITE;
list->balloon_bg = Pg_BALLOONCOLOR;
list->balloon_fg = Pg_BLACK;
list->font = Pt_GET_MAGIC_FONT_NAME( TextFont09 );
list->dnd_selection_color = PgRGB( 216, 216, 216 );
getfontsize( list );

basic->margin_width =
basic->margin_height = 0;
basic->flags = Pt_ALL_ETCHES | Pt_OPAQUE_ETCHES |
               Pt_ALL_OUTLINES /*| Pt_LEFT_INLINE*/ |
               Pt_FLAT_FILL;
basic->inline_color = Pg_GREY;
basic->fill_color = PgGrey( 244 );
widget->eflags &= ~Pt_DAMAGE_ON_FOCUS;
list->slider_width = SCROLLBAR_DEFAULT_WIDTH;
list->max_top = list->top_item = 1;
```

Initialization method

None.

Extent method

If a **PtDivider** widget is the child, the Extent method:

- calls the Extent method of **PtDivider** via *PtExtentWidget()*
- adjusts the size of the **PtDivider** widget according to the resize policy and the Pt_LIST_SNAP flag

Then the Extent method of **PtCompound** is invoked via *PtSuperClassExtent()*.

Connection method

None.

Realization method

Realizes the scrollbar if necessary and registers a balloon callback with the parent.

Draw method

Renders the widget's border, margins, and (possibly) background. Then the List Draw method is called to draw the list.

Unrealization method

Deregisters a balloon callback with the parent.

Destruction method

None.

Got Focus method

If the Pt_FOCUS_RENDER flag is set, the Got Focus method damages the current item (see "Current item" in the description of **PtGenList** in the *Widget Reference*). If the Pt_SELECTION_MODE_AUTO flag is set but the Pt_SELECTION_MODE_NOFOCUS flag isn't set and no items are selected, the current item is selected. Then the Got Focus method of **PtCompound** is invoked via *PtSuperClassGotFocus()*.

Lost Focus method

If necessary, the current item is damaged. Then the Lost Focus method of **PtCompound** is invoked via *PtSuperClassLostFocus()*.

Calc Opaque Rect method

Inherited from **PtBasic**.

Child Created method

Sets the child redirector function to *PtCompoundRedirect()* via the Pt_SET_CHILD_REDIRECT_F manifest defined by **PtContainer**. This prevents the list widget from having more than one **PtDivider** child.

Child Realized method

If the child isn't the scrollbar (it's a divider), the Child Realized method:

- Sets *list->divider* to the widget pointer of the child.
- Adjusts the top margin.
- Sets the orientation of the child to horizontal.
- Sets the child's *Pt_ARG_DIVIDER_OFFSET* resource and the Pt_CALLBACKS_ACTIVE flag.

- Copies the *Pt_ARG_DIVIDER_SIZES* resource of the child to the *Pt_ARG_LIST_COLUMN_POS* resource of the list widget.
- Attaches a function to the *Pt_CB_DIVIDER_DRAG* callback list.

Child Moved/Resized method

If the child is a divider (i.e. *list*->*divider*), the Child Moved/Resized method sets the divider's *Pt_ARG_DIVIDER_OFFSET* resource and adjusts the top margin of the list widget.

Child Unrealized method

If the child is the same as *list*->*divider*, the Child Unrealized method adjusts the top margin, removes the callback, and sets *list*->*divider* to NULL.

Child Destroyed method

Sets the child redirector function to a private function that accepts a **`PtDivider`** child only.

Child Setting Resources method

Inherited from **`PtContainer`**.

Child Getting Resources method

Inherited from **`PtContainer`**.

Child Getting Focus method

Inherited from **`PtContainer`**.

Child Losing Focus method

Inherited from **`PtContainer`**.

List Draw method

None.

List Mouse method

None.

List Key method

None.

List Select method

None.

List Inflate method

None.

List Attributes method

None.

Widget actions

PtGenList is sensitive to the following events:

- Ph_EV_KEY
- Ph_EV_BUT_PRESS
- Ph_EV_PTR_MOTION_BUTTON
- Ph_EV_BUT_RELEASE
- Ph_EV_BUT_REPEAT

The callback function invokes the List Key or List Mouse method and performs the selection.

If your widget class defines Pt_SET_RAW_CALLBACKS, keep this in mind: if your raw callback is sensitive to one of the events listed above and the callback returns Pt_END or Pt_HALT, **PtGenList** behavior for that event won't occur unless you invoke **PtGenList**'s raw handlers within the callback prior to returning. This can be done via *PtSuperClassRawEvent()*.

Resource definitions

```
static const PtResourceRec_t resources[] =
{
    {Pt_ARG_AREA,gl_arg_resize, NULL,
     Pt_ARG_IS_STRUCT( PtWidget_t, area )
    },
    {Pt_ARG_DIM,gl_arg_resize, NULL,
     Pt_ARG_IS_STRUCT( PtWidget_t, area.size )
    },
    {Pt_ARG_FLAGS,arg_wflags, NULL,
     Pt_ARG_IS_FLAGS( PtWidget_t, flags )
    },
    {Pt_ARG_POS,gl_arg_resize, NULL,
     Pt_ARG_IS_STRUCT( PtWidget_t, area.pos )
    },
    {Pt_ARG_COLOR,arg_txtcolor, NULL,
     Pt_ARG_IS_COLOR( PtBasicWidget_t, color )
    },
    {Pt_ARG_MARGIN_HEIGHT,gl_arg_resize, NULL,
     Pt_ARG_IS_NUMBER( PtGenListWidget_t, marg_height )
    },
    {Pt_ARG_MARGIN_WIDTH,gl_arg_resize, NULL,
     Pt_ARG_IS_NUMBER( PtGenListWidget_t, marg_width )
    },
    {Pt_ARG_LIST_FLAGS,gl_arg_flags, NULL,
     Pt_ARG_IS_FLAGS( PtGenListWidget_t, flags )
    },
    {Pt_ARG_LIST_FONT,arg_font, NULL,
     Pt_ARG_IS_STRING( PtGenListWidget_t, font )
    },
    {Pt_ARG_SCROLLBAR_WIDTH,gl_arg_resize, NULL,
     Pt_ARG_IS_NUMBER( PtGenListWidget_t, slider_width )
    },
    {Pt_ARG_SELECTION_MODE,arg_selmode, NULL,
     Pt_ARG_IS_NUMBER( PtGenListWidget_t, sel_mode )
    },
    {Pt_ARG_TOP_ITEM_POS,arg_top_pos, NULL,
     Pt_ARG_IS_NUMBER( PtGenListWidget_t, top_item  )
    },
    {Pt_ARG_SCROLLBAR,gl_arg_flags, NULL,
     Pt_ARG_IS_BOOLEAN( PtGenListWidget_t, flags ),
     Pt_LIST_VSCROLLBAR_ALWAYS
    },
    {Pt_ARG_SELECTION_FILL_COLOR, arg_selfillcolor, NULL,
     Pt_ARG_IS_COLOR( PtGenListWidget_t, selection_fill_color )
    },
    {Pt_ARG_SELECTION_TEXT_COLOR, arg_seltxtcolor, NULL,
     Pt_ARG_IS_COLOR( PtGenListWidget_t, selection_text_color)
    },
    {Pt_ARG_LIST_SB_RES, arg_setsb, arg_getsb
    },
    {Pt_ARG_LIST_COLUMN_POS, arg_columns, NULL,
     Pt_ARG_IS_ARRAY( PtGenListWidget_t, columns ),
     Pt_ARG_IS_NUMBER( PtGenListWidget_t, ncolumns )
    },
    {Pt_ARG_SB_FILL_COLOR, arg_setsbcolor, arg_getsbcolor,0
    },
    {Pt_ARG_SB_ARROW_COLOR, arg_setsbpencolor, arg_getsbpencolor,0
    },
    {Pt_ARG_SB_TROUGH_COLOR, arg_setsbtroughcolor, arg_getsbtroughcolor,0
    },

};
```

Functions

`static void` *arg_resize()*

This function:

- adjusts the number of displayed items
- resizes the scrollbar
- adjusts the *Pt_ARG_DIVIDER_OFFSET* resource of the widget pointed to by *list*->*divider*

`static void` *arg_font()*

This function:

- allocates a copy of the new font name and frees the old string
- stores the height of the new font in *list*->*font_height*

`static void` *arg_top_pos()*

This function:

- calculates a new range of displayed items
- blits some of the currently visible items to their new positions (blits only the items that will remain visible after the change)
- adjusts the scrollbar position
- invokes the *Pt_CB_SCROLL_MOVE* callback

`static void` *arg_selmode()*

This function:

- clears the current selection
- if the new value is valid, sets *list*->*sel_mode*, *list*->*sel_xmode*, and *list*->*sel_flags*

`static void` *arg_flags()*

For *Pt_ARG_LIST_FLAGS*, this function:

- adjusts the Pt_GETS_FOCUS flag of the scrollbar if the Pt_LIST_SCROLLBAR_GETS_FOCUS flag is changed
- adjusts *list*->*sel_xmode* and *list*->*sel_flags* if the Pt_LIST_NON_SELECT flag is changed

`static void` *arg_setsb()*

This function:

- checks if allowed resources were specified
- calls *PtSetResources()* for the scrollbar

`static void` *arg_getsb()*

Calls *PtGetResources()* for the scrollbar.

`static void` *arg_columns()*

This function:

- saves the new value
- damages the appropriate portions of the widget

For more information, see the chapter on Creating a List Widget.

PtGenTree

This class is used for creating tree widgets.

Class hierarchy

PtWidget → **PtBasic** → **PtContainer** → **PtCompound** → **PtGenList** → **PtGenTree**

Class extensions

```
typedef void PtGenTreeDrawItemF_t(
    PtWidget_t *widget, PtGenTreeItem_t *item,
    PhRect_t const *where, int lmargin, int rmargin
    );

typedef int PtGenTreeItemStateF_t(
    PtWidget_t *widget, PtGenTreeItem_t *item,
    PhEvent_t *event, int reason
    );

typedef struct Pt_gen_tree_widget_class {
    PtGenListClass_t        list;
    PtGenTreeDrawItemF_t    *tree_draw_item_f;
    PtGenTreeItemStateF_t   *tree_state_f;
    }
        PtGenTreeClass_t;

#define Pt_SET_TREE_DRAW_F \
        Pt_ARG_IS_POINTER( PtGenTreeClass_t, tree_draw_item_f )
#define Pt_SET_TREE_STATE_F \
        Pt_ARG_IS_POINTER( PtGenTreeClass_t, tree_state_f )
```

Methods

PtGenTree defines the class methods described below.

Defaults method

```
tree->flags = Pt_TREE_HAS_BUTTONS |
              Pt_TREE_TO_LEFT | Pt_TREE_TO_RIGHT |
              Pt_TREE_INDENT_BUTTONS |
              Pt_TREE_SHOW_CONNECTORS;
tree->list.gflags = Pt_GEN_LIST_SHOW_DAMAGED |
                    Pt_GEN_LIST_ITEM_BACKGROUND;
tree->list.selection_fill_color = PgRGB( 142, 162, 155 );
tree->line_spacing = 3;
tree->line_color = PgRGB( 239, 239, 239 );
tree->margin_color = PgRGB( 225, 225, 225 );
```

Initialization method

None.

Extent method

Inherited from **PtGenList**.

Connection method

None.

Realization method

None.

Draw method

Inherited from `PtGenList`.

Unrealization method

None.

Destruction method

None.

Got Focus method

Inherited from `PtGenList`.

Lost Focus method

Inherited from `PtGenList`.

Calc Opaque Rect method

Inherited from `PtBasic`.

Child Created method

Inherited from `PtGenList`.

Child Realized method

Inherited from `PtGenList`.

Child Moved/Resized method

Inherited from `PtGenList`.

Child Unrealized method

Inherited from `PtGenList`.

Child Destroyed method

Inherited from `PtGenList`.

Child Setting Resources method

Inherited from `PtContainer`.

Child Getting Resources method

Inherited from `PtContainer`.

Child Getting Focus method

Inherited from `PtContainer`.

Child Losing Focus method

Inherited from **PtContainer**.

List Draw method

For each visible item that has the Pt_LIST_ITEM_DAMAGED flag set, the List Draw method calls the Tree Draw Item method and draws the tree ornaments.

List Mouse method

Invokes the *Pt_CB_GEN_TREE_INPUT* callback list. Depending on the result of the callback and the pointer position, the List Mouse method returns Pt_CONTINUE, returns Pt_END, or calls *PtGenTreeCollapse()* or *PtGenTreeExpand()* (see the Photon *Widget Reference*) and returns Pt_END.

List Key method

Invokes the *Pt_CB_GEN_TREE_INPUT* callback list. Depending on the result of the callback and the key code, the List Key method returns Pt_CONTINUE, returns Pt_END, or calls *PtGenTreeCollapse()* or *PtGenTreeExpand()* (see the Photon *Widget Reference*) and returns Pt_HALT.

Tree Draw Item method

None.

Tree Item State method

None.

Widget actions

None.

Resource definitions

```
static const PtResourceRec_t resources[] = {
    {   Pt_ARG_TREE_FLAGS, arg_flags, NULL,
        Pt_ARG_IS_FLAGS( PtGenTreeWidget_t, flags )
        },
    {   Pt_ARG_TREE_LINE_SPACING, arg_line_spacing, NULL,
        Pt_ARG_IS_NUMBER( PtGenTreeWidget_t, line_spacing )
        },
    {   Pt_ARG_TREE_LINE_COLOR, Pt_CHANGE_RESIZE_REDRAW, NULL,
        Pt_ARG_IS_NUMBER( PtGenTreeWidget_t, line_color )
        },
    {   Pt_ARG_TREE_MARGIN_COLOR, Pt_CHANGE_RESIZE_REDRAW, NULL,
        Pt_ARG_IS_NUMBER( PtGenTreeWidget_t, margin_color )
        },
    {   Pt_CB_GEN_TREE_INPUT, Pt_CHANGE_INVISIBLE, NULL,
        Pt_ARG_IS_CALLBACK( PtGenTreeWidget_t, input_cb )
    }   };
```

Functions

```
static void arg_flags()
```

This function:

- Adjusts *list->gflags* if the Pt_TREE_TO_RIGHT flag has changed.
- Damages the widget or marks it for resizing.

For more information, see the chapter on Creating a Tree Widget.

PtLabel

The **PtLabel** class provides fundamental multiline-text string and image handling.

Class hierarchy

PtWidget → **PtBasic** → **PtLabel**

Methods

PtLabel defines the class methods described below.

Defaults method

```
widget->flags |= Pt_FOCUS_RENDER;
widget->resize_flags |= Pt_RESIZE_XY_AS_REQUIRED;
label->basic.flags = Pt_ALL_ETCHES | Pt_ALL_BEVELS |
                     Pt_FLAT_FILL;
label->basic.fill_color = Pg_TRANSPARENT;
label->font = strdup( "TextFont09" );
label->flags |= Pt_LABEL_SELECT_SHIFT;
label->uline1 = Pg_BLACK;
label->uline2 = Pg_TRANSPARENT;
label->uline_type            =(unsigned short) Pt_NO_ULINE;
label->type                  = Pt_Z_STRING;
label->text_image_spacing    = 2;
label->h_alignment           = Pt_LEFT;
label->v_alignment           = Pt_CENTER;
label->string                = strdup("");
label->inflate_f             = PtInflateBalloon;
label->balloon_fill_color    = Pg_BALLOONCOLOR;
label->balloon_color         = Pg_BLACK;
label->balloon_text          = strdup("");
if ( _Ph_->draw_context->gin.cmd_buf_limit < 4096 )
    PgSetDrawBufferSize(4096);
```

Initialization method

None.

Extent method

Determines the required canvas size based on the widget's text string or image data in conjunction with *label->type* (Pt_Z_STRING, Pt_TEXT_IMAGE), margins, etc. The Extent method also takes into account multiple lines of text and underlining.

Connection method

If *label*->*flags* has the Pt_SHOW_BALLOON flag set, a balloon callback is attached to the parent widget.

Realization method

Inherited from **PtBasic**.

Draw method

Calls the Draw method of **PtBasic** via *PtSuperClassDraw()*. Draws the text in the label using the specified font, color, etc.

Unrealization method

If this label has a balloon displayed (*label*->*balloon_widget* != NULL), that widget is destroyed. If *label*->*flags* has the Pt_SHOW_BALLOON flag set, it detaches the balloon callback from the parent.

Got focus method

Inherited from **PtBasic**.

Lost Focus method

Inherited from **PtBasic**.

Calc Opaque Rect method

If *label*->*type* is Pt_Z_STRING, the Calc Opaque Rect method is called via *PtSuperClassCalcOpaque()*.

If *label*->*type* is Pt_IMAGE, *label*->*flags* has its Pt_OPAQUE flag set.

If *label*->*type* is Pt_BITMAP and *label*->*data*->*image*->*type* is Pg_BITMAP_BACKFILL, the Pt_OPAQUE bit of *widget*->*flags* is set.

Widget actions

None.

Resource definitions

```
static const PtResourceRec_t resources[] =
{
    { Pt_ARG_BALLOON_TEXT, (void*)PtModifyBallonText, NULL,
      Pt_ARG_IS_STRING( PtLabelWidget_t, balloon_text ) },
    { Pt_ARG_FLAGS, set_flags, NULL,
      Pt_ARG_IS_FLAGS (PtWidget_t, flags) },
    { Pt_ARG_HORIZONTAL_ALIGNMENT, Pt_CHANGE_REDRAW, NULL,
      Pt_ARG_IS_NUMBER( PtLabelWidget_t, h_alignment ) },
{ Pt_ARG_LABEL_IMAGE, Pt_CHANGE_CANVAS_REDRAW, NULL,
      Pt_ARG_IS_IMAGE( PtLabelWidget_t, data ) },
    { Pt_ARG_LABEL_FLAGS, label_modify_flags, NULL,
      Pt_ARG_IS_FLAGS( PtLabelWidget_t, flags ) },
    { Pt_ARG_LABEL_TYPE, Pt_CHANGE_RESIZE_REDRAW, NULL,
      Pt_ARG_IS_NUMBER( PtLabelWidget_t, type) },
    { Pt_ARG_MARGIN_BOTTOM, Pt_CHANGE_CANVAS_REDRAW, NULL,
      Pt_ARG_IS_NUMBER( PtLabelWidget_t, margin_bottom ) },
    { Pt_ARG_MARGIN_LEFT, Pt_CHANGE_CANVAS_REDRAW, NULL,
      Pt_ARG_IS_NUMBER( PtLabelWidget_t, margin_left ) },
    { Pt_ARG_MARGIN_RIGHT, Pt_CHANGE_CANVAS_REDRAW, NULL,
      Pt_ARG_IS_NUMBER( PtLabelWidget_t, margin_right ) },
    { Pt_ARG_MARGIN_TOP, Pt_CHANGE_CANVAS_REDRAW, NULL,
      Pt_ARG_IS_NUMBER( PtLabelWidget_t, margin_top ) },
    { Pt_ARG_SELECT_SHIFT, Pt_CHANGE_REDRAW, NULL,
      Pt_ARG_IS_BOOLEAN( PtLabelWidget_t, flags ),
      Pt_LABEL_SELECT_SHIFT },
    { Pt_ARG_TEXT_FONT, Pt_CHANGE_RESIZE_REDRAW, NULL,
      Pt_ARG_IS_STRING( PtLabelWidget_t, font ) },
    { Pt_ARG_TEXT_STRING, PtModifyLabelString, NULL,
      Pt_ARG_IS_STRING( PtLabelWidget_t, string ) },
    { Pt_ARG_UNDERLINE1, Pt_CHANGE_RESIZE_REDRAW, NULL,
      Pt_ARG_IS_NUMBER( PtLabelWidget_t, uline1) },
    { Pt_ARG_UNDERLINE2, Pt_CHANGE_RESIZE_REDRAW, NULL,
      Pt_ARG_IS_NUMBER( PtLabelWidget_t, uline2) },
    { Pt_ARG_UNDERLINE_TYPE, Pt_CHANGE_RESIZE_REDRAW, NULL,
      Pt_ARG_IS_NUMBER( PtLabelWidget_t, uline_type) },
    { Pt_ARG_VERTICAL_ALIGNMENT, Pt_CHANGE_REDRAW, NULL,
      Pt_ARG_IS_NUMBER( PtLabelWidget_t, v_alignment ) },
    { Pt_ARG_BALLOON_POSITION, balloon_position, NULL,
      Pt_ARG_IS_NUMBER( PtLabelWidget_t, balloon_pos ) },
    { Pt_ARG_LABEL_BALLOON, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_POINTER( PtLabelWidget_t, inflate_f) },
    { Pt_ARG_ACCEL_KEY, Pt_CHANGE_RESIZE_REDRAW, NULL,
      Pt_ARG_IS_STRING( PtLabelWidget_t, accel_key ) },
    { Pt_ARG_BALLOON_FILL_COLOR, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_NUMBER( PtLabelWidget_t, balloon_fill_color ) },
    { Pt_ARG_BALLOON_COLOR, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_NUMBER( PtLabelWidget_t, balloon_color ) },
    { Pt_ARG_LINE_SPACING, Pt_CHANGE_RESIZE_REDRAW, NULL,
      Pt_ARG_IS_NUMBER( PtLabelWidget_t, line_spacing ) },
    { Pt_ARG_TEXT_IMAGE_SPACING, Pt_CHANGE_RESIZE_REDRAW, NULL,
      Pt_ARG_IS_NUMBER( PtLabelWidget_t, text_image_spacing ) },
};
```

Functions

```
static int label_modify_flags( PtWidget_t *widget,
                               PtArg_t const *argt );
```

If the Pt_SHOW_BALLOON flag is being set, the balloon callback is attached to the parent. If the Pt_SHOW_BALLOON flag is being cleared, the balloon callback is detached from the parent. The value of *label*->*flags* is based on *argt*->*value* and *argt*->*len*. This is typically done as follows:

```
label->flags = (label->flags & ~argt->len) | argt->value;
```

```
int PtModifyLabelString( PtWidget_t *widget,
                         PtArg_t const *argt );
```

This frees the current string, allocates enough space for the new string, copies in the new string, flags the widget to be resized (*widget*->*flags* |= Pt_WIDGET_RESIZE;), and damages the widget.

If a balloon is displayed and Pt_ARG_BALLOON_TEXT is not set, the balloon is destroyed and a new balloon is inflated with the new string. If *label*->*flags* has the

Pt_BALLOON_AS_REQUIRED bit set, the new balloon is created only if the label is clipped by its parent.

```
static int PtModifyBalloonText( PtWidget_t *widget,
                                PtArg_t const *arg );
```

This frees the current balloon text, allocates enough space for the new balloon text and copies it in. If a balloon is currently displayed, the balloon is destroyed and a new balloon is inflated with the new text. If *label->flags* has the Pt_BALLOON_AS_REQUIRED bit set, the new balloon is created only if the label is clipped by its parent.

PtGraphic

This class provides standard graphic resources such as *Pt_ARG_POINTS* and *Pt_ARG_ORIGIN*.

Class hierarchy

PtWidget → **PtBasic** → **PtGraphic**

Methods

PtGraphic defines the class methods described below.

Defaults method

```
graphic->line_cap              = Pg_BUTT_CAP;
graphic->line_join             = Pg_MITER_JOIN;
graphic->basic.margin_height   = 0;
graphic->basic.margin_width    = 0;
graphic->basic.fill_color      = Pg_TRANSPARENT;
```

Initialization method

None.

Extent method

Determines the render rectangle for the graphic widget, given the area, point array, and current settings of graphic flags.

Connection method

None.

Realization method

None.

Draw method

Inherited from **PtBasic**.

Unrealization method

None.

Destruction method

None.

Got Focus method

Inherited from **PtBasic**.

Lost Focus method

Inherited from **PtBasic**.

Calc Opaque Rect method

Inherited from **PtBasic**.

Widget actions

None.

Resource definitions

```
static const PtResourceRec_t resources[] = {
    Pt_ARG_AREA,            graphic_modify_area, 0,
        Pt_ARG_IS_STRUCT( PtWidget_t, area ), 0,
    Pt_ARG_DIM,         graphic_modify_area, 0,
        Pt_ARG_IS_STRUCT( PtWidget_t, area.size ) |
        Pt_ARG_PARM( sizeof( PhPoint_t ) ), 0,
    Pt_ARG_DASH_LIST,   Pt_CHANGE_REDRAW, 0,
        Pt_ARG_IS_ARRAY( PtGraphicWidget_t, dash_list ),
        Pt_ARG_IS_NUMBER( PtGraphicWidget_t, dash_len ),
    Pt_ARG_GRAPHIC_FLAGS,   Pt_CHANGE_RESIZE, 0,
        Pt_ARG_IS_FLAGS( PtGraphicWidget_t, flags ),0,
    Pt_ARG_LINE_WIDTH,  Pt_CHANGE_RESIZE_REDRAW, 0,
        Pt_ARG_IS_NUMBER( PtGraphicWidget_t, line_width ), 0,
    Pt_ARG_LINE_JOIN,   Pt_CHANGE_REDRAW, 0,
        Pt_ARG_IS_NUMBER( PtGraphicWidget_t, line_join ), 0,
    Pt_ARG_LINE_CAP,    Pt_CHANGE_REDRAW, 0,
        Pt_ARG_IS_NUMBER( PtGraphicWidget_t, line_cap ), 0,
    Pt_ARG_ORIGIN,  Pt_CHANGE_RESIZE_REDRAW, 0,
        Pt_ARG_IS_STRUCT( PtGraphicWidget_t, origin ),0,
    Pt_ARG_POINTS,  Pt_CHANGE_RESIZE_REDRAW, 0,
        Pt_ARG_IS_ARRAY( PtGraphicWidget_t, point_array),
        Pt_ARG_IS_NUMBER( PtGraphicWidget_t, npoints),
    Pt_CB_RESCALE,  Pt_CHANGE_INVISIBLE, 0,
        Pt_ARG_IS_CALLBACK_LIST( PtGraphicWidget_t, rescale ), 0,
    Pt_ARG_DASH_SCALE,  Pt_CHANGE_REDRAW, 0,
        Pt_ARG_IS_NUMBER( PtGraphicWidget_t, dash_scale ), 0,
};
```

Functions

graphic_modify_area()

Updates the widget's area or dimension and invokes the *Pt_CB_RESCALE* callback.

PtGauge

This class provides standard gauge resources such as maximum, minimum, and orientation.

Class hierarchy

PtWidget → **PtBasic** → **PtGauge**

Methods

PtGauge defines the class methods described below.

Defaults method

```
gauge->font = strdup("TextFont09");
gauge->flags = Pt_GAUGE_HORIZONTAL;
gauge->maximum = 100;
```

Initialization method

None.

Extent method

Inherited from **PtBasic**.

Connection method

None.

Realization method

None.

Draw method

Inherited from **PtBasic**.

Unrealization method

None.

Destruction method

None.

Got Focus method

Inherited from **PtBasic**.

Lost Focus method

Inherited from **PtBasic**.

Calc Opaque Rect method

Inherited from **PtBasic**

Widget actions

None.

Resource definitions

```
static const PtResourceRec_t resources[] =
{
    { Pt_ARG_GAUGE_FLAGS, Pt_CHANGE_INVISIBLE, NULL,
      Pt_ARG_IS_FLAGS( PtGaugeWidget_t, flags ),
      Pt_GAUGE_RO_FLAGS },
    { Pt_ARG_GAUGE_FONT, Pt_CHANGE_CANVAS_REDRAW, NULL,
      Pt_ARG_IS_STRING( PtGaugeWidget_t, font ) },
    { Pt_ARG_GAUGE_MINIMUM, Pt_CHANGE_CANVAS_REDRAW, NULL,
      Pt_ARG_IS_NUMBER( PtGaugeWidget_t, minimum ) },
    { Pt_ARG_GAUGE_MAXIMUM, Pt_CHANGE_CANVAS_REDRAW, NULL,
      Pt_ARG_IS_NUMBER( PtGaugeWidget_t, maximum ) },
    { Pt_ARG_GAUGE_VALUE, Pt_CHANGE_REDRAW, NULL,
      Pt_ARG_IS_NUMBER( PtGaugeWidget_t, value ) },
    { Pt_ARG_ORIENTATION, Pt_CHANGE_RESIZE_REDRAW, NULL,
      Pt_ARG_IS_BOOLEAN( PtGaugeWidget_t, flags ),
      Pt_GAUGE_HORIZONTAL },
    { Pt_ARG_GAUGE_VALUE_PREFIX, Pt_CHANGE_CANVAS_REDRAW, NULL,
      Pt_ARG_IS_STRING( PtGaugeWidget_t, prefix ) },
    { Pt_ARG_GAUGE_VALUE_SUFFIX, Pt_CHANGE_CANVAS_REDRAW, NULL,
      Pt_ARG_IS_STRING( PtGaugeWidget_t, suffix ) },
    { Pt_ARG_GAUGE_H_ALIGN, Pt_CHANGE_CANVAS, NULL,
      Pt_ARG_IS_NUMBER( PtGaugeWidget_t, h_alignment ) },
    { Pt_ARG_GAUGE_V_ALIGN, Pt_CHANGE_CANVAS, NULL,
      Pt_ARG_IS_NUMBER( PtGaugeWidget_t, v_alignment ) },
};
```

Functions

None.

Chapter 5

Creating a List Widget

In this chapter. . .

Overview

The Photon library provides the generic list widget class **`PtGenList`** for creating custom list widgets. The **`PtGenList`** class displays a vertical list of any number of items. A user can select one or more items from this list, depending on the selection policy.

The child class shouldn't override the Draw method or consume mouse or key events. Instead, it should define a List Draw method for drawing and may define a Mouse and/or Key Event method if additional handling of those event types is required. Usually, the child class will also define a Selection method that will be called by the **`PtGenList`** event handler.

Item structure

The **`PtGenList`** class never allocates or frees items. This is the responsibility of the child class. The **`PtGenList`** class expects each item to be represented by a **`PtGenListItem_t`** structure — see the Photon *Widget Reference*.

When you call a *PtGenList*()* convenience function, you give it a pointer to the **`PtGenListItem_t`** structure as an item. When **`PtGenList`** calls one of your methods, it provides a pointer to the **`PtGenListItem_t`** structure as an item.

Since a child class will most likely need additional data describing the item, it will usually define its item as a structure whose first member is **`PtGenListItem_t`**. This makes conversions to and from **`PtGenListItem_t`** easy.

The child class is responsible for allocating items and adding them to the widget. Before adding an item to the widget, the members of the item structure should be set to the required values. After adding the item to the widget, don't modify the **`PtGenListItem_t`** directly — use the convenience functions instead.

The **`PtGenListItem_t`** structure is defined as follows:

```
typedef struct Pt_genlist_item {
     unsigned flags;
     PhDim_t size;
     PtGenListItem_t *next, *prev;
     }
     PtGenListItem_t;
```

flags The following flags describe the state of the item:

Pt_LIST_ITEM_SELECTED
: This item is selected. Use *PtGenListSelect()* and *PtGenListUnselect()* to modify this flag.

Pt_LIST_ITEM_CURRENT
: This item is the current item (see "Current item" in the description of **`PtGenList`** in the *Widget Reference*). Use *PtGenListGoto()* to modify this flag.

Pt_LIST_ITEM_DAMAGED

This item should be redrawn. Use *PtGenListDamageItem()* to force a redraw.

Pt_LIST_ITEM_ABOVE

This item is above the visible range of items. Use the *Pt_ARG_TOP_ITEM_POS* resource or *PtGenListShow()* to scroll the list.

Pt_LIST_ITEM_BELOW

This item is below the visible range of items. Use the *Pt_ARG_TOP_ITEM_POS* resource or *PtGenListShow()* to scroll the list.

The Pt_LIST_ITEM_USED_FLAGS macro defines the flags used by the **PtGenList** widget. The remaining bits are available for the child class.

size A **PhDim_t** structure (see the Photon *Library Reference*) that defines the width and height of the item. If the child class needs to modify the size of an item after it has been added to the widget, it should use the *PtGenListLockItem()* and *PtGenListUnlockItem()* convenience functions. If the widget has columns, the widths of the items are ignored.

next, *prev* The widget uses these links to find the next and previous items in the list. Don't modify these links after adding the item to the widget. The *next* link is used for linking items before they're added to a widget (see *PtGenListAddItems()*).

Widget instance structure

Some members of the **PtGenListWidget_t** structure may be used by the child class. In general, don't modify the structure members directly; use the provided resources and convenience functions instead.

For information on the correspondence between structure members and resources, see the "Resource definitions" section for **PtGenList** in the chapter on Using Widget Superclasses.

gflags Flags that affect the behavior of the widget. The child class will probably set all or most of these flags to a fixed value; however, if a class has to modify *gflags* after the widget has been created, use *PtGenListSetGflags()*.

Pt_GEN_LIST_NO_BACKGROUND

If set, the Draw method won't draw the background (under the items) or margins.

Pt_GEN_LIST_ITEM_BACKGROUND

If this flag is set but the Pt_GEN_LIST_NO_BACKGROUND flag is clear, the Draw method will draw the background beneath each item and call the List Draw method once for each item that needs to be drawn.

Pt_GEN_LIST_NO_CLIPPING

If this flag is clear, the Draw method will set clipping to the widget's canvas before calling the List Draw method. The clipping won't be set if no items are wider than the canvas.

Pt_GEN_LIST_SHOW_DAMAGED

If this flag is set, the Draw method will scan the damage list and set the Pt_LIST_ITEM_DAMAGE flag in the items that need to be drawn. The List Draw method won't be called at all if no items are damaged.

Pt_GEN_LIST_FULL_WIDTH

If this flag is set, the space to the right of an item is considered part of the item — the width stored in the item is treated as a suggested minimum. If that space is damaged, the item will be marked as damaged. If this flag isn't set, the space to the right of an item is treated like the margin. Mouse clicks on that space are ignored.

Pt_GEN_LIST_NO_AUTOFOCUS

If this flag is clear, giving focus to the widget when there's no current item in that widget will automatically set the current item to the first displayed item (see "Current item" in the description of **`PtGenList`** in the *Widget Reference*).

Pt_LIST_BALLOONS_IN_COLUMNS

If this flag is set and the widget has columns, the widget will destroy and recreate the balloon when the mouse pointer crosses column boundaries.

sel_xmode and *sel_xflags*

The "decomposed" value of the current selection mode. The value of *sel_xmode* can be one of:

- Pt_SELECTION_MODE(Pt_SELECTION_MODE_NONE)
- Pt_SELECTION_MODE(Pt_SELECTION_MODE_SINGLE)
- Pt_SELECTION_MODE(Pt_SELECTION_MODE_MULTIPLE)
- Pt_SELECTION_MODE(Pt_SELECTION_MODE_RANGE)

The *sel_xflags* member contains the "flags" part of the current selection mode:

- Pt_SELECTION_FLAGS(Pt_SELECTION_MODE_NOSCROLL)

- Pt_SELECTION_FLAGS(Pt_SELECTION_MODE_NOMOVE)
- Pt_SELECTION_FLAGS(Pt_SELECTION_MODE_NOREST)
- Pt_SELECTION_FLAGS(Pt_SELECTION_MODE_AUTO)
- Pt_SELECTION_FLAGS(Pt_SELECTION_MODE_NOCLEAR)
- Pt_SELECTION_FLAGS(Pt_SELECTION_MODE_TOGGLE)
- Pt_SELECTION_FLAGS(Pt_SELECTION_MODE_NOFOCUS)

current_item The pointer to the current item (see “Current item” in the description of **PtGenList** in the *Widget Reference*).

cur_ndx The index of the current item (the first item on the list has an index of 1).

Methods

The methods described in this section are defined in the **PtGenList** class.

List Draw method

The Draw method calls the List Draw method with the following arguments:

PtGenListWidget_t ***widget***

The widget pointer.

PtGenListItem_t ***items***

A pointer to the **PtGenListItem_t** structure for the first item that needs to be redrawn.

unsigned *index* The index of the item to be redrawn (the first item on the list has an index of 1).

unsigned *nitems* The number of items the function should look at.

PhRect_t ***where** A pointer to a **PhRect_t** structure (see the Photon *Library Reference*) that defines the extent of the items (the function is allowed to modify the **PhRect_t** structure pointed to by *where*).

List Mouse method

The list class’s raw callbacks invoke the Mouse List method on every mouse event if the mouse points to an item. The function can return a value other than Pt_CONTINUE to suppress normal mouse handling.

The List Mouse method is called with the following arguments:

PtGenListWidget_t ***widget***

The widget pointer.

`PtGenListItem_t *`*item*

A pointer to the **`PtGenListItem_t`** structure for the item under the mouse cursor.

`unsigned` *index*

The index of that item (the first item on the list has an index of 1).

`PhPoint_t *`*where*

A pointer to a **`PhPoint_t`** structure (see the Photon *Library Reference*) that defines the mouse position, relative to the item. The function is allowed to modify the structure pointed to by *where*.

`int` *column*

The index of the column under the mouse pointer, or -1 if the pointer isn't on a column or the widget has no columns.

`PhEvent_t const *`*event*

A pointer to a **`PhEvent_t`** structure (see the Photon *Library Reference*) that describes the event.

List Key method

The list class's raw callbacks invoke the List Key method on every key event. This method should return one of the following values:

Pt_CONTINUE

The **`PtGenList`** class will normally process the data contained in the **`PhKeyEvent_t`** structure. Note that the class's raw callbacks are allowed to modify the contents of that structure.

Pt_END

The widget will ignore the event and the class's raw callbacks will return Pt_CONTINUE immediately.

Pt_HALT

The event will be consumed by the widget, but **`PtGenList`** itself won't take any further action. The class's raw callbacks return Pt_END immediately.

The List Key method is called with the following arguments:

`PtGenListWidget_t *`*widget*

The widget pointer.

`PhEvent_t const *`*event*

A pointer to a **`PhEvent_t`** structure (see the Photon *Library Reference*) that describes the event.

`PhKeyEvent_t *`*kevent*

A pointer to the event data (which the function can modify). See **`PhKeyEvent_t`** in the Photon *Library Reference*.

`PtGenListItem_t *`*newcur*

A pointer to the **`PtGenListItem_t`** structure for the new current item (if the event is processed normally).

`int` *index* The index of that item (the first item on the list has an index of 1).

List Select method

The list class's raw callbacks invoke the List Select method when an item is selected or unselected. The arguments are:

`PtGenListWidget_t *`*list*

The widget pointer.

`PtGenListItem_t *`*item*

A pointer to a **`PtGenListItem_t`** structure. In Pt_SELECTION_MODE_RANGE selection mode, it's a pointer to the first selected item. In other modes, it's a pointer to the item that has been selected or unselected.

`int` *index* The index of that item (the first item on the list has an index of 1).

`int` *column* The index of the column under the mouse pointer, or -1 if the pointer isn't on a column or the widget has no columns.

`int` *nitems* The current number of selected items (the same as *list*->*sel_count*).

`int` *subtype* The selection subtype.

`PhEvent_t const *`*event*

A pointer to a **`PhEvent_t`** structure (see the Photon *Library Reference*) that describes the event.

List Inflate method

The List Inflate method is called whenever a balloon widget needs to be created. The List Inflate method should create a balloon and return its widget pointer.

The List Inflate method is called with the following arguments:

`PtWidget_t *`*widget*

The list widget.

`PtWidget_t *`*parent*

The *parent* widget for the balloon.

`PtGenListItem_t *`*item*

A pointer to the **`PtGenListItem_t`** structure for the item under the mouse pointer.

unsigned *index* The index of that item (the first item on the list has an index of 1).

int *column* The index of the column under the mouse pointer, or -1 if the pointer isn't on a column or the widget has no columns.

PhArea_t **area* A pointer to a **PhArea_t** structure (see the Photon *Library Reference*) that defines the area (relative to the *parent* widget) corresponding to the entire item. Use *PtGenListSetColumnBalloon()* to adjust the area to the specified column if you're not using *PtGenListCreateTextBalloon()*. These functions are described in the Photon *Widget Reference*.

List Attributes method

The List Attributes is called from the widget's draw functions (*PtGenListDrawString()* and *PtGenListDrawBackground()*). It should return a pointer to a **PtGenListItemAttrs_t** attribute structure filled in with information about how to draw the item, and has the following arguments:

**PtWidget_t ****widget*
: The widget pointer.

**PtGenListItem_t ****item*
: A pointer to the item that's being drawn.

If the method returns NULL, the calling draw function uses the widget's resources. Also, if any of the colors in the attributes structure are set to Pg_TRANSPARENT, or the font is NULL, the corresponding widget-wide setting is used.

Convenience functions

The **PtGenList** class defines the following convenience functions (see the Photon *Widget Reference*):

PtGenListAddItems()
: Add items to a list.

PtGenListAllItems()
: Get pointers to all the items in a list.

PtGenListClearSelection()
: Clear the selection.

PtGenListDamageItem()
: Redraw an item when its data has been changed.

PtGenListDrawBackground()
: Draw the background of a list.

PtGenListDrawString()	Draw a string.
PtGenListFirstItem()	Return a pointer to the first item in a list.
PtGenListGetCurrent()	Return a pointer to the current item in a list.
PtGenListGetSelIndexes()	Get the indexes of the selected items.
PtGenListGoto()	Set the current item so that the new current item is visible.
PtGenListHold()	Prevent visible repair of a list widget.
PtGenListItemIndex()	Find the index of an item.
PtGenListItemRealloc()	Reallocate memory for an item.
PtGenListLastItem()	Return a pointer to the last item in a list.
PtGenListLockItem()	Lock an item so it can be resized.
PtGenListRelease()	Release a hold on visible repairs of a list widget.
PtGenListRemoveItems()	Remove items from a list.
PtGenListResize()	Resize a list widget.
PtGenListSelect()	Select an item in a list.
PtGenListSelectedItems()	Get pointers to the selected items.
PtGenListSetGflags()	Modify the *gflags* field of the widget.
PtGenListSetSelIndexes()	Set the selection indexes.
PtGenListShow()	Set the current position so a given item is visible.
PtGenListUnlockItem()	Unlock an item so it can be updated.

PtGenListUnselect()	Unselect an item in a list.
PtSuperClassGenListDraw()	Invoke the Draw List method in a superclass.
PtSuperClassGenListInflate()	Invoke the List Inflate method in a superclass.
PtSuperClassGenListKey()	Invoke the List Key method in a superclass.
PtSuperClassGenListMouse()	Invoke the List Mouse method in a superclass.
PtSuperClassGenListSelect()	Invoke the List Select method in a superclass.

PtSuperClassGenListDraw()

Invoke the List Draw method in a superclass

Synopsis:

```
void PtSuperClassGenListDraw(
    PtWidgetClassRef_t *cref,
    PtWidget_t *widget,
    PtGenListItem_t *item,
    unsigned index,
    unsigned nitems,
    PhRect_t *where );
```

Arguments:

cref	The superclass whose method you want to call.
widget	A pointer to the widget for which to call the superclass's method.
item	A pointer to the **PtGenListItem_t** structure (see the *Widget Reference*) for the first item that needs to be redrawn.
index	The index of the item to be redrawn (the first item on the list has an index of 1).
nitems	The number of items the function should look at.
where	A pointer to a **PhRect_t** structure (see the Photon *Library Reference*) that defines the extent of the items. The function can modify this rectangle.

Description:

This function can be used to invoke the List Draw method of the class defined by *cref*.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtGenList, **PtGenListItem_t** in the Photon *Widget Reference*

PhRect_t in the Photon *Library Reference*

Synopsis:

```
PtWidget_t *PtSuperClassGenListInflate(
    PtWidgetClassRef_t *cref,
    PtWidget_t *wgt,
    PtWidget_t *parent,
    PtGenListItem_t *item,
    unsigned index,
    int column,
    PhArea_t *area );
```

Arguments:

cref	The superclass whose method you want to call.
wgt	A pointer to the widget for which to call the superclass's method.
parent	A pointer to the parent widget for the balloon.
item	A pointer to the **PtGenListItem_t** structure (see the *Widget Reference*) for the first item under the ballon.
index	The index of the item (the first item on the list has an index of 1).
column	The index of the column under the mouse pointer, or -1 if the pointer isn't on a column or the widget has no columns.
area	A pointer to a **PhArea_t** structure (see the Photon *Library Reference*) that defines the area (relative to the parent widget) corresponding to the entire item.

Description:

This function can be used to invoke the List Inflate method of the class defined by *cref*.

Returns:

A widget pointer to the balloon instance created by this function.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

`PtGenList`, **`PtGenListItem_t`** in the Photon *Widget Reference*

`PhArea_t` in the Photon *Library Reference*

Invoke the List Key method in a superclass

Synopsis:

```
int PtSuperClassGenListKey(
    PtWidgetClassRef_t *cref,
    PtWidget_t *wgt,
    PhEvent_t *ev,
    PhKeyEvent_t *kev,
    PtGenListItem_t *newcur,
    unsigned newpos );
```

Arguments:

cref	The superclass whose method you want to call.
wgt	A pointer to the widget for which to call the superclass's method.
ev	A pointer to a **PhEvent_t** structure (see the Photon *Library Reference*) that defines the event.
kev	A pointer to a **PhKeyEvent_t** structure (see the Photon *Library Reference*) that defines the event data. The function can modify this structure.
newcur	A pointer to a **PtGenListItem_t** structure (see the Photon *Widget Reference*) for the new current item (if the event is processed normally).
newpos	The index of that item (the first item on the list has an index of 1).

Description:

This function can be used to invoke the List Key method of the class defined by *cref*.

Returns:

A nonzero value if the key event was consumed, 0 otherwise.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

`PtGenList`, **`PtGenListItem_t`** in the Photon *Widget Reference*

`PhEvent_t`, **`PhKeyEvent_t`** in the Photon *Library Reference*

PtSuperClassGenListMouse()

Invoke the List Mouse method in a superclass

Synopsis:

```
int PtSuperClassGenListMouse(
    PtWidgetClassRef_t *cref,
    PtWidget_t *wgt,
    PtGenListItem_t *item,
    unsigned index,
    PhPoint_t *where,
    int column,
    PhEvent_t *ev );
```

Arguments:

cref	The superclass whose method you want to call.
widget	A pointer to the widget for which to call the superclass's method.
item	A pointer to the **PtGenListItem_t** structure (see the *Widget Reference*) for the item under the mouse pointer.
index	The index of that item (the first item on the list has an index of 1).
where	A pointer to a **PhPoint_t** structure (see the Photon *Library Reference*) that defines the mouse position, relative to the item. The function can modify this structure.
column	The index of the column under the mouse pointer, or -1 if the pointer isn't on a column or the widget has no columns.
ev	A pointer to a **PhEvent_t** structure (see the Photon *Library Reference*) that defines the event.

Description:

This function can be used to invoke the List Mouse method of the class defined by *cref*.

Returns:

A nonzero value if the event was consumed, 0 otherwise.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

`PtGenList`, **`PtGenListItem_t`** in the Photon *Widget Reference*

`PhEvent_t`, **`PhPoint_t`** in the Photon *Library Reference*

PtSuperClassGenListSelect()

Invoke the List Select method in a superclass

Synopsis:

```
void PtSuperClassGenListSelect(
    PtWidgetClassRef_t *cref,
    PtWidget_t *wgt,
    PtGenListItem_t *item,
    int pos,
    int column,
    int nitems,
    int subtype,
    PhEvent_t *ev );
```

Arguments:

cref	The superclass whose method you want to call.
widget	A pointer to the widget for which to call the superclass's method.
item	A pointer to the **PtGenListItem_t** structure (see the *Widget Reference*). In Pt_SELECTION_MODE_RANGE selection mode, it's a pointer to the first selected item. In other modes, it's a pointer to the item that has been selected or unselected.
pos	The index of that item (the first item in the list has an index of 1).
column	The index of the column under the mouse pointer, or -1 if the pointer isn't on a column or the widget has no columns.
nitems	The number of items being selected or unselected.
subtype	The selection subtype.
ev	A pointer to a **PhEvent_t** structure (see the Photon *Library Reference*) that defines the event.

Description:

This function can be used to invoke the List Select method of the class defined by *cref*.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

`PtGenList`, **`PtGenListItem_t`** in the Photon *Widget Reference*

`PhEvent_t` in the Photon *Library Reference*

Chapter 6

Creating a Tree Widget

In this chapter. . .

Overview

The **PtGenTree** class is a subclass of **PtGenList**. You can use a **PtGenTree** widget to display a hierarchy of items as lists in a *tree*.

When an item in the hierarchy has an item or list of items below it, that item can be expanded. An expanded item drops a list to reveal all items in the next level below. An expanded item can be collapsed. When an expandable item is collapsed, the list rolls up and its items are concealed. An item can be marked as expandable even if it doesn't have a list of items below it — you can add the list of items just before the expandable item is expanded.

Any **PtGenTree** widget can contain multiple items at the root level, which contains the first level of items to display. Root-level items have no other items/levels above them — they represent the top of the hierarchy.

A child class of **PtGenTree** isn't supposed to define a List Draw method. Instead, it should define a Tree Draw Item method that will be called by the List Draw method of **PtGenTree**.

PtGenTree's Draw List method assumes that the Pt_GEN_LIST_SHOW_DAMAGED flag is set. The child class should never clear this flag.

The **PtGenTree** class doesn't use recursive functions. The amount of stack needed by any *PtGenTree*()* function doesn't depend on the tree's size or depth.

Item structure

The item structure used by **PtGenTree** is defined as follows:

```
typedef struct Pt_gentree_item {
    PtGenListItem_t list;
    struct Pt_gentree_item *father, *son, *brother;
    PhDim_t dim;
    }
        PtGenTreeItem_t;
```

list The item structure, of type **PtGenListItem_t** (see the Photon *Widget Reference*) used by the **PtGenList** superclass. The **PtGenTree** class defines some new flags that can be set in *item->list.flags*:

Pt_TREE_ITEM_EXPANDABLE

Set this flag to mark an item as expandable. When you add a branch to an item, *PtGenTreeAddFirst()* (see the Photon *Widget Reference*) sets this flag in the parent item automatically.

Pt_TREE_ITEM_EXPANDED

The branches of this item are currently on display.

father, *son*, *brother*

Tree links. You can use them to traverse the tree structure, but don't modify them directly — it's safer to use the convenience functions to modify the tree structure.

dim A **`PhDim_t`** structure (see the Photon *Library Reference*) that defines the size of the item, excluding the tree ornaments (lines and button).

When an item is added to the widget, the widget calculates *item*->*list.size* based on the size specified in *item*->*dim*, the minimum height of the item, and the item's position in the tree. The height of an item in a tree widget is always an even number of pixels — if you specify an odd number for the height in the *dim* field, a gap of at least one pixel will be displayed between the current item and any other item directly below (see "Current item" in the description of **`PtGenList`** in the *Widget Reference*).

Methods

Tree Draw Item method

The List Draw method calls the Tree Draw Item method with the following arguments:

`PtGenTreeWidget_t *`*widget*

The widget pointer.

`PtGenTreeItem_t *`*item*

A pointer to the **`PtGenTreeItem_t`** structure for the item that needs to be redrawn.

`PhRect_t const *`*where*

A pointer to a **`PhRect_t`** structure (see the Photon *Library Reference*) that defines the extent of the item.

`int` *lmargin* If positive, an additional left margin that should be added to the first column.

`int` *rmargin* If positive, an additional right margin that should be added to the last column.

The **`PtGenTree`** List Draw method is responsible for drawing the lines and boxes representing the tree structure. The Tree Draw Item method should draw only the item. For example, the Tree Draw Item method of **`PtTree`** draws only the image and the string.

Tree Item State method

PtGenTreeExpand() and *PtGenTreeCollapse()* (see the Photon *Widget Reference*) call the Tree Item State method with the following arguments:

`PtGenTreeWidget_t *`*widget*
: The widget pointer.

`PtGenTreeItem_t *`*item*
: A pointer to the **`PtGenTreeItem_t`** structure for the item that is being collapsed or expanded.

`PhEvent_t *`*event*
: The *event* argument to *PtGenTreeExpand()* or *PtGenTreeCollapse()*. See **`PhEvent_t`** in the Photon *Library Reference*.

`int` *reason*
: Either Pt_TREE_EXPANDING or Pt_TREE_COLLAPSING.

If *reason* is Pt_TREE_EXPANDING, the item is about to be expanded. The Tree Item State method can update the item's branches before the actual expansion. After the function returns, the widget will display a list of items in the expanded branch.

If an item in the list has its Pt_TREE_ITEM_EXPANDED flag set, the items below will be displayed too. The Tree Item State method returns zero to permit the expansion, or a nonzero value to prevent it — *PtGenTreeExpand()* returns this value (see the Photon *Widget Reference*).

If *reason* is Pt_TREE_COLLAPSING, the item has been collapsed. Its branches are concealed and the Tree Item State method can free the associated items. The Tree Item State method returns a nonzero value if the item is destroyed, or zero if the item still exists — *PtGenTreeCollapse()* returns this value (see the Photon *Widget Reference*).

Convenience functions

The **`PtGenTree`** class defines the following convenience functions (see the Photon *Widget Reference*):

PtGenTreeAddAfter()
: Add items after a given item.

PtGenTreeAddFirst()
: Add items in front of any existing items.

PtGenTreeAllItems()
: Get pointers to all the items in the tree.

PtGenTreeClearSelection()
: Clear the selection.

PtGenTreeCollapse()	Collapse a subtree.
PtGenTreeDamageItem()	Redraw an item when its data has changed.
PtGenTreeExpand()	Expand a given subtree.
PtGenTreeExpandParents()	Expand any collapsed ancestors of a given item.
PtGenTreeFreeAllItems()	Free all the items in a tree.
PtGenTreeFreeItems()	Free the items in a subtree.
PtGenTreeGetCurrent()	Get a pointer to the current item.
PtGenTreeGetSelIndexes()	Get the indexes of the selected items.
PtGenTreeGoto()	Set the current item and position so that a given item is visible.
PtGenTreeItemIndex()	Calculate the index of a given item.
PtGenTreeItemRealloc()	Reallocate an item.
PtGenTreeItemResize()	Resize an item.
PtGenTreeRemoveChildren()	Unlink all the children of a given item.
PtGenTreeRemoveItem()	Remove a given item and its children from its parents and siblings.
PtGenTreeRemoveList()	Remove a given items and its siblings from their parent.
PtGenTreeResize()	Resize many items.
PtGenTreeRootItem()	Get a pointer to the first root item.

PtGenTreeSelect()	Select a given item.
PtGenTreeSelectedItems()	Get pointers to the selected items.
PtGenTreeSetSelIndexes()	Set the selection indexes.
PtGenTreeShow()	Set the current position so that a given item is visible.
PtGenTreeUnselect()	Unselect a given item.
PtGenTreeUnselectNonBrothers()	Unselect all items that aren't siblings of a given item.
PtSuperClassGenTreeDrawItem()	Invoke the Tree Draw Item method of a given superclass.
PtSuperClassGenTreeItemState()	Invoke the Tree Item State method of a superclass.

PtSuperClassGenTreeDrawItem()

Invoke the Tree Draw Item method of a given superclass

Synopsis:

```
void PtSuperClassGenTreeDrawItem(
        PtWidgetClassRef_t *cref,
        PtWidget_t *wgt,
        PtGenTreeItem_t *item,
        PhRect_t const *where,
        int lmargin,
        int rmargin );
```

Arguments:

cref	The superclass whose method you want to call.
widget	A pointer to the widget for which to call the superclass's method.
item	A pointer to a **PtGenTreeItem_t** structure (see the Photon *Widget Reference*) for the item to be redrawn.
where	A pointer to a **PhRect_t** structure (see the Photon *Library Reference*) that defines the extent of the item.
lmargin	If positive, an additional left margin that should be added to the first column.
rmargin	If positive, an additional right margin that should be added to the last column.

Description:

This function invokes the Tree Draw Item method of the class defined by *cref*.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtGenTree, **PtGenTreeItem_t** in the Photon *Widget Reference*

PhRect_t in the Photon *Library Reference*

PtSuperClassGenTreeItemState()

Invoke the Tree Item State method of a superclass

Synopsis:

```
int PtSuperClassGenTreeItemState(
        PtWidgetClassRef_t *cref,
        PtWidget_t *wgt,
        PtGenTreeItem_t *item,
        PhEvent_t *event,
        int reason );
```

Arguments:

cref	The superclass whose method you want to call.
widget	A pointer to the widget for which to call the superclass's method.
item	A pointer to a **PtGenTreeItem_t** structure (see the Photon *Widget Reference*) for the item to be redrawn.
event	A pointer to a **PhEvent_t** structure (see the Photon *Library Reference*) that describes the event.
reason	Either Pt_TREE_EXPANDING or Pt_TREE_COLLAPSING.

Description:

This function invokes the Tree Item State method of the class defined by *cref*.

Returns:

The value returned by the specified Tree Item State method.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtGenTree, **PtGenTreeItem_t** in the Photon *Widget Reference*

PhEvent_t in the Photon *Library Reference*

Chapter 7

Binding Widgets into PhAB

In this chapter. . .

This chapter discusses adding custom widgets to PhAB, including widget design considerations as well as the steps to follow:

- Creating a shared object
- Creating a template
- Editing **`palette.def`**
- Creating a widget description table

Be sure to modify your application's Makefile so that it's linked with your new widget. Include your widget header in the global application header defined in the Application Start-up Info dialog.

Widget design considerations

This section describes the issues you need to consider when you add custom widgets to the PhAB widget palette:

- Single-value resources
- When to add custom widgets to palette files
- Displaying your custom widget

Single-value resources

PhAB has builtin editors for handling certain types of single-value resources. It also provides multiple-value editors for some resource types. If you design your resources to use the types supported by PhAB, developers will be able to use the widget in PhAB easily. If you define resources that have no associated editor in PhAB, you can create a resource editor for them as described in Creating custom resource editors, otherwise developers will be able to set and use these resources only through application code. The list of currently supported types can be found in the section on "Creating a widget description table."

When to add custom widgets to palette files

When you define a widget class, you assign it a widget number. This number is combined with the resource number to create a series of unique resource numbers for the widget. When you add the widget to the PhAB widget palette, you define these resource values in the widget palette file.

PhAB uses these numbers when it stores the widget in the module files. If you change the resource number or widget number after it has been used in a PhAB application, you won't be able to continue using the old widget (defined in the PhAB module) because the resource numbers will no longer match. For this reason, you should add widgets to the PhAB palette file only when almost all the widget's functionality has been completed and the resource numbers will no longer change.

Displaying your custom widget

As described in "Editing **palette.def**," later in this chapter, you can tell PhAB the name of the shared library for your widget. If PhAB can open this library, it can display your custom widget, and you'll see the results of editing the widget's resources.

If PhAB can't open your widget library, you won't be able to see the widget change visually when you make changes to the resources. The widget will display properly when you actually compile, link, and test the application.

Remember to include the widget header file in the application header so that the generated **abmain.c** file will know about your widget. Also, add your widget to the *MYOBJ* object list defined in the **indOfiles** file.

Creating a shared object

After you've created your widget, you need to build it into a shared object. To do this, compile your source code like this:

```
cc -shared -o libmy_wgt.so my_wgt.c -v -Wl,-hlibmy_wgt.so
```

If you want to make a debug version of your widget library, add the compiler option **-gdwarf-2** to the command line before the **-shared** option. For more information about compile options, see **qcc** in the QNX Neutrino *Utilities Reference*.

You need to place this library in a directory that's in the **LD_LIBRARY_PATH** path. You also need to put the header file for your custom widget in a place where you can find it later.

Creating a template

Use PhAB to create a template for your widget. For more information, see "Templates" in the Creating Widgets in PhAB chapter of the Photon *Programmer's Guide*).

Editing palette.def

Next, edit the **/usr/photon/appbuilder/palette.def** file. You need to add some lines that look like this:

```
l=PtWeb,<photon/PtWebClient.h>:ph
p=xpalette,Web Widgets
```

The first line is the library line, and starts with **l=**: It consists of:

- The library to load (e.g. **PtWeb**). PhAB adds **lib** to the start of the name, and **.so** to the end. In this example, the actual library is **libPtWeb.so**. Specify the name of the shared object that you created for your widget. If PhAB can open this library, it can display your widget "live," and you'll see the results of editing the resources immediately.

- The location of header file for this widget (e.g.**<photon/PtWebClient.h>**).
- Any dependency libraries for this widget, separated by colons. In the example above, there's only one dependency library, the **ph** library.

The second line identifies the palette file for this widget, and starts with **p=**. It consists of:

- The name of the palette file; the **.pal** extension is added automatically. In this example, the name of the palette file is **xpalette.pal**.
- The name of the group for widgets in that palette file. In this example it's **Web Widgets**.

Creating a widget description table

The description table for a single widget is stored in a widget palette file. The widget description table must describe all the resources and callbacks your custom widget understands.

The palette file can contain any number of widget description tables but must contain at least one. The name of your palette file must end with a **.pal** extension (e.g. **mywidget.pal**). To get a good idea of what a palette file should contain, look at the **/use/photon/appbuilder/ptpalette.pal** file.

Here's an example of a widget description table:

```
w=PwMenuWidget

h=4
PtWidget
PtBasic
PtContainer
PwMenuWidget

r=PW_LIST_DOWN,List Down Image,5001003,0,0,pixmap,NULL
r=PW_LIST_UP,List Up Image,5001004,0,0,pixmap,NULL
r=PW_SCROLL_DOWN,Scroll Down Image,5001005,0,0,pixmap,NULL
r=PW_SCROLL_UP,Scroll Up Image,5001006,0,0,pixmap,NULL
r=PW_SCROLL_LEFT,Scroll Left,5001007,0,0,pixmap,NULL
r=PW_SCROLL_RIGHT,Scroll Right, 5001008,0,0,pixmap,NULL

t=2
s=0xe906
```

The start of a new widget in the file is defined by a widget class name definition. This is followed by the widget hierarchy, resources, callbacks, type definition, and finally some initial default values to use when the widget is first created.

The widget description table defines the following settings:

- widget class name (**w=**)
- widget hierarchy (**h=**)
- list of resources (**r=**)

- list of callbacks (**`c=`**, **`k=`**, **`e=`**)
- inherited resources and callbacks (**`i=`**, **`n=`**)
- base widget (**`b=`**)
- change class definition (**`q=`**)
- create-type definition (**`t=`**)
- cursor styles (**`s=`**)
- default values (**`d=`**)

Widget class name (w=)

This setting starts the definition of a new widget:

`w=`*class_name*

Example:

```
w=ShadowedBox
```

Don't include spaces before or after the equals sign (=).

When PhAB encounters a class name setting, it allocates space in its internal list for the widget. Any settings found afterwards are applied to this widget until a new widget class name setting is encountered.

Widget hierarchy (h=)

This setting defines the widget hierarchy:

`h=`*number_of_levels*
highest_class_name
`[`*next_highest_class_name***`]`**
⋮
custom_widget_class_name

Example:

```
h=3
PtWidget
PtBasic
ShadowedBox
```

The **`h=`** setting indicates the number of levels in the hierarchy. This is followed by the widget class hierarchy names in descending order of inheritance.

The widget hierarchy setting tells PhAB which class in the widget's hierarchy to use when different classes of widgets are selected. For example, if you select a **`PtLabel`** and **`PtButton`** widget at the same time, the PhAB Control Panel must show you resources that apply to both widgets. PhAB does this by walking up the hierarchy list until it finds the identical class name for both widgets.

List of resources (`r=`)

If you want to be able to edit a resource in PhAB, you'll need either an `r=` entry (for new resources or inherited resources with a different default value) or an `i=` entry (for inherited resources) — see "Inherited resources and callbacks (`i=`, `n=`)" below.

The `r=` setting defines a resource for the widget:

```
r=manifest_name,desc_name,resource_no,reserved,select_ind,
datatype[(endian_string)][/abstract_name_of_editor],default_value
[,additional_info]
[additional_info_1
additional_info_2
⋮
additional_info_n]
```

Example:

```
r=SBW_SHADOW_COLOR,Shadow Color,5000000,0,1,crgb,0x0
r=Pt_ARG_HORIZONTAL_ALIGNMENT,Horizontal Alignment,3000,0,1,choice,2,3
Pt_LEFT,0
Pt_RIGHT,1
Pt_CENTER,2
```

Don't create resource entries for the *Pt_ARG_POS* and *Pt_ARG_DIM* resources. All widgets must support these, so PhAB handles them internally.

The arguments of the resource entry have the following meanings:

manifest_name	The valid C manifest name to access this resource from application code.
desc_name	A descriptive version of the manifest name, which is easier to understand and takes up less space (allowing the Control Panel to stay small).
resource_no	The actual resource number (e.g. `Pt_USER(0)=5000000`, `Pt_USER(1)=5001000`, and so on — `Pt_RESOURCE(Pt_USER(2),5)=5002005`).
reserved	Always use a value of 0.
select_ind	Indicates whether this resource supports multiple selections. A value of 0 will hide the resource when two or more widgets are selected. A value of 1 enables the resource.
type	Indicates the type of editor PhAB should use for this resource. For more detailed information about resource types, see Resource datatypes in the Creating Custom Resource Editors chapter. Valid types are:

`alloc`	A generic resource type, not covered by the other types.

`choice`	An exclusive choice type.
`code`	A pointer to a function (see Pointer-to-function resources below).
`crgb`	A color value of type **`PgColor_t`**.
`double`	A **`double`** value.
`flag`	Flag resource.
`font`	Font specification (string).
`list`	Array of text strings.
`multi`	Multiline text string.
`numeric`	Numeric type.
`pattern`	A pattern type, for example *Pt_ARG_FILL_COLOR*.
`pixmap`	Supports the creation/modification of **`PhImage_t`** structures.
`string`	Single-line text string.
`points`	Used internally by PhAB for multisegment lines. PhAB manages this resource type so you can use the points array provided by **`PtGraphic`**.

In addition, these types are supported for backwards compatibility, but are deprecated:

`datas`	Single-line text string (Alloc type). Deprecated; use **`string`** instead.
`float`	A **`float`** value. Deprecated; use **`double`** instead.
`short`	Numeric value. Deprecated; use **`numeric`** instead.
`ushort`	Unsigned value (a C type of unsigned short, unsigned long, unsigned int, or unsigned char). Deprecated; use **`numeric`** instead.

endian_string

Indicates the endian string for the resource. This is optional and is used only for **`alloc`** resource types.

Here's an example of a *data_type*(*endian_string*)/ *abstract_name_of_editor* string:
`alloc(24css+il4c)/foo_editor`

abstract_name_of_editor

Indicates the name of the editor for this resource, as defined in the **`res_editors.def`** file. PhAB parses a global **`res_editors.def`** file and a user specific **`res_editors.def`** file for the names of resource editors. See The res_editors.def file section of the Creating Custom Resource Editors chapter.

When *abstract_name_of_editor* is missing, it is assumed to be the same as the *data_type* string. Do not start your *abstract_name_of_editor* with a **`$`**. That's reserved for PhAB use.

default_value

This is the default value in the widget code itself. It's very important for this value to exactly match the real default value in the widget, because PhAB doesn't generate resource entries in the module files if it seems the resource matches the default value. This keeps the size of the module file to a minimum. If the default value you specify doesn't match, the widget may not behave as expected because a required resource setting will be missing from the module file.

If the resource datatype is **`alloc`**, you have to specify the total number of bytes for the default value, followed by a new line that contains the values. The values follow the endian string format. For instance, if your endian string is **`2i3s`** then you will have to specify 2 integer values followed by 3 short values. Each value is either a decimal value (for instance: **`79`**) or a hexadecimal value (for instance: **`0x4f`**). If the endian string is missing, the default endian string (**`+c`**) is used.

Each value is endian-less and they are separated by space or **`\n`** new lines.

Here's an example:

```
r=Pt_ARG_MY_RESOURCE,My Resource,100220,0,0,alloc(11s)/my_resource,22
0x0100 1 1 0 0 0 0 0 0 0 0
```

additional_info

This optional value can be used to specify additional information about the resource:

- A list of flag pairs for **`flag`**-type resources; see "Option and flag pairs" below.
- A list of option pairs for **`short`**-type resources; see "Option and flag pairs" below.
- A function prototype of **`code`**-type resources; see "Pointer-to-function resources" below.

The value can be specified as:

- The number of lines of additional information following the **`r=`** line.

  If there aren't any lines of additional information, omit *additional_info*. Don't specify a value of 0.
- The widget class for which the resource has been defined earlier, and from which you want to copy the additional information. This is useful, for example, if the resource's description or default value is different for the two widgets, but the additional information is the same. If the resource is the same in both widgets, it's easier to use an **`i=`** entry to make this widget inherit it from the other.

Option and flag pairs

For **`choice`** and **`flag`** resources, *additional_info* specifies the possible values. Each line is in the form:

*description***`,`***value*

where *description* is the text that PhAB is to display in the editor, and *value* is the corresponding value.

Pointer-to-function resources

For a resource that's a pointer to a function (i.e. *type* is **`code`**), *additional_info* specifies the number of following lines that define the function's prototype. The prototype should contain an **`@`** in place of the function name, but no terminating semicolon.

The *default_value* specifies the code that will be used for the function body whenever PhAB generates a function for the resource. If the code will fit on the line and doesn't contain any commas, you can specify it directly as *default_value*. Otherwise, put the code on the lines that follow the function prototype, and set *default_value* to be the number of lines of code.

Here are some examples:

```
r=ARG_SIMPLEFUNCTION,A function,5000001,5000001,1,return 0;,1
int @( void )

r=Pt_ARG_RAW_DRAW_F,Draw Function,24000,24000,1,code,1,1
void @( PtWidget_t *widget, PhTile_t *damage )
    PtSuperClassDraw( PtBasic, widget, damage );

r=Pt_ARG_LIST_BALLOON,Inflate Function,23031,23031,1,code,6,5
PtWidget_t *@(
        PtWidget_t *widget, PtWidget_t *parent,
        PhArea_t *area, PtListColumn_t const *column, int coln,
        const char *item, unsigned index, const char *font
        )
    return
        PtGenListCreateTextBalloon(
            widget, parent,
            PtGenListSetColumnBalloon( area, column ),
            item, coln, font
            );
```

List of callbacks (`c=`, `k=`, `e=`)

These settings define callbacks:

`c` | **`k`** | **`e=`***manifest_name***`,`***desc_name***`,`***resource_num***`,`***reserved*

Example:

```
c=Pt_CB_ACTIVATE,Activate,2009,0
k=Pt_CB_HOTKEY,Hotkey,1010,0
e=Pt_CB_RAW,Raw Event,1011,0
```

Photon supports three different types of callbacks. These are standard widget callbacks (`c=`), hotkey callbacks (`k=`), and raw callbacks (`e=`). Make sure you use the type that matches the definition of the callback in the widget.

The arguments of the callback entries are identical and have the following meanings:

manifest_name	The valid C manifest name to access this resource through application code.
desc_name	A descriptive version of the manifest name, which is easier to understand and takes up less space (allowing the Control Panel to stay small).
resource_no	The actual resource number (e.g. `Pt_USER(0)=5000000`, `Pt_USER(1)=5001000`, and so on — `Pt_RESOURCE(Pt_USER(2),5)=5002005`).
reserved	Always use a value of 0.

Callbacks can also be inherited from other widgets. See “Inherited resources and callbacks (`i=`, `n=`)”, below.

Inherited resources and callbacks (`i=`, `n=`)

Resource descriptions can be shared by multiple widget classes. This saves memory on runtime and helps keep the palette files consistent (e.g. if a new flag is added to a resource of a parent class, you don’t have to add it to the description of each child class manually).

These settings can be used to inherit resource or callback definitions from a widget defined earlier:

```
i=widget[,from[,to]]
n=widget[,from[,to]]
```

The `i=` line copies resources (defined by `r=` or `i=` lines). The `n=` line copies callbacks (defined by `c=`, `k=`, `e=`, or `i=` lines).

The *from* and *to* values are numbers that specify the resource numbers to be copied. If both are given, they define a range. If only the *from* value is given, it specifies one resource. If neither *from* nor *to* is given, all resources/callbacks will be copied.

The `i=` entry can be used only if the resource definitions for the child and parent classes are identical. If there are any differences (for example, the child class overrides the default value), you’ll need to use an `r=` resource definition — but the child class can still inherit any *additional_info* that the parent class defines or inherits. For more information, see “List of resources (`r=`).”

Base widget (`b=`)

This setting tells PhAB to use container emulation:

```
b=Container
```

Since PhAB can't display your widget directly, it must use a substitute widget in its place. If the widget isn't a container and you don't set this value, PhAB will use a **`PtBasic`** widget to emulate your widget. If the widget is a container, set the value as shown above and PhAB will use **`PtContainer`** to emulate your widget.

Change class definition (`q=`)

This definition table setting limits the classes the current container widget can be changed into, if it contains children:

`q=`*widgetclass***`[,`***widgetclass***`]`**

Example:

```
q=PtContainer,PtGenList
```

The change class definition tells PhAB which classes this container widget class may be changed into, if it contains children widgets. This operation is performed when a user selects the **`Change Class`** command in PhAB.

The general rule is, if a widget class has a setting of **`q=a,b,c`**, it can only be class changed into a class that has a setting of **`q=a,...`** , **`q=b,...`**, **`or q=c,...`**. That is, the first item of the target class's **`q=`** setting must match a widget from the **`q=`** setting of the original class.

For example, all list and tree widgets have the setting **`q=PtGenList,PtContainer`**, and **`PtPane`** has **`q=PtContainer`**. This means you can change from a list with a child into a **`PtPane`**, but *not* from a **`PtPane`** with a child into a list.

If the change class definition **`q=`** is missing from a widget class's definition table, then that widget class cannot be used as a target when the original widget has children.

If a container widget has no children, it can be changed into any other type of widget.

Create-type definition (`t=`)

This setting defines the type of creation mode to use:

`t=`*number*

Example:

```
t=2
```

The type definition tells PhAB how this widget should be created. For example, if **`t=1`**, PhAB automatically creates the widget as soon as the user clicks in the module. This is because type 1 indicates the widget has a preset size. A value of **`t=2`** means the user can drag out the size when creating the widget.

Valid values for *number* range from 1 through 6 and have the following meanings:

When *number* is:	Create type is:
`1`	Preset, resizable
`2`	Resizable on create
`3`	Line (2 points)
`4`	Preset, Nonresizable
`5`	Polygon (multipoint)
`6`	Bezier (multipoint with handles)

For more information, see "Creating a widget" in the Creating Widgets in PhAB chapter of the Photon *Programmer's Guide*.

Cursor styles (`s=`)

This setting determines the cursor style when creating the widget:

`s=`*start_cursor_style[,drag_cursor_style]*

Example:

```
s=0xe914,0xe914
```

This setting defines the look of the cursor when the widget is being created in PhAB. The value you choose for a cursor style setting (**`s=`**) will depend on the value you specify for the create type setting (**`t=`**). For consistency with other widgets in PhAB, we recommend that you assign cursor style values according to the table below:

If create type is:	Cursor style should be:
`t=1`	`s=0xe906`
`t=2`	`s=0xe914,0xe914`
`t=3`	`s=0xe906`
`t=4`	`s=0xe906`
`t=5`	`s=0xe906`
`t=6`	`s=0xe906`

Default values (`d=`)

This setting lets you give the widget some default values to override the defaults built into the widget:

`d=`*class_name***`,`***no_of_resource_definitions*
definition_1
definition_2

⋮
definition_n

Each *definition* consists of three values:

- *resource_number*
- *resource_type*
- *resource_value*

For example:

```
// Resizable example.
d=ShadowedBox,1
1005
dim
1,1

// Preset example.
d=PtPrintSel,1
1005
dim
418,285
```

Each resource *definition* is made up of three lines, and only simple resource types can be used. In the example above, the *Pt_ARG_DIM* (1005) resource is set to 1 pixel high and 1 pixel wide. This is a good starting point for a widget with a create type number of 2.

CAUTION: You must always give a widget a default value and starting dimension. If you don't, you'll get unexpected results.

If **`t=1`** or **`t=4`**, set the **`dim`** resource to the preset size. If the value is anything else, set **`dim`** to **`1,1`**. The **`dim`** resource is defined as "*width,height*" in pixels.

When used in conjunction with PhAB widget templates, these overrides are not used, and are simply ignored.

This is true for all default overrides, except for resources that can not be accessed through the PhAB resource editor.

Chapter 8

Widget Building Library API

This chapter contains descriptions of the following functions, which are included in the widget building library API:

PtAddWidgetData()	Add data to the widget data chain
PtAnchorDeregister()	Deregister a widget from its parent for anchoring
PtAnchorRegister()	Register a widget with its parent for anchoring
PtAnchorWidget()	Anchor the provided widget
PtApplyAnchors()	Anchor a widget and its children
PtAttemptResize()	Adjust the size of a widget
PtCalcAnchorOffsets()	Update the anchoring values (rules) for the given widget
PtCalcRegion()	Determine whether or not a widget needs a region
PtChildBoundingBox()	Calculate a widget's canvas and its children's bounding boxes
PtClipAdd()	Add a clipping rectangle to the stack
PtClipRemove()	Take a clipping rectangle off the stack
PtCompoundRedirect()	Redirect widgets to a parent
PtCoreChangeRegion()	Determine if a region is required
PtCreateWidgetClass()	Create a widget class
PtDamageExposed()	Damage the specified widgets
PtDestroyCallbackList()	Free the specified callbacks
PtDestroyHotkeyCallbacks()	Free the specified hotkey callbacks
PtDestroyRawCallbacks()	Free the specified raw callbacks
PtFindNextWidgetData()	Find the next appropriate data block

PtFindResource()	Find the record associated with a resource
PtFindResourceRecord()	Deprecated. Use *PtFindResource()*
PtFindWidgetData()	Find the first data block of a given type and subtype
PtGetCallbackList()	Get a callback list
PtGetStruct()	Retrieve the specified resource
PtInvokeCallbackList()	Invoke a callback list
PtInvokeCallbackType()	Invoke a callback list of a specific type
PtInvokeResizeCallbacks()	Invoke the resize callbacks of the specified container
PtMoveResizeWidget()	Synchronize a widget's extent
PtRemoveWidgetData()	Remove data from the widget data chain
PtResizeCanvas()	Set the size of a widget's canvas
PtResizePolicy()	Determine whether a widget has a resize policy
PtSetExtentFromArea()	Calculate the extent of a widget
PtSetStruct()	Set the specified resource
PtSetValue()	Set the value of a resource using **`mod_f`**
PtSuperClassCalcOpaque()	Call the Calc Opaque Rect method of the specified superclass
PtSuperClassChildCreated()	Invoke a Child Created method
PtSuperClassChildDestroyed()	Invoke a Child Destroyed method
PtSuperClassChildGettingFocus()	Invoke a Child Getting Focus method

PtSuperClassChildGettingResources()	Invoke a Child Getting Resources method
PtSuperClassChildLosingFocus()	Invoke a Child Losing Focus method
PtSuperClassChildMovedResized()	Invoke a Child Moved/Resized method
PtSuperClassChildRealized()	Invoke a Child Realized method
PtSuperClassChildSettingResources()	Invoke a Child Setting Resources method
PtSuperClassChildUnrealized()	Invoke a Child Unrealized method
PtSuperClassConnect(), *PtSuperClassConnectFrom()*	Invoke the Connection method of the specified widget class
PtSuperClassDraw()	Invoke the Draw method of the specified superclass
PtSuperClassExtent()	Invoke the Extent method of the specified superclass
PtSuperClassGetResources()	Get the specified resource
PtSuperClassGotFocus()	Invoke the Got Focus method of the specified superclass
PtSuperClassInit(), *PtSuperClassInitFrom()*	Invoke the Initialize method of the specified widget class
PtSuperClassLostFocus()	Invoke the Lost Focus method of the specified superclass
PtSuperClassRawEvent(), *PtSuperClassRawEventFrom()*	Invoke the raw callback list of the specified widget class
PtSuperClassRealized()	Invoke the Realization method of the specified widget class
PtSuperClassSetResources()	Set resources
PtUpdateVisibility()	Tell the widget library about a change in visibility

PtWidgetAbove()	Get the widget that's above a given widget in a family hierarchy

PtAddWidgetData()

Add data to the widget data chain

Synopsis:

```
int PtAddWidgetData( PtWidget_t *widget,
                     PtWidgetClassRef_t *type,
                     long subtype,
                     void *data );
```

Arguments:

widget	A pointer to the widget whose chain the data should be added to.
type	The class of the widget adding the data.
subtype	A subtype that's used to discriminate between multiple blocks of data added by the same widget class. The *subtype* shouldn't be -1, as this value has special meaning when searching for a specific block within the widget data chain.
data	A pointer to the data to be added to the widget data chain.

Description:

This function adds a piece of data to the widget data chain. The data provided must be in a block of memory allocated by *malloc()* (see the QNX Neutrino *Library Reference*).

You can retrieve this data by calling *PtFindWidgetData()* or *PtFindNextWidgetData()*.

Returns:

0 on success; -1 if an error occurred (e.g. out of memory).

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtFindWidgetData(), *PtFindNextWidgetData()*, *PtRemoveWidgetData()*

PtAnchorDeregister()

Deregister a widget from its parent for anchoring

Synopsis:

```
void PtAnchorDeregister( PtWidget_t *widget );
```

Arguments:

widget	A pointer to the widget that's to be deregistered.

Description:

This function deregisters *widget* from its parent. This prevents *widget* from being included in anchoring operations.

The deregister operation is done automatically when the anchor flags are cleared. You'll need to use this function only if you take over the *Pt_ARG_ANCHOR_FLAGS* and *Pt_ARG_ANCHOR_OFFSETS* resources.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtAnchorRegister()

Synopsis:

```
void PtAnchorRegister( PtWidget_t *widget );
```

Arguments:

widget	A pointer to the widget to register.

Description:

This function registers *widget* with its parent for anchoring.

Registration is done automatically when the anchor flags are set. You'll need to use this function only if you take over the *Pt_ARG_ANCHOR_FLAGS* and *Pt_ARG_ANCHOR_OFFSETS* resources.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtAnchorDeregister()

PtAnchorWidget()

Anchor the provided widget

Synopsis:

```
void PtAnchorWidget( PtWidget_t *widget );
```

Arguments:

widget	A pointer to the widget to anchor.

Description:

This function anchors the provided *widget*. If the widget's anchor offsets have yet to be calculated, they're calculated along with the anchor offsets for all children. No other action takes place.

If the widget's anchor offsets have been calculated, the widget and all its children's dimensions are adjusted to honor their anchor flags.

PtAnchorWidget() is used by *PtApplyAnchors()*.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtApplyAnchors(), *PtCalcAnchorOffsets()*

PtApplyAnchors()

Anchor a widget and its children

Synopsis:

```
int PtApplyAnchors( PtWidget_t *widget );
```

Arguments:

widget	A pointer to the widget to be anchored.

Description:

This function performs any necessary anchoring on the provided *widget* and all its registered children.

Returns:

1	Success.
0	An error occurred.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtAnchorDeregister(), *PtAnchorRegister()*, *PtAnchorWidget()*

Adjust the size of a widget

Synopsis:

```
int PtAttemptResize( PtWidget_t *widget,
                     PhRect_t const *canvas,
                     PhRect_t const *render );
```

Arguments:

widget	A pointer to the widget whose size you want to adjust.
canvas	A pointer to a **PhRect_t** structure (see the Photon *Library Reference*) that describes the widget's canvas.
render	A pointer to a **PhRect_t** structure that defines the part of the widget you want to render.

Description:

This function adjusts the size of the widget based on the differences between *canvas* and *render* and on the widget's resize flags.

PtResizeCanvas() is similar to this function but easier to use. You should call it instead of *PtAttemptResize()*.

The widget's actual size is modified (*widget*->*area.size*). If the resize policy of the widget prevents *PtAttemptResize()* from adjusting the widget's size (i.e. the canvas won't fit within the provided render rectangle), *PtAttemptResize()* sets the Pt_UCLIP bit of the widget's resize flags. If this bit is set, the widget's Draw method should apply clipping via *PtClipAdd()* prior to rendering its data.

Returns:

1	Successful completion.
0	No resize occurred.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtChildBoundingBox(), *PtClipAdd()*, *PtClipRemove()*, *PtResizeCanvas()*

PgExtentText(), **`PhRect_t`**, *PtCalcCanvas()* in the Photon *Library Reference*

Update the anchoring values (rules) for the given widget

Synopsis:

```
int PtCalcAnchorOffsets( PtWidget_t *widget );
```

Arguments:

widget	A pointer to the widget whose anchoring values you want to update.

Description:

This function updates the anchoring rules for the given *widget* based on its current anchor flags and its parent's canvas rectangle.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtAnchorWidget(), *PtApplyAnchors()*

Determine whether or not a widget needs a region

Synopsis:

```
int PtCalcRegion( unsigned int *fields,
                  PtWidget_t *widget,
                  PhRegion_t *region,
                  PhRect_t *rect );
```

Arguments:

fields	A bitmap that specifies which fields of the **PhRegion_t** structure pointed to by *region* the function should fill in. For more information, see *PhRegionOpen()* in the Photon *Library Reference*.
widget	A pointer to the widget you want to test.
region	A pointer to a **PhRegion_t** structure in which the function stores information about the region.
rect	A pointer to a **PhRect_t** structure that defines the rectangle for the region.

Description:

This function determines whether or not the given *widget* needs a region and stores information about the region in the **PhRegion_t** structure pointed to by *region*.

Returns:

0	The widget doesn't need a region.
1	The widget needs a region.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PhRect_t, **PhRegion_t**, *PhRegionOpen()* in the Photon *Library Reference*

PtChildBoundingBox()

Calculate a widget's canvas and its children's bounding boxes

Synopsis:

```
PhRect_t *PtChildBoundingBox( PtWidget_t *widget,
                              PhRect_t *canvas,
                              PhRect_t *render );
```

Arguments:

widget A pointer to the widget for which you want to calculate the canvas.

canvas A pointer to a **PhRect_t** structure (see the Photon *Library Reference*). If this pointer isn't NULL, the rectangle it points to is set to the canvas rectangle of the **PtBasic**-class level for the specified *widget*.

render A pointer to a **PhRect_t** structure in which the function stores the bounding box. You must provide a non-NULL pointer for this argument.

Description:

This function calculates the canvas of *widget* and finds the bounding box of *widget*'s children relative to the origin of the parent's position.

Returns:

The same pointer as the *render* argument.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtSuperClassExtent()

PhRect_t, *PtCalcCanvas()* in the Photon *Library Reference*

Synopsis:

```
int PtClipAdd( PtWidget_t *widget,
               PhRect_t *rect );
```

Arguments:

widget	A pointer to the widget being clipped.
rect	A pointer to a **PhRect_t** structure (see the Photon *Library Reference*) that specifies the clipping to be added.

Description:

This function adds a clipping rectangle to the clipping stack. The rectangle added to the clipping stack is the intersection of the last rectangle on the stack and the provided rectangle *rect*.

Prior to entering a widget's Draw method, the canvas rectangle derived from the **PtBasic**-class level is pushed onto the clipping stack. This prevents any children from drawing beyond the canvas of the parent container.

A widget can, however, draw beyond its own canvas or extent unless additional clipping is performed. *PtAttemptResize()* and *PtResizeCanvas()* set the Pt_UCLIP bit of a widget's resize flags if the widget requires additional clipping (to prevent it from drawing beyond its own canvas).

Returns:

The current level of stack clipping.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtAttemptResize(), *PtClipRemove()*, *PtResizeCanvas()*

PhRect_t, *PtCalcCanvas()* in the Photon *Library Reference*

PtClipRemove()

Take a clipping rectangle off the stack

Synopsis:

```
int PtClipRemove();
```

Description:

This function pops the last clipping rectangle off the clipping stack.

Returns:

The current level of stack clipping.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtAttemptResize(), PtClipAdd(), PtResizeCanvas()

PtCalcCanvas() in the Photon *Library Reference*

Synopsis:

```
PtWidget_t *PtCompoundRedirect(
                PtWidget_t *container,
                PtWidgetClassRef_t *child_cref );
```

Arguments:

container	A pointer to the container widget from which you want to redirect the children.
child_cref	The class of the child widget (e.g. **PtButton**).

Description:

This function returns the parent of a compound widget, making the compound widget seem like a simple widget (i.e. users can't place widgets inside *container*).

This is especially useful for rejecting widgets or redirecting widgets to subordinate containers (e.g. **PtScrollArea** does this).

This redirector function can be added to a custom compound widget by using the Pt_SET_CHILD_REDIRECT_F manifest defined by **PtContainer**.

Returns:

A pointer to the parent of the given compound widget.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

"Container widget anatomy" in the Anatomy of a Widget chapter.

PtCoreChangeRegion()

Determine if a region is required

Synopsis:

```
void PtCoreChangeRegion( unsigned int fields,
                         PtWidget_t *widget );
```

Arguments:

fields	A bitmap that indicates which attributes of the widget to check. For more information, see *PhRegionOpen()* in the Photon *Library Reference*.
widget	A pointer to the widget to be tested.

Description:

This function examines the current state of *widget* with respect to *fields* and determines if *widget* requires a region. If a region is required, *PtCoreChangeRegion()* determines what attributes (e.g. sensitivity) are required.

PtCoreChangeRegion() may call one of the following functions with appropriate attributes:

If the widget:	**This function is called:**
Is a subclass of `PtWindow`	*PhWindowChange()*
Already has a region	*PhRegionChange()*
Doesn't have a region	*PhRegionOpen()*

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PhWindowChange(), *PhRegionChange()*, *PhRegionOpen()* in the Photon *Library Reference*

PtCreateWidgetClass()

Create a widget class

Synopsis:

```
PtWidgetClass_t *PtCreateWidgetClass(
                   PtWidgetClassRef_t *superclass_ref,
                   unsigned int size,
                   unsigned int num_args,
                   PtArg_t const *args );
```

Arguments:

superclass_ref	The superclass for the new widget class.
size	The size of the new widget class. If this is 0, the size of the superclass is used; if nonzero, it must be at least the size of the superclass.
num_args	The number of entries in the *arg* array.
args	An array of class attributes and member functions to be applied when creating the new class.

Description:

This function creates a new widget class based on *superclass_ref*. If the specified superclass hasn't yet been created, it's created now.

If the *size* parameter is zero, the new class is the same size as the specified superclass. Otherwise *size* bytes are allocated for the new class. The specified superclass is then copied into the newly allocated class (inheritance). The *version*, *resources*, *num_resources*, *callbacks*, *dflts_f*, *connect_f*, *init_f*, *unrealize_f*, and *destroy_f* members are cleared because they shouldn't be inherited.

Returns:

A pointer to the newly created class:

```
base->superclass = superclass ? superclass->wclass:NULL;
```

Examples:

This example is from the `ShadowedBox` sample widget.

```
//
// ShadowedBox class-creation function
//
PtWidgetClass_t *PtCreateBasicClass( void )
{
    static const PtResourceRec_t resources[] =
    {
    {   SBW_SHADOW_COLOR, Pt_CHANGE_REDRAW, 0,
        Pt_ARG_IS_NUMBER( ShadowedBoxWidget, shadow_color ) },
    {   SBW_SHADOW_OFFSET, Pt_CHANGE_REDRAW, 0,
        Pt_ARG_IS_NUMBER( ShadowedBoxWidget, shadow_offset ) }
    };

    static const PtArg_t args[] =
        {
        { Pt_SET_VERSION, 110},
        { Pt_SET_STATE_LEN, sizeof( ShadowedBoxWidget ) },
        { Pt_SET_DFLTS_F, (long)shadowbox_dflts },
        { Pt_SET_DRAW_F, (long)shadowedbox_draw },
        { Pt_SET_FLAGS, 0, Pt_RECTANGULAR },
        { Pt_SET_RESOURCES, (long) resources },
        { Pt_SET_NUM_RESOURCES,
          sizeof( resources )/sizeof( resources[0] ) }
        };

    return( ShadowedBox->wclass = PtCreateWidgetClass(
        PtBasic, 0, sizeof( args )/sizeof( args[0] ), args ) );
}
```

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

`PtArg_t` in the Photon *Library Reference*

Damage the specified widgets

Synopsis:

```
void PtDamageExposed( PtWidget_t *widget,
                      PhTile_t *tile );
```

Arguments:

widget A pointer to the widget to damage.

tile A list of **PhTile_t** structures (see the Photon *Library Reference*) that define the rectangles to damage. These rectangles should be relative to the widget's origin.

Description:

This function damages the list of rectangles given in *tile* on the parent of *widget*. The damage may extend beyond the extent of the widget.

This function frees the tile list automatically.

Examples:

To redraw a transparent widget due to a data change:

```
tile = PhGetTile();
PtWidgetExtent( widget, &tile->rect );
tile->next = NULL;
PtDamageExposed( widget, tile );
```

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PhGetTile(), **PhTile_t** in the Photon *Library Reference*

PtDestroyCallbackList()

Free the specified callbacks

Synopsis:

```
int PtDestroyCallbackList(
        PtCallbackList_t **cbp );
```

Arguments:

cbp A pointer to the callback list to be freed.

Description:

This function frees the entire callback list pointed to by *cbp*. The *cbp* argument is set to NULL when *PtDestroyCallbackList()* is successful.

The widget library automatically frees all allocated resources including callback lists when a widget is destroyed.

Returns:

0 Successful completion.

-1 An error occurred.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtDestroyHotkeyCallbacks(), *PtDestroyRawCallbacks()*

PtDestroyHotkeyCallbacks()

Free the specified hotkey callbacks

Synopsis:

```
void PtDestroyHotkeyCallbacks( PtWidget_t *widget );
```

Arguments:

widget	A pointer to the widget whose hotkey callbacks you want to free.

Description:

This function frees all hotkey callbacks connected to *widget*.

The widget library automatically frees all allocated resources including lists when a widget is destroyed.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtDestroyCallbackList(), *PtDestroyRawCallbacks()*

PtDestroyRawCallbacks()

Free the specified raw callbacks

Synopsis:

```
void PtDestroyRawCallbacks( PtWidget_t *widget );
```

Arguments:

widget	A pointer to the widget whose raw callbacks you want to free.

Description:

This function frees all raw callbacks connected to *widget*.

The widget library automatically frees all allocated resources including callback lists when a widget is destroyed.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtDestroyCallbackList(), *PtDestroyHotkeyCallbacks()*

Find the next appropriate data block

Synopsis:

```
void * PtFindNextWidgetData(
           PtWidget_t *widget,
           PtDataHdr_t *data_node,
           PtWidgetClassRef_t *type,
           long subtype,
           PtDataHdr_t **_node )
```

Arguments:

widget	A pointer to the widget whose data you want to search.
data_node	A pointer to the data block from which to start the search. If *data_node* is NULL, the function searches for the first instance of data that matches the type and subtype provided.
type	The type of data to seek. If *type* is NULL, any type matches.
subtype	The subtype of data to seek. If *subtype* is -1, any subtype matches.
_node	If you provide a non-NULL pointer for this argument, it's set to point to the widget *data_node* that contained the returned data, so you can continue the search from that node.

Description:

This function (starting from *data_node*) finds the next widget data block that matches the *type* and *subtype* provided.

Returns:

A void pointer to the widget data, or NULL if it wasn't found.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtAddWidgetData(), PtFindWidgetData(), PtRemoveWidgetData()

PtFindResource()

Find the record associated with a resource

Synopsis:

```
PtResourceRec_t const * PtFindResource(
    long type,
    PtWidgetClass_t const * const a_class );
```

Arguments:

type	The resource you want to find (e.g. *Pt_ARG_COLOR*).
a_class	The widget class to search.

Description:

This function finds the resource record for the resource given by *type* in the *a_class* class or any of its superclasses. You can use this function to detect whether a widget implements a particular resource or not, or in your own Set Resource/Get Resource methods.

Returns:

A pointer to a resource record, or NULL if no resource is found.

Examples:

```
my_label_setcolor( PtWidget_t *widget, PgColor_t color )
{
  const PtResourceRec_t *res_rec;
  PtArg_t argt;
  PtSetArg( &argt, Pt_ARG_COLOR, color, 0 );
  res_rec = PtFindResource( Pt_ARG_COLOR,
                                  PtLabel->wclass );
  PtSetValue( widget, res_rec, &argt );
}
```

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtSetValue()

PtFindWidgetData()

Find the first widget data block of a given type and subtype

Synopsis:

```
void * PtFindWidgetData(
           PtWidget_t *widget,
           PtWidgetClassRef_t *type,
           long subtype,
           PtDataHdr_t **_node );
```

Arguments:

widget	A pointer to the widget that you want to search.
type	The type of data to seek. If *type* is NULL, any type matches.
subtype	The subtype of data to seek. If *subtype* is -1, any subtype matches.
_node	If you provide this argument, it's set to point to the widget *data_node* that contained the returned data, so you can continue the search from that node.

Description:

This function finds the first widget data block that matches the *type* and *subtype* provided.

Returns:

A void pointer to the widget data, or NULL if it wasn't found.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtAddWidgetData(), *PtFindNextWidgetData()*, *PtRemoveWidgetData()*

Synopsis:

```
void *PtGetCallbackList( PtWidget_t *widget,
                         long cb_type );
```

Arguments:

widget	The widget pointer to get the callback list from.
cb_type	The callback list type to return.

Description:

This function returns the requested callback list of *cb_type*.

Returns:

A pointer to a **PtCallbackList_t** if the callback list type exists, NULL otherwise.

Examples:

```
PtCallbackList_t *cb;
if( (cb = PtGetCallbackList( widget, Pt_CB_ARM) ) {
    // do the work to create and fill in the callback data
   ...
   PtInvokeCallbackList( cb, widget, &cbinfo );
}
```

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtInvokeCallbackList(), *PtInvokeCallbackType()*.

PtCallbackInfo_t in the Photon *Widget Reference*

PtGetStruct()

Retrieve the specified resource

Synopsis:

```
int PtGetStruct( char *base,
                 PtResourceRec_t const *mod,
                 PtArg_t *arg );
```

Arguments:

base	The base address in the widget from which to fetch the resource.
mod	The resource record for the resource.
arg	A pointer to a **PtArg_t** structure (see the Photon *Library Reference*) that describes the resource you want to retrieve. For more information, see below.

Description:

This function retrieves the resource specified by *arg* from the widget at address *base* as described by *mod*.

If the *value* and *len* members of *arg* are non-NULL, they're assumed to contain the addresses of pointers of the type appropriate for the resource. The pointers are set to point to the resource's value in the widget's internal memory.

Don't use these pointers to change the resource's value.

If either of the *value* and *len* members of *arg* is NULL, the retrieved resources are stored in these members.

Returns:

0	Successful completion.
-1	An error occurred.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtSetStruct(), *PtSuperClassGetResources()*, *PtSuperClassSetResources()*

`PtArg_t` in the Photon *Library Reference*

PtInvokeCallbackList()

Invoke a callback list

Synopsis:

```
int PtInvokeCallbackList( PtCallbackList_t *cb_list,
                          PtWidget_t *widget,
                          PtCallbackInfo_t *cbinfo );
```

Arguments:

cb_list	The list of callbacks to invoke.
widget	The widget pointer to pass to the callbacks as the first argument.
cbinfo	A pointer to a **PtCallbackInfo_t** structure (see the Photon *Widget Reference*) that's passed to each callback in the list as the third argument.

Description:

This function invokes the provided callback list *cb_list*.

The **cb_data** member of each item in the callback list is passed as the second argument to the associated callback.

Returns:

A return status from the callback list:

- Pt_CONTINUE
- Pt_HALT
- Pt_END

If the returned status is Pt_END, have your function consume the event (i.e. return Pt_END).

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtGetCallbackList() and *PtInvokeCallbackType()*

PtCallbackInfo_t in the Photon *Widget Reference*

PtInvokeCallbackType()

Invoke a callback list of a specific type

Synopsis:

```
int PtInvokeCallbackType( PtWidget_t *widget,
                          long type,
                          PtCallbackInfo_t *cbinfo );
```

Arguments:

widget	The widget pointer to pass to the callbacks as the first argument.
type	The type of callback list to invoke, for example *Pt_CB_ARM*.
cbinfo	A pointer to a **PtCallbackInfo_t** structure (see the Photon *Widget Reference*) that's passed to each callback in the list as the third argument.

Description:

This function invokes a callback list of *type* for a *widget*. It's a convenience function that you can use instead of *PtGetCallbackList()* and *PtInvokeCallbackList()*.

Returns:

A return status from the callback list:

- Pt_CONTINUE
- Pt_HALT
- Pt_END

If the returned status is Pt_END, have your function consume the event (i.e. return Pt_END).

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtGetCallbackList() and *PtInvokeCallbackList()*

PtCallbackInfo_t in the Photon *Widget Reference*

PtInvokeResizeCallbacks()

Invoke the resize callbacks of the specified container

Synopsis:

```
void PtInvokeResizeCallbacks( PtWidget_t *container );
```

Arguments:

container	A pointer to the container widget whose resize callbacks you want to invoke.

Description:

This function sets up a **cbinfo** structure and invokes the resize callbacks attached to the specified *container*.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

Synopsis:

```
int PtMoveResizeWidget( PtWidget_t *widget,
                        unsigned blit );
```

Arguments:

widget	A pointer to the widget whose extent you want to synchronize.
blit	A flag that indicates whether or not to use blitting; one of:

- 0 — don't blit.
- Pt_BLIT_FORCE — always blit (this may cause unexpected effects).
- Pt_BLIT — blit when possible.

Description:

This function synchronizes a widget's extent with its position and size resources. Any region adjustments, blits, or damages are performed automatically.

This function calls the widget's Extent method to calculate its new extent.

Returns:

0	No action.
Nonzero	The widget was modified or damage was generated.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

Remove data from the widget data chain

Synopsis:

```
int PtRemoveWidgetData(
        PtWidget_t *widget,
        PtWidgetClassRef_t *type,
        long subtype );
```

Arguments:

widget	A pointer to the widget from whose chain you want to remove the data.
type	The class of the widget removing the data.
subtype	The subtype of data to remove. This is used to discriminate between multiple blocks of data added by the same widget class.

Description:

This function removes a piece of data from the widget data chain and frees the memory allocated for the data.

Returns:

0 if the data was found and released; -1 if it couldn't be found.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtAddWidgetData(), *PtFindWidgetData()*, *PtFindNextWidgetData()*

Synopsis:

```
int PtResizeCanvas( PtWidget_t *widget,
                    PhDim_t const *render );
```

Arguments:

widget	A pointer to the widget whose canvas you want to set.
render	A pointer to a **PhDim_t** structure (see the Photon *Library Reference*) that defines the desired size of the canvas.

Description:

This function changes the canvas belonging to the given widget to be the size specified in the **PhDim_t** pointed to by *render*.

This function is similar to *PtAttemptResize()*, but is easier to use.

The widget's actual size, *widget*->*area.size*, is modified. If the widget's resize policy prevents *PtResizeCanvas()* from adjusting the widget's size (i.e. the canvas won't fit within the provided render rectangle), *PtResizeCanvas()* sets the Pt_UCLIP bit in the widget's resize flags. If this bit is set, the widget's Draw method should apply clipping via *PtClipAdd()* before rendering its data.

Returns:

0 if the size didn't change, or nonzero if the height or width changed.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtAttemptResize(), *PtChildBoundingBox()*, *PtClipAdd()*, *PtClipRemove()*

PgExtentText(), **PhDim_t**, *PtCalcCanvas()* in the Photon *Library Reference*

PtResizePolicy()

Determine whether a widget has a resize policy

Synopsis:

```
int PtResizePolicy( PtWidget_t *widget );
```

Arguments:

widget	A pointer to the widget to check for a resize policy.

Description:

This function determines whether a resize policy is currently in effect for the specified *widget*.

Returns:

0	No resize policy.
Nonzero	A resize policy is in effect. This returned value is a combination of the resize policy flags in effect.

Examples:

You can test the return of *PtResizePlicy()* to determine which policies are in effect:

```
int resizePolicy;
resizePolicy=PtResizePolicy(myButton);

// test if any resize policies are set:
if(resizePolicy & Pt_RESIZE_XY_BITS == 0) {
  // no policies are set: do some stuff
}
```

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

PtSetExtentFromArea()

Calculate the extent of a widget

Synopsis:

```
PhRect_t * PtSetExtentFromArea(
              PtWidget_t *widget,
              PhArea_t const *area,
              PhRect_t *extent );
```

Arguments:

widget	A pointer to the widget for which you want to calculate the extent.
area	A pointer to a **PhArea_t** structure that defines the area that the extent will be based on.
extent	A pointer to a **PhRect_t** where the function can store the extent.

Description:

This function calculates the extent rectangle of *widget* and places the result in the structure pointed to by *extent*. The extent is calculated based on the *area*, and the widget's borders only (i.e. no anchoring or resize policy is enforced).

Returns:

The same pointer as the *extent* rectangle.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PhArea_t, **PhRect_t** in the Photon *Library Reference*

PtSetStruct()

Set the specified resource

Synopsis:

```
int PtSetStruct( char *base,
                 PtResourceRec_t const *mod,
                 PtArg_t const *arg );
```

Arguments:

base The base address of the widget whose resources are being modified.

mod A resource record that describes the type of resource being modified.

arg A pointer to a **PtArg_t** structure (see the Photon *Library Reference*) that indicates which resource to modify, as well as the value to assign to it.

Description:

This function sets the resource specified by *arg* on the widget at address *base* in the manner described by *mod*.

Unlike *PtSetValue()*, *PtSetStruct()* doesn't examine the *mod_f* member of *mod* (e.g. for a Pt_CHANGE_RESIZE flag). It sets the appropriate structure members based on *mod*->*value* and *mod*->*len*.

If you want to do the extra widget processing as well as set the appropriate structure members, use *PtSetValue()*. For a cleaner solution, consider using *PtSuperClassSetResources()*.

Returns:

0	No change.
1	A change was made.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtGetStruct(), *PtSetValue()*, *PtSuperClassGetResources()*, *PtSuperClassSetResources()*

`PtArg_t` in the Photon *Library Reference*

PtSetValue()

Set the value of a resource using mod_f

Synopsis:

```
int PtSetValue( PtWidget_t *widget,
                PtResourceRec_t const *mod,
                PtArg_t const *args );
```

Arguments:

widget	A pointer to the widget whose resource is being modified.
mode	A resource record that describes the type of resource being modified.
arg	A pointer to a `PtArg_t` structure (see the Photon *Library Reference*) that indicates which resource to modify, as well as the value to assign to it.

Description:

This function sets the value of a particular resource using the information provided in *mod*, including the *mod_f* member.

Consider calling *PtSuperClassSetResources()* for a cleaner solution. To set structure members without any further action, call *PtSetStruct()*.

Returns:

0	Nothing has changed.
1	The value has changed.
2	The value and length have changed.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtSetStruct(), *PtSuperClassSetResources()*

`PtArg_t` in the Photon *Library Reference*

PtSuperClassCalcOpaque()

Call the Calc Opaque Rect method of specified superclass

Synopsis:

```
void PtSuperClassCalcOpaque(
         PtWidgetClassRef_t *cref,
         PtWidget_t *widget );
```

Arguments:

cref	The superclass whose method you want to call.
widget	A pointer to the widget for which to call the superclass's method.

Description:

This function calls the Calc Opaque Rect method of the specified superclass. Typically, this function calculates the rectangle representing the portion of the widget that isn't transparent and sets or clears the widget's Pt_OPAQUE flag.

The opaque rectangle for a widget is usually its canvas rectangle or the canvas rectangle derived from its **PtBasic**-class level.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

Invoke a Child Created method

Synopsis:

```
void PtSuperClassChildCreated(
                 PtWidgetClassRef_t *cref,
                 PtWidget_t *widget,
                 PtWidget_t *child );
```

Arguments:

cref	The container superclass whose method you want to call.
widget	A pointer to the widget for which to call the superclass's method.
child	A pointer to the newly created widget.

Description:

This function invokes the Child Created method of the container class specified by *cref*.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

Synopsis:

```
void PtSuperClassChildDestroyed(
         PtWidgetClassRef_t *cref,
         PtWidget_t *widget,
         PtWidget_t *child );
```

Arguments:

cref	The container superclass whose method you want to call.
widget	A pointer to the widget for which to call the superclass's method.
child	A pointer to the widget that's just been destroyed.

Description:

This function invokes the Child Destroyed method of the container class specified by *cref*.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

PtSuperClassChildGettingFocus()

Invoke a Child Getting Focus method

Synopsis:

```
int PtSuperClassChildGettingFocus(
                PtWidgetClassRef_t *cref,
                PtWidget_t *widget,
                PtWidget_t *child,
                PhEvent_t *event );
```

Arguments:

cref	The container superclass whose method you want to call.
widget	A pointer to the widget whose child is getting focus.
child	A pointer to the widget that's getting focus.
event	A pointer to a **PhEvent_t** structure (see the Photon *Library Reference*) that describes the event that's causing the change in focus.

Description:

This function invokes the Child Getting Focus method of the container class specified by *cref*.

Returns:

Pt_END	The container prevented the child from having focus.
Pt_CONTINUE	The child may obtain focus.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PhEvent_t in the Photon *Library Reference*

Invoke a Child Getting Resources method

Synopsis:

```
int PtSuperClassChildGettingResources(
                PtWidgetClassRef_t *cref,
                PtWidget_t *widget,
                PtWidget_t *child,
                PtArg_t *argt);
```

Arguments:

cref	The container class whose method you want to invoke.
widget	A pointer to the widget whose child is having one of its resources set.
child	A pointer to the widget that's having one of its resources set.
argt	A pointer to a **PtArg_t** structure (see the Photon *Library Reference*) that describes the resource being retreived and where to store its value.

Description:

This function invokes the Child Getting Resources method of the container class specified by *cref*.

Returns:

Pt_END	The container prevented the resource query from receiving further processing — the container may have already satisfied the query.
Pt_CONTINUE	The resource query may be applied to the child.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtArg_t in the Photon *Library Reference*

PtSuperClassChildLosingFocus()

Invoke a Child Losing Focus method

Synopsis:

```
int PtSuperClassChildLosingFocus(
                PtWidgetClassRef_t *cref,
                PtWidget_t *widget,
                PtWidget_t *child,
                PhEvent_t *event );
```

Arguments:

cref	The container superclass whose method you want to call.
widget	A pointer to the widget whose child is losing focus.
child	A pointer to the widget that's losing focus.
event	A pointer to a **PhEvent_t** structure (see the Photon *Library Reference*) that describes the event that's causing the change in focus.

Description:

This function invokes the Child Losing Focus method of the container class specified by *cref*.

Returns:

Pt_END	The container prevented the child from losing focus.
Pt_CONTINUE	The child may lose focus.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PhEvent_t in the Photon *Library Reference*

Synopsis:

```
void PtSuperClassChildMovedResized(
                  PtWidgetClassRef_t *cref,
                  PtWidget_t *widget,
                  PtWidget_t *child,
                  PhArea_t *current_area,
                  PhRect_t *current_extent,
                  PhArea_t *old_area,
                  PhRect_t *old_extent );
```

Arguments:

cref	The container class whose method you want to invoke.
widget	A pointer to the widget whose child was resized.
child	A pointer to the widget that was resized.
current_area	A pointer to a **PhArea_t** structure that defines the widget's current area (after the resize).
current_extent	A pointer to a **PhRect_t** structure that defines the widget's current extent (after the resize).
old_area	A pointer to a **PhArea_t** structure that defines the widget's old area (before the resize).
old_extent	A pointer to a **PhRect_t** structure that defines the widget's old extent (before the resize).

Description:

This function invokes the Child Moved Resized method of the container class specified by *cref*.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

`PhArea_t`, **`PhRect_t`** in the Photon *Library Reference*

PtSuperClassChildRealized()

Invoke a Child Realized method

Synopsis:

```
void PtSuperClassChildRealized(
                 PtWidgetClassRef_t *cref,
                 PtWidget_t *widget,
                 PtWidget_t *child );
```

Arguments:

cref	The container class whose method you want to invoke.
widget	A pointer to the widget whose Child Realized method is being invoked.
child	A pointer to the widget that has been realized.

Description:

This function invokes the Child Realized method of the container class specified by *cref*.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

Invoke a Child Setting Resources method

Synopsis:

```
int PtSuperClassChildSettingResources(
                PtWidgetClassRef_t *cref,
                PtWidget_t *widget,
                PtWidget_t *child,
                PtArg_t const *argt );
```

Arguments:

cref	The container class whose method you want to invoke.
widget	A pointer to the widget whose child is having one of its resources set.
child	A pointer to the widget that's having one of its resources set.
argt	A pointer to a **`PtArg_t`** structure (see the Photon *Library Reference*) that describes the resource being set and its new value.

Description:

This function invokes the Child Setting Resources method of the container class specified by *cref*.

Returns:

Pt_END	The container prevented any further changes to the resource — the container may have already applied the change to the child.
Pt_CONTINUE	Further changes to the child's resource may be applied.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

`PtArg_t` in the Photon *Library Reference*

Synopsis:

```
void PtSuperClassChildUnrealized(
                  PtWidgetClassRef_t *cref,
                  PtWidget_t *widget,
                  PtWidget_t *child );
```

Arguments:

cref	The container class whose method you want to invoke.
widget	A pointer to the widget whose Child Unrealized method is being invoked.
child	A pointer to the widget that has just been unrealized.

Description:

This function invokes the Child Unrealized method of the container class specified by *cref*.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

Invoke the Connection method of specified widget class

Synopsis:

```
int PtSuperClassConnect(
        PtWidgetClassRef_t *cref,
        PtWidget_t *widget);

int PtSuperClassConnectFrom(
        PtWidgetClassRef_t *cref,
        PtWidget_t *widget );
```

Arguments:

cref	The superclass whose method you want to invoke.
widget	A pointer to the widget for which to invoke the method.

Description:

PtSuperClassConnect() invokes the Connection method of the specified widget class *cref*.

PtSuperClassConnectFrom() calls the Connection methods of all superclasses starting with the superclass specified by *cref*.

Returns:

Pt_CONTINUE	The connection callback chain can continue
Pt_HALT or Pt_END	The connection callbacks should stop.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

PtSuperClassDraw()

Invoke the Draw method of the specified superclass

Synopsis:

```
void PtSuperClassDraw( PtWidgetClassRef_t *wc_ref,
                       PtWidget_t *widget,
                       PhTile_t const *damage );
```

Arguments:

wc_ref	The superclass whose method you want to invoke.
widget	A pointer to the widget being drawn.
damage	A pointer to a list of **PhTile_t** structures (see the Photon *Library Reference*) that define the damaged areas to be drawn.

Description:

This function invokes the Draw method of the specified superclass *wc_ref*. Use this function to save code and complexity in your subclass's Draw method.

Examples:

```
static void my_draw( PtWidget_t *widget, PhTile_t *damage )
{
  // draw fill & borders as needed.
  PtSuperClassDraw( PtBasic, widget, damage );

  PtCalcCanvas( widget, &canvas );

  // Check if PtAttemptResize() function set Pt_UCLIP flag
  // in the Extent method.
  if( widget->resize_flags & Pt_UCLIP )
     PtClipAdd( widget, &canvas );

  PgDrawLine( canvas.ul, canvas.lr );
  PgDrawLine( canvas.lr, canvas.ul );

  if( widget->resize_flags & Pt_UCLIP )
     PtClipRemove();
}
```

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

`PhTile_t` in the Photon *Library Reference*

Synopsis:

```
void PtSuperClassExtent( PtWidgetClassRef_t *wc_ref,
                         PtWidget_t *widget );
```

Arguments:

wc_ref	The superclass whose method you want to invoke.
widget	A pointer to the widget for which to invoke the method.

Description:

This function invokes the Extent method of the specified superclass *wc_ref*.

The **PtLabel** class's Extent method handles multiline text (with underlining and margins) and the resize policy.

The **PtContainer** class's Extent method handles the resize policy for all its subclasses.

The **PtGraphic** class's Extent method calculates an extent based on an array of points, line weight, origin, and resize policy.

Examples:

To have a widget honor a minimum x dimension resource:

```
static void my_container_extent( PtWidget_t *widget )
{
  MyWidget_t *mw = (MyWidget_t *)widget;
  PhRect_t canvas, render;

  if( PtResizePolicy( widget ) )
  {
     PtChildBoundingBox( widget, &canvas, &render );
     if( render.lr.x - render.ul.x + 1 < mw->min_x )
       render.lr.x = render.ul.x + mw->min_x -1;
     PtAttemptResize( widget, &canvas, &render );
  }else if( widget->area.size.x < mw->min_x )
     widget->area.size.x = mw->min_x;

  PtSuperClassExtent( PtBasic, widget );

}
```

Classification:

Photon

Safety	
Interrupt handler	No

continued. . .

Safety	
Signal handler	No
Thread	No

Synopsis:

```
int PtSuperClassGetResources(
                      PtWidgetClassRef_t *wc_ref,
                      PtWidget_t *widget,
                      int num_args,
                      PtArg_t *args );
```

Arguments:

wc_ref	The superclass whose method you want to call.
widget	A pointer to the widget for which to call the superclass's method.
num_args	The number of entries in the *args* array.
args	An array of **PtArg_t** structures (see the Photon *Library Reference*) that define which resources to get.

Description:

This function gets resources given by *num_args* and *args* in the manner defined by *wc_ref*. This is extremely helpful when overriding the **query_f** member of an overridden resource.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtArg_t in the Photon *Library Reference*

Invoke the Got Focus method of the specified superclass

Synopsis:

```
void PtSuperClassGotFocus( PtWidgetClassRef_t *cref,
                           PtWidget_t *widget,
                           PhEvent_t *event );
```

Arguments:

cref	The superclass whose method you want to call.
widget	A pointer to the widget for which to call the superclass's method.
event	A pointer to a **PhEvent_t** structure (see the Photon *Library Reference*) that describes the event.

Description:

This function invokes the Got Focus method of the superclass specified by *cref*.

The **PtBasic** class's Got Focus method is the method that normally invokes the widget's Got Focus method or the user-level Got Focus callback.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PhEvent_t in the Photon *Library Reference*

Invoke the Initialize method of specified widget class

Synopsis:

```
int PtSuperClassInit( PtWidgetClassRef_t *cref,
                      PtWidget_t *widget );

int PtSuperClassInitFrom( PtWidgetClassRef_t *cref,
                          PtWidget_t *widget );
```

Arguments:

cref	The superclass whose method you want to call.
widget	A pointer to the widget for which to call the superclass's method.

Description:

PtSuperClassInit() invokes the Initialize method of the specified widget class *cref*.

PtSuperClassInitFrom() calls the Initialize method of all superclasses starting with the superclass specified by *cref*. When *PtSuperClassInitFrom()* is used in a Initialize method, Pt_END should be returned.

Returns:

Pt_CONTINUE	The Initialization method chain can continue.
Pt_HALT or Pt_END	The Initialization method chaining should stop.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

PtSuperClassLostFocus()

Invoke the Lost Focus method of the specified superclass

Synopsis:

```
int PtSuperClassLostFocus(
        PtWidgetClassRef_t *cref,
        PtWidget_t *widget,
        PhEvent_t *event );
```

Arguments:

cref	The superclass whose method you want to call.
widget	A pointer to the widget for which to call the superclass's method.
event	A pointer to a **PhEvent_t** structure (see the Photon *Library Reference*) that describes the event.

Description:

This function invokes the Lost Focus method of the superclass specified by *cref*.

The **PtBasic** class's Lost Focus method is the one that normally invokes the widget's Lost Focus method or the user-level Lost Focus callback.

Returns:

The maximum value returned by the Lost Focus callback chain.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PhEvent_t in the Photon *Library Reference*

PtSuperClassRawEvent(), *PtSuperClassRawEventFrom()*

Invoke the raw callback list of the specified widget class

Synopsis:

```
int PtSuperClassRawEvent( PtWidgetClassRef_t *cref,
                          PtWidget_t *widget
                          void *data,
                          PtCallbackInfo_t *cbinfo );

int PtSuperClassRawEventFrom(
                  PtWidgetClassRef_t *cref,
                  PtWidget_t *widget,
                  void *data,
                  PtCallbackInfo_t *cbinfo );
```

Arguments:

cref	The superclass whose method you want to call.
widget	A pointer to the widget for which to call the superclass's method.
data	Arbitrary data to pass to the raw callbacks as the *client_data* argument.
cbinfo	Callback information to pass to the raw callbacks as the *cbinfo* argument.

Description:

PtSuperClassRawEvent() invokes the raw callback list of the specified widget class.

PtSuperClassRawEventFrom() calls the raw callback lists of all superclasses starting with the superclass specified by *cref*. When *PtSuperClassRawEventFrom()* is used in a class's raw callback, the callback should return Pt_END.

Returns:

Pt_END if the event was consumed, Pt_CONTINUE if it wasn't.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

`PtCallbackInfo_t` in the Photon *Widget Reference*

PtSuperClassRealized()

Invoke Realization function of specified widget class

Synopsis:

```
void PtSuperClassRealized( PtWidgetClassRef_t *cref,
                           PtWidget_t *widget );
```

Arguments:

cref	The superclass whose method you want to call.
widget	A pointer to the widget for which to call the superclass's method.

Description:

This function invokes the Realization method of the specified widget class *cref*.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

Synopsis:

```
int PtSuperClassSetResources(
                          PtWidgetClassRef_t *wc_ref,
                          PtWidget_t *widget,
                          int num_args,
                          PtArg_t const *args )
```

Arguments:

wc_ref The superclass whose method you want to call.

widget A pointer to the widget for which to call the superclass's method.

num_args The number of entries in the *args* array.

args An array of **PtArg_t** structures (see the Photon *Library Reference*) that define the resources to set and their values.

Description:

This function sets the resources given by *num_args* and *args* in the manner defined by *wc_ref*. This is extremely helpful when overriding the **query_f** member of an overridden resource.

Returns:

The number of resources set.

Examples:

```
my_modify_area( PtWidget_t *widget, PtArg_t *argt )
{
     MyWidget_t *mw = (MyWidget_t *)widget;

     mw->area_changed = Pt_TRUE;
     // Apply the resource the same way a superclass does.
     PtSuperClassSetResources(
         widget->class_rec->superclass->cref,
         widget, 1, argt );

     // Set the resource so that it's treated
     // like a PtBasic class widget.
     PtSuperClassSetResources( PtBasic, widget, 1, argt );
}
```

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

`PtArg_t` in the Photon *Library Reference*

Tell the widget library about a change in visibility

Synopsis:

```
PtUpdateVisibility( PtWidget_t *widget,
                    PhRect_t *rect );
```

Arguments:

widget	A pointer to a container widget whose visibility has changed.
rect	A pointer to a **PhRect_t** structure that defines the area over which the visibility has changed.

Description:

This function tells the widget library that a change has occurred that may affect the visibility of widgets that intersect with the provided *rect* in the given container *widget*. This change may make the intersecting widgets completely obscured, completely unobscured, or partially obscured. This information is used to optimize refreshing the screen:

- Widgets that are completely obscured aren't drawn (since you wouldn't see them anyway).
- Widgets that are completely unobscured are drawn and don't cause widgets above them to be repaired (a completely unobscured widget has no intersecting widgets above it).
- Otherwise a widget is drawn when damaged and causes all intersecting widgets above it to be repaired.

Returns:

0 on success; -1 if *widget* isn't a container.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

`PhRect_t` in the Photon *Library Reference*

PtWidgetAbove()

Get the widget that's above a given widget in a family hierarchy

Synopsis:

```
PtWidget_t * PtWidgetAbove( PtWidget_t *root,
                            PtWidget_t *widget );
```

Arguments:

root A pointer to the highest widget that you want to consider in the widget family hierarchy.

widget A pointer to the widget for which you want to find a widget above.

Description:

This function returns a pointer to the widget that's in front of *widget*, provided the returned widget isn't any higher in the widget family hierarchy than *root*.

PtWidgetAbove() skips any disjoint widgets that it finds as it traverses the hierarchy.

Returns:

A pointer to the widget above, or NULL if there isn't one. If *widget* is the same as *root*, the function returns the first child of *root*, or NULL if *root* has no children.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PtWidgetBrotherBehind(), *PtWidgetBrotherInFront()*, *PtWidgetChildBack()*, *PtWidgetChildFront()*, *PtWidgetFamily()*, *PtWidgetParent()*, *PtWidgetTree()*, *PtWidgetTreeTraverse()* in the Photon *Library Reference*

Chapter 9

Creating Custom Resource Editors

This chapter describes the resource plugin API for creating your own resource editors for PhAB.

In PhAB, widgets have resources that are displayed in the Resources control panel. You modify these resources using either a small, specialized "frugal"editor directly in the control panel, or by opening a more complex "full"editor.

Previously the code for these resource editors was statically built into PhAB. Now the editors are resource editor plugins — they are small pieces of code and data put together into a DLL that PhAB loads at runtime. The purpose of this chapter is to describe how you can write your own resource editors.

Any resource has a type and a person that writes a resource editor plugin will write a plugin for one of these defined types:

- **`RES_DATATYPE_STRING`**
- **`RES_DATATYPE_MULTI`**
- **`RES_DATATYPE_CODE`**
- **`RES_DATATYPE_FONT`**
- **`RES_DATATYPE_COLOR`**
- **`RES_DATATYPE_DOUBLE`**
- **`RES_DATATYPE_NUMERIC`**
- **`RES_DATATYPE_CHOICE`**
- **`RES_DATATYPE_FLAG`**
- **`RES_DATATYPE_PATTERN`**
- **`RES_DATATYPE_LIST`**
- **`RES_DATATYPE_PIXMAP`**
- **`RES_DATATYPE_ALLOC`**

Each of these types is described in the section Resource datatypes. If you write a custom widget and devise a new resource that doesn't seem to fit in any of the above types, then you should use **`RES_DATATYPE_ALLOC`** since it describes a general resource datatype. This resource type consists of a buffer of bytes, with a given length. A protocol for ensuring the endian safety when saving/loading the alloc resource is documented in the section Endian issues.

Once you've chosen one of these types for a newly devised resource, the resource type is recorded in the widget's palette file as a string. See the sections Editing palette.def and Creating a widget description table in the Binding Widgets into PhAB chapter.

You can put one, two or more editors into the same DLL, or you can put a frugal editor into one DLL and a full editor into a different DLL. You can choose to only write the full editor and let the frugal editor be the predefined one, or use the frugal editor written by another user, and so on.

To decide which resource editor should be used for a resource type, PhAB looks at the **`res_editors.def`** to match entries with the *abstract_name_of_editor* specified in the **`palette.def`** file. There is a **`res_editors.def`** file for each user on a system, and a global **`res_editors.def`** file for all users. See The **`res_editors.def`** file section for more information about the structure of this file.

With the resource editor plugin API, you can:

- override the predefined resource editors. For instance, you might want to override the **`RES_DATATYPE_PIXMAP`** resource editor with your own. You specify the new editor in the **`palette.def`** file.
- write a specialized resource editor for a datatype that already exists.

  For instance, if you have a new widget class that has a new resource representing a date (**`time_t`**), the default numeric resource editor might be inappropriate. Instead, you can specify that for this date resource, an alternate custom resource editor is used.
- devise a brand new resource type using the **`RES_DATATYPE_ALLOC`** type and write a resource editor for it. PhAB and the aplib will know how to save it and load it at runtime, and the resource editor plugin gives you a way to change it in PhAB.

This chapter contains:

- Resource datatypes — describes the resource datatypes supported by the plugin API.
- The life cycle of a plugin instance — describes the life cycle of of resource editor plugins.
- The **`res_editors.def`** file — describes the configuration file you need to edit when you create a new resource and resource editor.
- Endian issues — describes how endian issues are handled with the **`RES_DATATYPE_ALLOC`** type.

See these chapters for more information about building a resource editor using the plugin API:

- The resource plugin API
- An example resource editor plugin

Resource datatypes

When you create a new resource, for example for a new widget, you need to tell PhAB about the resource and how it should be handled. You need to enroll the resource in one of the types listed below by entering the resource in the widget's palette file. For more information on this, see Creating a widget description table in the Binding Widgets into PhAB chapter.

A widget resource can be one of the following datatypes:

- **`RES_DATATYPE_CHOICE`** — an exclusive choice resource type, for example *Pt_ARG_LABEL_TYPE*.
- **`RES_DATATYPE_CODE`** — a function resource type, for example *Pt_ARG_RAW_DRAW_F*
- **`RES_DATATYPE_COLOR`** — a color resource type, for example *Pt_ARG_FILL_COLOR*.
- **`RES_DATATYPE_DOUBLE`** — a numeric double resource type, for example *Pt_ARG_NUMERIC_VALUE* for a **`PtNumericFloat`**.
- **`RES_DATATYPE_FLAG`** — a flag resource type, for example *Pt_ARG_FLAGS*.
- **`RES_DATATYPE_FONT`** — a font resource type, for example *Pt_ARG_TEXT_FONT*.
- **`RES_DATATYPE_LIST`** — a list resource type, for example *Pt_ARG_ITEMS*.
- **`RES_DATATYPE_MULTI`** — a multi line string resource type, for example *Pt_ARG_TEXT_STRING*.
- **`RES_DATATYPE_NUMERIC`** — a numeric resource type, for example *Pt_ARG_NUMERIC_VALUE* for a **`PtNumericInteger`**.
- **`RES_DATATYPE_PATTERN`** — a pattern resource type, *Pt_ARG_FILL_PATTERN*.
- **`RES_DATATYPE_PIXMAP`** — an image resource type, for example *Pt_ARG_LABEL_IMAGE*.
- **`RES_DATATYPE_STRING`** — a string resource type, for example *Pt_ARG_WINDOW_TITLE*.
- **`RES_DATATYPE_ALLOC`** — a generic resource type, not covered by the other types. For example, *Pt_ARG_ROW_LAYOUT_DATA*.

Resource datatypes general notes

Resource data is passed from PhAB to the plugin instance via a call to **`ResPluginSetDataF_t`**, and passed from the plugin instance to PhAB with *apply()*, **`ResPluginAnyChangesF_t`**, or *answer_changes()*. Each of these functions has a *value* and an *n* parameter for the data, though for each resource type these parameters are used differently.

For some resource datatypes, additional format information is required. Format data is passed as a pointer to this structure:

```
typedef struct ResPluginFormatData_ {
  int n;
  const void *value;
} ResPluginFormatData_t ;
```

Each resource data type uses the members of this structure differently. The resource editor should not assume that the pointer to **`ResPluginFormatData_t`** remains valid byond the call that passed the pointer.

For some datatypes, the "master copy rule" applies, which means PhAB maintains a master copy of the data and these conditions apply:

- When this data is being passed from PhAB to the plugin, PhAB holds the "master copy" and the value is guaranteed to remain a valid pointer until PhAB informs the plugin about a new value by calling the **`ResPluginSetDataF_t`** method. When the **`ResPluginSetDataF_t`** method is called, the old master copy is still valid.
- When this data is passed from the plugin to PhAB, PhaB frees its master copy and the data passed by the plugin becomes the master copy.

For other datatypes, the master copy rule doesn't apply. In these cases, when the data is passed, the recipient (either the plugin or PhAB) must make its own copy of the passed data.

RES_DATATYPE_ALLOC

This is the generic datatype that you can use for newly devised resources that do not fit any of the other predefined types. There is no predefined resource editor for this data type. An example of this resource type is *Pt_ARG_ROW_LAYOUT_DATA* (see below).

When this datatype is passed between the plugin and PhAB, in the passing function the parameter *value* is an array of bytes and *n* is the number of bytes being passed.

To allocate memory for this data type in your resource editor, you should use the *alloc_mem()* function exported by PhAB to allocate memory, and *free_mem()* to free it.

The palette file *type* string for this resource type is **`alloc`**.

An example of implementing RES_DATATYPE_ALLOC

Let's look at an example of implementing the *Pt_ARG_ROW_LAYOUT_DATA* resource editor.

This resource datatype does not require additional format information from **`ResPluginFormatData_t`**.

RES_DATATYPE_CHOICE

This data type represents a list of choices, which are string and numeric value pairs that a user can choose from. An example of this resource type is *Pt_ARG_LABEL_TYPE*.

When this datatype is passed between the plugin and PhAB, in the passing function the parameter *value* is not used. The *n* parameter contains the numeric value.

The master copy rule doesn't apply, so the plugin should make its own copy of the data when it is passed.

The **`ResPluginFormatData_t`** structure is used to indicate the list of choices and the associated numeric values. In the structure, *value* is an array of **`ResPluginChoiceFormat_t*`**, and *n* indicates the number of the items in the array.

The resource editor can safely assume that the array will remain valid beyond the call that passed this structure (that is, it will stay valid during the existence of the plugin).

The **`ResPluginChoiceFormat_t`** is defined as:

```
typedef struct {
  char *name;
  long value;
} ResPluginChoiceFormat_t;
```

The members are:

name	the choice name
value	the choice value

The value being passed to the plugin or from the plugin has to be one of the values indicated in the format structure.

The palette file *type* string for this resource type is **`choice`**.

RES_DATATYPE_CODE

This data type represents a function, for example *Pt_ARG_RAW_DRAW_F*. It is similar to the **`RES_DATATYPE_STRING`** resource type, except that the master copy rule doesn't apply. This means that you have to make a copy of the value in the resource editor plugin, because it might point to memory on the stack, which is invalid beyond the call that passed the value.

An editor for this resource should allow the user to edit one line of characters.

The resulting line of characters should be a valid string for specifying a function name in PhAB. For more information on properly formatting this string, see Function names and filenames in the Working with Code chapter of the *Photon Programmer's Guide*.

The **`ResPluginFormatData_t`** structure is used to indicate the prototype of the function. The *n* member is not used and the *value* member is a pointer to the following structure:

```
/* format for code datatype */
typedef struct {
  char *prototype;
  } ResPluginCodeFormat_t;
```

The *prototype* member should point to a function prototype string. For example:

```
PtWidget_t* @( PtWidget_t *window, PtWidget_t *widget, int position,
               char *text, char *font, PgColor_t fill_color,
               PgColor_t text_color )
```

The **@** is used to indicate the function name place holder. The plugin could use the provided prototype to display a list of already defined functions that match the prototype.

The resource editor can safely assume that the *value* pointer in the format structure will remain valid beyond the call that passed this structure. In fact, it will stay valid during the existence of the plugin.

The palette file *type* string for this resource type is **code**.

RES_DATATYPE_COLOR

This data type represents a color resource, for example *Pt_ARG_FILL_COLOR*.

When this datatype is passed between the plugin and PhAB, in the passing function the *value* parameter is not used. The *n* parameter contains the color, which is a **PgColor_t** type.

The master copy rule doesn't apply, so your plugin should make a copy of this data when it receives it.

No format data is required.

The palette file *type* string for this resource type is **crgb**.

RES_DATATYPE_DOUBLE

This data type represents a double-precision floating point value, such as *Pt_ARG_NUMERIC_VALUE* for **PtNumericFloat**.

When this datatype is passed between the plugin and PhAB, in the passing function the *value* parameter is a pointer to a double representing the value, and the *n* parameter is not used.

The master copy rule applies.

The **ResPluginFormatData_t** structure indicates the range of values the resource editor should allow this resource to have. In **ResPluginFormatData_t**, the *n* member is not used and the *value* member is a pointer to this structure:

```
typedef struct {
  double min;
  double max;
} ResPluginDoubleFormat_t;
```

The *min* and *max* members indicate the minimum and maximum values allowed for the data type. The resource editor can safely assume that the *value* pointer in the format structure will remain valid beyond the call that passed this information. In fact, it will remain valid during the existance of the plugin.

The palette file entry for this data type is **double**. The palette file string for this resource type indicates the range this way :

```
r=manifest_name,desc_name,resource_no,reserved,
  select_ind,type, default_value[,additional_info]
```

where:

- *type* is **`double`**
- *additional_info* (if required) can be either:
  - **`f`** — specifies single-precision 32 bit floating point resources
  - *min*/*max* — specifies the explicit minimum and maximum values

For example:

```
r=Pt_ARG_NUMERIC_INCREMENT,Numeric increment,53003,
  0,0,double,1,0/100
```

Also see the chapter Binding Widgets into PhAB in the *Photon Programmer's Guide*.

RES_DATATYPE_FLAG

This data type represents a flag resource, for example *Pt_ARG_FLAGS*.

When this datatype is passed between the plugin and PhAB, in the passing function the *value* parameter is an unsigned long integer representing the value, and the *n* parameter is not used.

The master copy rule doesn't apply.

The **`ResPluginFormatData_t`** structure is used to indicate the list of values, names and masks. In the **`ResPluginFormatData_t`** structure, the *value* member is an array of **`ResPluginFlagFormat_t*`** , and the *n* member is the number of items in the array.

The resource editor can safely assume that the array of **`ResPluginFlagFormat_t*`** will remain valid beyond the call that passed this structure. In fact, it will stay valid during the existence of the plugin.

The **`ResPluginFlagFormat_t`** is defined as:

```
typedef struct {
  char *name;
  unsigned long value;
  unsigned long mask;
} ResPluginFlagFormat_t;
```

where *name* is the flag's name, *value* is the flag's value and *mask* is the associated mask.

The flags should be presented as names in the resource editor, so that a user can choose one or more values. When the user chooses more than one value, the resulting value is all selected values ORed together.

The *mask* controls how the different values interact with each other. All the values that match a bit in a mask are exclusive values, that is, they exclude each other.For instance if the current value of the resource is *current_value* and the user selects another flag of the *value* that has a *mask* associated, the resulting value will be:

```
(current_value & ( ~ mask ) ) | value
```

That means that first the *mask* is used to clear all the corresponding bits from the *current_value* and then the *value* is OR-ed in.

The *mask* can be `0`, which means that the respective flag value doesn't interact with any other flag values.

The palette file *type* string for this resource type is **`flag`**.

RES_DATATYPE_FONT

This data type represents a font resource, such as *Pt_ARG_TEXT_FONT*.

This type is the same as the **`RES_DATATYPE_STRING`** resource type, but the resulting string has to be a valid font name. For more information on generating a valid font name, see *PgGenerateFontName()*.

The **`ResPluginFormatData_t`** structure is used to pass extra information about the fonts allowed for selection. The *value* member is not used, and the *n* member can be:

RES_DATATYPE_FONT_FIXED

This resource requires a fixed font.

To define a font resource in a palette file, use this string format:

```
r=manifest_name,desc_name,resource_no,reserved,
  select_ind, type,default_value[,additional_info]
```

where *type* is **`font`** and if the font is fixed-width, *additional_info* is **`fixed`**.

RES_DATATYPE_LIST

This resource type represents a list, such as *Pg_ARG_ITEMS*.

When this datatype is passed between the plugin and PhAB, in the passing function the *value* parameter is an array of strings, the last item of the array being NULL, and the *n* parameter is the number of strings in the array, not including the last item.

The master copy rule applies.

No format data is required.

You should should use *alloc_mem()* exported from PhAB in your resource editor to allocate memory for this resource, and *free_mem()* to free it.

The palette file *type* string for this resource type is **`list`**.

RES_DATATYPE_MULTI

This resource type represents a multi-line text string, such as *Pt_ARG_TEXT_STRING*.

This resource type is the same as the **`RES_DATATTYPE_STRING`**, with the difference that the **`RES_DATATYPE_MULTI`** type can contain newline **`\n`** characters. The resource editor should allow you to expand on multiple lines.

No format data is required.

The palette file *type* string for this resource type is **`multi`**.

RES_DATATYPE_NUMERIC

This resource type represents a numeric value, including short, integer, long signed and unsigned values. An example is *Pt_ARG_NUMERIC_VALUE*.

When this datatype is passed between the plugin and PhAB, in the passing function the *value* parameter is not used. The parameter *n* contains the numeric value.

The master copy rule doesn't apply.

The **`ResPluginFormatData_t`** structure is used to indicate the range of values the editor should allow. In the structure, the *n* parameter is not used and the *value* parameter is a pointer to this structure:

```
typedef struct {
  int64_t min;
  int64_t max;
} ResPluginNumericFormat_t;
```

The *min* and *max* fields indicate the minimum and maximum values allowed in the editor. The resource editor can safely assume that the *value* pointer in the format structure will remain valid beyond the call that passed this structure. In fact, it will remain valid during the existence of the plugin.

The palette file *type* string for this resource type is **`numeric`**. The previous string **`short`** is deprecated, but it is still recognized for backward compatibility. The palette file string for this resource type indicates the range this way:

```
r=manifest_name,desc_name,resource_no,reserved,
  select_ind,type, default_value[,additional_info]
```

where *type* is **`numeric`** and *additional_info* can be:

- **`s8`** — signed byte
- **`s16`** — signed short
- **`s32`** — signed int
- **`u8`**, **`u16`**, **`u32`** — the unsigned counterparts
- **`s`** — a shortcut for signed int
- **`u`** — a short cut for unsigned int
- *min*/*max* the explicit minimum and maximum values

Also see the chapter Binding Widgets into PhAB.

If the *additional_info* section is missing, the resources is assumed to be **`s32`**, a signed int.

RES_DATATYPE_PATTERN

This data type represents a pattern.

When this datatype is passed between the plugin and PhAB, in the passing function the *value* parameter is a pointer to a **PgPattern_t**, and the *n* parameter is not used.

The master copy rule doesn't apply, so the value pointer might be allocated on the stack and your plugin should make a copy of the data as soon as it receives the data.

No format data is required.

The palette file *type* string for this resource type is **pattern**.

RES_DATATYPE_PIXMAP

This data type represents an image map, for example *Pt_ARG_LABEL_IMAGE*.

When this datatype is passed between the plugin and PhAB, in the passing function the *value* parameter is a **PhImage_t** pointer and the *n* parameter is not used.

The master copy rule applies over the whole image. When this value is passed, the **PhImage_t*** is passed together with all associated data such as the image data and image palette.

No format data is required.

You should use *alloc_image()* exported from PhAB to allocate the image pointer, and *free_image()* to free it.

The palette file *type* string for this resource type is **pixmap**.

RES_DATATYPE_STRING

This data type represents a string.

When this datatype is passed between the plugin and PhAB, in the passing function the *value* parameter is an array of characters, NULL terminated, and the *n* parameter is set to the length of the string.

The master copy rule applies.

You should use the exported **PhABExportAllocMemF_t** to allocate memory, and **PhABExportFreeMemF_t** to free the memory.

This is the same as the **RES_DATATYPE_MULTI** type , with the difference that the data cannot contain '\n' characters, and the resource editor should allow only one line of characters to be edited.

No format data is required.

The palette file *type* string for this resource type is **string**.

The life cycle of a plugin instance

The life cycle of a plugin depends on how it is written. A resource editor plugin can be a frugal editor, or a full editor, and the full editor can be implemented to use an external application. Each scenario is described here.

The frugal resource editor

The following scenario applies to a frugal resource editor:

- PhAB creates an instance of the plugin using the **`ResPluginFrugalCreateF_t`** method.
- The user interacts with the plugin
- The plugin can call into PhAB with the *apply()* method, requesting PhAB apply the current value.
- The plugin can call into PhAB with the *open()* method, requesting PhAB open a full editor to edit this resource.
- PhAB gives the plugin new data it just got from the full editor; the plugin must take the new data and throw away any modified version of the old data it might have.
- ...
- PhAB calls the **`ResPluginDestroyF_t`** method to destroy the plugin instance.

The full resource editor

The following scenario applies for a full resource editor that doesn't use an external application:

- PhAB creates an instance of the plugin using its **`ResPluginFullCreateF_t`** method.

  In this method:

  - We recommend that in order to ensure a consistent look and feel for all resource editors, that you use the convenience function *create_window()*, exported from PhAB.
  - The *create_window()* function creates the resource editor window and fills in a **`PtWidget_t`** ** with a pointer to the container widget that the plugin has to populate.
  - The plugin populates the container widget.
  - The plugin returns from its "create" method.
- Instead of using the *create_window()* convenience function, you can choose construct the resource window in the plugin yourself.
- The user edits the data inside the editor window.

- The plugin should show its state graphically. If the window was created using *create_window()* it can use the convenience function *set_state()* to render the state.
- The plugin can call into PhAB with the *apply()* method, requesting PhAB to apply the current resource editor value.
- PhAB can call the **`ResPluginAnyChangesF_t`** method and the plugin should answer if there are changes to its data. The call to this function is made because PhAB wants to close or disable the editor's window, or put a new value into the editor, and it wants to know what to do with the old value (for instance, when the selection changes). If there are changes, they are passed in this function call.
- PhAB can call the **`ResPluginDisableF_t`** method, and the plugin has to throw away it's value, and disable the content of the window, except for the **Cancel** button. If you used the *create_window()* function to create the resource editor window, use the *set_state()* function exported by PhAB to disable that part of the interface that was not created directly by you.
- PhAB can later call **`ResPluginSetDataF_t`** and the plugin should re-enable itself and display the new data.
- If the frugal editor asks PhAB to change the value while the full editor has some modification in it, then the full editor plugin will get a call to **`ResPluginSetDataF_t`** and the plugin is already enabled. The full editor can have one of the following behaviors:

  1. Throw away its own modifications and use the new data passed from PhAB.
  2. Keep the modifications it already has.

- The user may press **Cancel** or close the editor's window. In this case if the window was not created with *create_window()*, the plugin has to call into PhAB with the *closing()* method. If *create_window()* was used, then PhAB drives the plugin and the closing method shouldn't be called.
- PhAB calls **`ResPluginDestroyF_t`** to destroy the plugin instance.

An external application resource editor

When your full resource editor uses an external application, PhAB assumes that the plugin does not have access to the external application code — the external application is considered to be a black box. The only assumptions made are:

- The plugin can spawn the external application.
- The plugin has a way of passing data to the external application, for example, by putting the data into a file and giving the file to the external application.
- The plugin has a way of detecting when the external application was closed, for example by polling the PID or by attaching a SIGCHLD handler.
- The plugin has a way of detecting when the user has saved the changes, for example by using *stat()* to examine the modification time of a data file.

- The plugin can send a Ph_WM_CLOSE event, and the external application displays a standard "save, discard, or cancel" dialog, before closing.

For an example of a resource editor that uses an external application, see the external application example in the Plugin Examples chapter. That example shows how you can use ped as an editor for a PtButton's *Pt_ARG_TEXT_STRING* resource.

The following scenario applies for a full resource editor that uses an external application:

- PhAB creates an instance of the plugin using its **`ResPluginFullCreateF_t`** method.
- Inside this method, the plugin packages the resource data passed as an argument and gives it to the external application. For example, it might package the data into a file and spawn an external application, passing the file as an argument.
- The user starts editing the data inside the editor's window.
- The plugin has a way to monitor the external application for the following events:
  - The user chooses **Save** in the external application. At this point, the plugin calls into PhAB with the *apply()* method.
  - The user closes the external application. At this point the plugin checks if there are changes and possibly calls apply, and then calls the exported *closing()* method. Because the user has already made the decision about saving or not saving the data, when PhAB calls the **`ResPluginAnyChangesF_t`** method, the plugin should return RESPLUGIN_NO_CHANGES inside the *closing()* method.
- PhAB can decide to call the **`ResPluginAnyChangesF_t`** method and the plugin should answer if there are changes or not. The call to this function is made because PhAB wants to close the editor's window or disable the editor's window, or PhAB wants to put a new value in the resource editor's window and wants to know what to do with the old value (for instance, when the selection changes).
- If the plugin is able, it can answer right away whether there are changes or not. But most likely the plugin will not know and will want to let the external application decide if there are changes or not. Therefore, the plugin should send a Ph_WM_CLOSE event to the external application's window and bring it to front, and then return RESPLUGIN_WAIT to the call to **`ResPluginAnyChangesF_t`**.
- At this point PhAB goes into a waiting state, in which the user cannot change the current selection and PhAB displays a message telling the user what's happening.
- The external application will display a typical "save, discard, or cancel" dialog.
- Any choice other than **Cancel** will terminate the external application, the plugin will detect this and will call into PhAB with the *answer_changes()* method, giving PhAB the new data, if necessary. Note that at this point PhAB doesn't mind if the plugin always replies that there are changes — it might be easier for the plugin to always grab the file and pass the data to PhAB).

- If the user chooses **Cancel**, then PhAB will remain in the waiting state until the user closes the external application and the plugin calls with the *answer_changes()* method. PhAB always assumes that a call to *answer_changes()* means the user has closed the editor's window. The plugin doesn't have to call the exported *closing()* method explicitly.
- PhAB calls **`ResPluginDestroyF_t`** to destroy the plugin instance.

The `res_editors.def` file

The mapping between the *abstract_name_of_editor* in the palette files and the actual frugal and full editors is done in the **`res_editors.def`** file (see Creating a widget description table in the Binding Widgets into PhAB chapter).

There are two **`res_editors.def`** files, one at the user level file located under the user's home directory along with the other PhAB configuration files (**`~/.ph/phab`**), and a global file, located in the same directory as the PhAB executable. The user's **`res_editors.def`** file overrides the settings in the global file.

The format of both files is:

```
e=abstract_name_of_editor
[p=path]
[F=full_editor]
[p=path]
[f=frugal_editor]
```

Each resource definition in the palette files should have a corresponding *abstract_name_of_editor* definition (the **`r=`** line).

The lines that define resources in the palette file are supposed to have an abstract_name_of_editor for each resource definition line (the lines that begin with r=). See Creating a widget description table in the Binding Widgets into PhAB chapter. When the *abstract_name_of_editor* for a resource is missing, it is assumed that the *abstract_name_of_editor* is the datatype string.

For instance, for the *Pt_ARG_CONTAINER_FLAGS* definition, the *abstract_name_of_editor* and the datatype string are both **`flag`**:

```
r=Pt_ARG_CONTAINER_FLAGS,Container Flags,10005,10005,
  1,flag,0x30,9
```

Each one of the *abstract_name_of_editors* specified in all the palette files must have a section in at least one of the **`res_editors.def`** files (either the user specific or the global file). This section indicates the path and the name of the DLL that contains the code for the plugin. Please note that the predefined editors are statically built into PhAB and are not specified in the **`res_editors.def`** files. You can override these predefined editors by adding sections to the **`res_editors.def`** file.

For instance you can define a section **`e=`***string* to override the default resource editor for the **`RES_DATATYPE_STRING`** resource datatype.

The **`res_editors.def`** file defines these settings:

e=abstract_name_of_editor

The settings for a particular resource editor. This line must match the abstract name of editor in a palette file.

p=path

An optional setting, which can be used to specify the path to the next shared objects. It applies to only the shared objects specified inside the current **`e=abstract_name_of_editor`** section.

An empty line **`p=`** means the path is PhAB's standard location for the plugin editors, which is **`plugins/resource`** in PhAB's directory.

If the part following **`p=`** doesn't start with a slash **`/`**, the path is considered to be relative to the user's home directory.

If no path information is available when the **`F=`** or **`f=`** settings are parsed, then the path is considered to be PhAB's standard location for the plugin editors, which is **`plugins/resource`** in PhAB's directory.

If the setting is **`p=$`**, then the **$LD_LIBRARY_PATH** environment variable is used.

F=full_editor, f=frugal_editor

Specifies the full and frugal editors. These lines have the form *editor@dll_name*.

The *dll_name* includes the shared library extension. On QNX the extension for shared objects is **`.so`**, while on Windows it is **`.so`** or **`.dll`**.

For example, the *frugal_editor* can be specified as: **`date@editors.so`**). If the *@dll_name* part is missing, the dll name is considered to be the same as the editor's name plus the extension.

For instance, assume you want to write a resource editor to edit a date. The datatype used is numeric, but the default editors for the numeric dataype are not suitable for editing a date format:

a)

```
e=date
p=/tmp/plugins
F=date1@exp_date
p=
f=date2@date
```

In this example, the date type uses the full editor **`date1`** located in the **`/tmp/plugins/exp_date.so`**, and the frugal editor **`date2`**, located in **`date.so`**, in PhAB's standard plugin directory **`plugins/resource`** under the PhAB's executable directory.

b)

```
e=date
f=date2
```

This example uses the **date2** editor for the frugal editor, located in **plugins/resource/date2.so**.

c)

```
e=date
p=my_plugins
F=date
```

This example uses the full editor **date** located in **my_plugins/date.so**, under the user's home directory.

If a palette file specifies an abstract name of an editor and there is no information about it in any of the **res_editors.def** files, and PhAB detects this at startup, it will exit with an error, except for the cases where it is safe to use the default datatype editor instead.

The **def_res.def** file in PhAB's executable directory lists the abstract editors (one editor per line) for which it is safe to use the default datatype editor, anytime something prevents a different editor from being used.

For instance, in the example c) above, the frugal editor for **date** is not specified (there is no "f=" entry). If the predefined frugal editor for the datatype numeric is to be used, **def_res.def** has to specify **date** inside.

The **RES_DATATYPE_ALLOC** datatype can't be listed in **def_res.def** since there is no default editor for it.

Endian issues

Because you can run PhAB on one platform and target another platform with a different endianness, PhAB needs to know how to load and save the widget files and the aplib needs to know how to load the content of the resource file at run time.

For the predefined datatypes, this is already taken care of, because the widget files are saved in a endian-insensitive form, and at runtime they are converted to the right endian form.

For the **RES_DATATYPE_ALLOC** datatype, you can specify an endian signature. This is a string that you put in the palette files. Each time a resource is saved, the string tells PhAB how to save the resource data in a endian-insensitive form. The string is saved along the resource data in the widget files. When the widget files are loaded either at runtime by aplib, or by PhAB, the endian string is read before reading the actual data. The string tells aplib and PhAB how to convert the loaded data to the right endian form.

Here's an example of endian string:

```
24css+il4c
```

This string describes an endian structure with:

- 24 characters (24 bytes endian insensitive)

- 2 shorts followed by an array of structures containing:
  - one integer (4 bytes)
  - one long (8 bytes)
  - 4 characters

Use:

- **`c`** for a character (1 byte endian insensitive)
- **`s`** for a **"**short**"** (2 bytes)
- **`i`** for an integer (4 bytes)
- **`l`** for a long (8 bytes)

Each of these can be preceded by a number to indicate a sequence of the same type data.

Use a **`+`** to indicate the start of an array of structures. The number of items in the array is determined by looking at the length of the resource data that's left to be loaded for that particular resource.

You can only specify an endian string for **`RES_DATATYPE_ALLOC`** resource types, and it's optional. A **`RES_DATATYPE_ALLOC`** resource type that has no endian string will be considered to be endian insensitive and in this case it will be the widget's and the plugin's responsibilities to correctly interpret the array of bytes.

In other words, when the endian string is missing, it's the same as setting the endian string to **`+c`**.

Chapter 10

The resource editor API

This chapter lists the structures that support the resource editor plugin API, the functions exported by PhAB that support the API, and the functions you need to provide in your plugin.

Resource editor code is put in a DLL. You can put one, two, or more resource editors into a single DLL. Alternatively, you can put the frugal resource editor for a resource type in one DLL, and the full editor in another. Each DLL is organized as an addon that uses the Addon Interface API.

The DLL must declare the addon interface as:

```
#define RESPLUGIN_VERSION 202

AOInterface_t interfaces[]=
{
  { "PhAB Resource Editors", RESPLUGIN_VERSION, &tab },
  { 0,0,0 }
};
```

Note that the RESPLUGIN_VERSION is defined as **202**.

The *tab* variable must point to an instance of the **ResPlugin_t** structure.

Resource Editor API structures

You have to provide all the methods defined in **ResPlugin_t**, **ResPluginFrugalEditor_t**, and **ResPluginFullEditor_t** in the resource editor plugin, otherwise PhAB will not load and use the plugin.

When a new plugin instance is created, it is given a pointer to a structure that is exported from PhAB to the plugin and contains functions that the plugin can call into PhAB. All these functions take at least a **PhABHandle_t** as an argument.

Functions defined in **ResPlugin_t** that you must provide in the plugin:

- **ResPluginLoadingF_t** — a function called just after the DLL is loaded by PhAB into its address space, used to set up any resources common to the plugins in the DLL.
- **ResPluginUnloadingF_t** — a function called before the DLL is unloaded from PhAB's address space. This function is called once for each successful call to **ResPluginLoadingF_t**.

Functions defined in **ResPluginCommon_t** that you must provide in the plugin:

- **ResPluginSetDataF_t** — a function to set the data value in a resource editor.
- **ResPluginDestroyF_t** — a function to destroy a resource editor and free any resources allocated.

Functions defined in **ResPluginFrugalEditor_t** that you must provide in the plugin:

- **ResPluginFrugalCreateF_t** — a function to create an instance of a frugal resource editor.

Functions defined in **`ResPluginFullEditor_t`** that you must provide in the plugin:

- **`ResPluginAnyChangesF_t`** — a function called by PhAB to determine whether the resource editor contains changes.
- **`ResPluginBlockF_t`** — a function called by PhAB to tell the resource editor to temporarily block input.
- **`ResPluginDisableF_t`** — a function called by PhaB to tell the resource editor to disable itself, and appear disabled (greyed out).
- **`ResPluginFullCreateF_t`**— a function to create an instance of a full resource editor.
- **`ResPluginGetChangesF_t`** — a function called by PhAB to retrieve any changes in the resource editor.
- **`ResPluginGetAreaF_t`** — a function called by PhAB to find out the area of the resource editor window.
- **`ResPluginToFrontF_t`** — a function called by PhAB to bring the resource editor window to the front.

Functions exported from PhAB

- *alloc_image()* — called by a plugin to allocate memory for **`RES_DATATYPE_PIXMAP`** data.
- *alloc_mem()* — called by a plugin to allocate memory for its copy of data.
- *answer_changes()* — called by a plugin to answer PhAB's call to **`ResPluginAnyChangesF_t`**.
- *apply()* — called by a plugin to apply its data to the widget in PhAB.
- *closing()* — called by a plugin to tell PhAB that the resource editor will close (for example, the user clicked the **Close** button.)
- *cmp()* — a function a plugin can use to compare two **`ResDatatype_t`** values.
- *dup()* — a function a plugin can use to duplicate a **`ResDatatype_t`** value.
- *free()* — a function a plugin can use to free a **`ResDatatype_t`** value.
- *free_image()* — a function a plugin can use to free **`RES_DATATYPE_PIXMAP`** data allocated by *alloc_image()*.
- *free_mem()* — a function a plugin can use to free memory allocated by *alloc_mem()*.
- *get_res()* — a function to get resource data from another resource editor plugin, allowing one editor to use another as a "sub-editor".
- *open()* — a function a frugal resource editor can call to open a full resource editor for its datatype.

The resource editor's window supporting functions

These functions are exported from PhAB in the **`PhABResExportFull_t`** structure, which is passed as a pointer when the plugin instance is created. They are convenience functions that a full editor can use in order to ensure a consistent look for the resource editor windows. We recommend that you use these functions to create and manage the editor window, except for the case when your plugin spawns an external application. In that case the external application should provide the window.

- *create_window()* — a function that creates a window container which the plugin can use as the full resource editor window.
- *destroy()* — a function to destroy the window created by *create_window()*.
- *get_area()* — a function to get the area of the window created by *create_window()*.
- *message()* — a function that displays a message in PhAB.
- *set_state()* — a function to set the state of the window created by *create_window()*.
- *to_front()* — a function to bring the window created by *create_window()* to the front.

A function exported by PhAB to allocate memory for an image

Synopsis:

```
PhImage_t* alloc_image  (
  PhImage_t *src );
```

Arguments:

src	The **PhImage_t** image for which you want to allocate memory.

Description:

This function is exported from PhAB in the **PhABResExportCommon_t** structure.

This function allocates a new Photon image, based on the *src* image. The *src* image is duplicated: the function allocates a new palette, a new alpha map, etc.

After an image is allocated with *alloc_image()*, you are free to modify it. If you need to allocate memory for the image palette, image data, or alpha map, use the *alloc_mem()* function.

The newly allocated image will have the *flags* member set to Ph_RELEASE_IMAGE_ALL, meaning that all the fields of the new image that required allocating memory will be released when the image is released.

You should free the image with the PhAB exported *free_image()* function.

Returns:

A pointer to the image, or NULL when an error occurs.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

alloc_mem(), *free_image()*, **PhABResExportCommon_t**, **PhImage_t**

PhABResExportCommon_t.*alloc_mem()*

A function exported by PhAB to allocate memory for the resource editor's copy of some data

Synopsis:

```
char* alloc_mem  ( int size )
```

Arguments:

size	The size, in bytes, of the buffer you want allocated.

Description:

This function is exported from PhAB in the **PhABResExportCommon_t** structure.

This function can be used by a resource editor to allocate memory for its copy of some data. This memory should be freed with the PhAB exported *free_mem()* function.

Returns:

A pointer to the allocated memory, or NULL if an error occurred.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

*free_mem()***PhABResExportCommon_t**

PhABResExportFull_t.*answer_changes()* © 2010, QNX Software Systems GmbH & Co. KG.

A function exported by PhAB to answer a call to a **ResPluginAnyChangesF_t** *function*

Synopsis:

```
void answer_changes  (
  PhABHandle_t phab,
  int answer,
  int n,
  void *pvalue )
```

Arguments:

phab	A handle, provided by PhAB as the *phab* argument when the plugin is created with **ResPluginFrugalCreateF_t** or **ResPluginFullCreateF_t**.
answer	Specifies whether the resource editor contains changes. Can be: ● RESPLUGIN_CHANGES — plugin contains changes ● RESPLUGIN_NO_CHANGES — plugin doesn't contain changes
n	The new value. Its value depends on the datatype.
value	The new value. Its value depends on the datatype.

Description:

This function is exported from PhAB in the **PhABResExportFull_t** structure

This function is called from the full resource editor after the editor returns RESPLUGIN_WAIT to a call to the function defined by **ResPluginAnyChangesF_t** from PhAB. It should specify whether the editor contains any changes to its data. If there are changes, the plugin should use *n* and *value* to pass the new data back to PhAB.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PhABResExportFull_t, **ResPluginAnyChangesF_t**, **ResPluginFrugalCreateF_t**, **ResPluginFullCreateF_t**.

PhABResExportCommon_t.*apply()*

Function exported by PhAB to apply changes in the resource editor

Synopsis:

```
int apply (
  PhABHandle_t phab,
  int n,
  void * value )
```

Arguments:

phab	A handle, provided by PhAB as the *phab* argument when the plugin is created with **ResPluginFrugalCreateF_t** or **ResPluginFullCreateF_t**.
n	Resource data, depending on the data type.
value	Resource data, depending on the data type.

Description:

This function is exported from PhAB in the **PhABResExportCommon_t** structure.

This function is called from the plugin when resource data changes have to be applied to the selected widget or widgets, for example, when a user clicks the **Apply** button in the resource editor.

The data value is represented by the parameter pair *n* and *value*. How these parameters are passed depends on the data type of the resource. See the description of resource data types for a discussion of how these parameters are passed.

The return value of this function indicates whether PhAB has taken control over the resource data. This prevents memory leaks when the master copy rule applies. When the *apply()* function returns zero, PhAB has taken the given value and has made it the master copy. When the *apply()* function returns non zero, PhaB has not made the given value the master copy, it has used the default value instead. In this case the plugin should update its internal structures by freeing any data it allocated for the value and using the default value instead.

Returns:

0	PhAB has made the resource data represented by *value* and *n* the master copy.
Non 0	PhAB has not made a master copy and is using the default value instead.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PhABResExportCommon_t, **ResPluginFrugalCreateF_t**, **ResPluginFullCreateF_t**.

Function exported by PhAB to inform PhAB that the resource editor is closing

Synopsis:

```
void closing ( PhABHandle_t phab )
```

Arguments:

phab	A handle, provided by PhAB as the *phab* argument when the plugin is created with **ResPluginFullCreateF_t**.

Description:

This function is exported from PhAB in the **PhABResExportFull_t** structure

This function is called from the full resource editor to inform PhAB that the editor wants to initiate the closing procedure. This function should not be called from inside the resource editor's destroy function, since in this case PhAB initiated the closing procedure.

Closing the plugin window may be triggered by a user clicking a **Cancel** button or the window's close button. This function should be called before the closing occurs, because PhAB may cancel the closing action.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PhABResExportFull_t, **ResPluginAnyChangesF_t** **ResPluginFullCreateF_t**.

PhABResExportCommon_t.*cmp()*

A function exported by PhAB to compare two resource editor values

Synopsis:

```
int cmp (
  ResDatatype_t type,
  int n1,
  void *v1,
  int n2,
  void *v2 );
```

Arguments:

type	The data type of the values you want to compare.
n1, *v1*	The value members for the first value you want to compare. The values depend on the data type.
n2, *v2*	The value members for the second value you want to compare. The values depend on the data type.

Description:

This function is exported from PhAB in the **PhABResExportCommon_t** structure.

This is a convenience function that you can use to compare two values. While in some cases, for instance with the RES_DATATYPE_NUMERIC datatype, it might be easy enough to just compare the values without using this function. In other cases, as with RES_DATATYPE_PIXMAP, it is easier to use this function.

Returns:

0	the values are equal
non-zero	the values are not equal

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PhABResExportCommon_t

PhABResExportFull_t.*create_window()*

A function exported by PhAB to create a resource editor window

Synopsis:

```
PhabResWindowHandle_t create_window (
  PhArea_t *area,
  char *caption,
  unsigned int flags,
  PtWidget_t **container,
  ResPluginActionNotifyF_t *notify,
  void *notify_data )
```

Arguments:

area The area of the window, represented by a **PhArea_t**.

caption The window's caption string, related to the resource being currently edited.

flags Additional information about how the window should look. Set to RESPLUGIN_FIXED_SIZE to make the resulting window non-resizeable.

container Filled by the *create_window()* function with a pointer to a container widget. You should use this widget pointer as the parent for whatever widgets are needed to render the full resource editor.

notify A pointer to a callback that notifies the resource editor of changes to the window. This callback has the following synopsis:

```
typedef void ResPluginActionNotifyF_t (
ResPluginAction_t action, void *notify_data );
```

Action is returned as one of:

- RESPLUGIN_ACTION_DEFAULT — the resource editor user has requested the default action.
- RESPLUGIN_ACTION_CLOSE — the resource editor user has requested to close the plugin's window.
- RESPLUGIN_ACTION_APPLY — the resource editor user has requested the apply action.

notify_data A pointer to data that you want to pass as the second argument to the *notify* function.

Description:

This function is exported from PhAB in the **PhABResExportFull_t** structure.

This convenience function should be called from within the full editor's create function to create a typical resource editor window. The function creates the window with all the necessary callbacks already attached and will notify the plugin about various actions using the *notify* function and *notify_data*.

Returns:

A **PhabResWindowHandle_t** which has to be used in the related windowing functions

	success
NULL	error

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

destroy(), *get_area()*, *get_res()*, **PhABResExportFull_t**, *set_state()*, *to_front()*.

A function exported by PhAB to destroy a window created by create_window()

Synopsis:

```
void destroy (
  PhabResWindowHandle_t wnd )
```

Arguments:

wnd	The window handle for the window you want to destroy, originally returned by **PhABExportCreateWindowF_t** *create_window()*.

Description:

This function is exported from PhAB in the **PhABResExportFull_t** structure.

This convenience function should be called from the full editor to destroy the convenience window *wnd*, created by calling *create_window()*. The only time this function should be called is from the destroy method of the full resource editor.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

create_window(), *get_area()*, *get_res()*, **PhABResExportFull_t**, *set_state()*, *to_front()*.

PhABResExportCommon_t.*dup()*

A PhAB exported function to duplicate a value

Synopsis:

```
void dup (
  ResDatatype_t type,
  int n,
  void *v,
  int *dest_n,
  void **dest_value );
```

Arguments:

type The data type of the data you want to duplicate.

n, *v* The source value you want to duplicate. The values depend on the data type.

dest_n, *dest_value*
The destination for value you want to duplicate. The values depend on the data type.

Description:

This function is exported from PhAB in the **PhABResExportCommon_t** structure.

This is a convenience function that you can use to duplicate a value.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

PhABResExportCommon_t

Synopsis:

```
void free (
  ResDatatype_t type,
  int n,
  void *v );
```

Arguments:

type	The type of the data you want to free.
n	The *n* value for the data you want to see. This value depends on the data type.
v	The *v* value for the data you want to see. This value depends on the data type.

Description:

Exported from PhAB in the **`PhABResExportCommon_t`** structure.

This is a convenience function that you can use to free a value.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

alloc_mem(), **`PhABResExportCommon_t`**.

A function exported by PhAB to free an image created with alloc_image()

Synopsis:

```
void free_image  ( PhImage_t *p )
```

Arguments:

p A pointer to the image date you want to free, returned by *alloc_image()*.

Description:

This function is exported from PhAB in the **PhABResExportCommon_t** structure.

This function should be used by the plugin to free the image allocated using the PhAB exported *alloc_image()* function.

Because the *flags* member is set to Ph_RELEASE_IMAGE_ALL when an image is allocated with *alloc_image()*, all the fields of the new image that required allocating memory are released when the image is released.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

alloc_image(), **PhABResExportCommon_t**

A function exported by PhAB to free memory allocated by alloc_mem()

Synopsis:

```
void free_mem  ( char *p )
```

Arguments:

p The pointer to the memory buffer returned by *alloc_mem()*.

Description:

This function is exported from PhAB in the **`PhABResExportCommon_t`** structure.

This function should be used by the resource editor to free the memory allocated using the *alloc_mem()*.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

alloc_mem(), **`PhABResExportCommon_t`**.

PhABResExportFull_t.*get_area()*

A function exported by PhAB to get the area of a window created by create_window()

Synopsis:

```
void get_area (
  PhabResWindowHandle_t wnd,
  PhArea_t *area)
```

Arguments:

wnd	The window handle returned by **PhABExportCreateWindowF_t** *create_window()*.
area	Filled in by the function with the area of the resource editor window.

Description:

This function is exported from PhAB in the **PhABResExportFull_t** structure.

You can call this function from the full editor to find out the current area of the window *wnd*.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

create_window(), *destroy()*,*get_res()*, **PhABResExportFull_t**, *set_state()*, *to_front()*.

PhABResExportCommon_t.*get_res()*

A function exported by PhAB to get the resource structure for another datatype

Synopsis:

```
void get_res (
  ResDatatype_t type
  char *abstract_name_editor
  ResPluginFrugalEditor_t **pfrugal_editor,
  ResPluginFullEditor_t **pfull_editor
   )
```

Arguments:

type
: The datatype for the resource editor that you want to obtain a handle for.

abstract_name_editor
: The name of the resource editor you want to obtain a handle for. Use NULL to get the handle for the pre-defined editor. Otherwise, use a name for an editor defined in the palette files.

pfrugal_editor
: This argument is filled in by the function with a pointer to a ResPluginFrugalEditor_t, which represents the frugal editor that matches the *type* and *abstract_name_editor*. Pass NULL in this parameter if you're not interested in obtaining this pointer.

pfull_editor
: This argument is filled in by the function with a pointer to a ResPluginFullEditor_t, which represents the full editor that matches the *type* and *abstract_name_editor*. Pass NULL in this parameter if you're not interested in obtaining this pointer.

Description:

This function is exported from PhAB in the **PhABResExportCommon_t** structure.

This convenience function can be called from either the frugal or full editor to obtain the handle for the editor of another resource type. This allows one plugin to call another currently loaded resource editor plugin as a sub-editor. For example, a pixmap full editor needs to be able to edit the color of a pixel. To do this, you can use *get_res()* in the pixmap editor to create an instance of the full color editor.

Examples:

Here is a partial example of calling the color editor from a different editor plugin.

```
/* taken from the pixmap editor plugin */
/* here "instance" is an instance to the full resource pixmap editor */
/* get the predefined resource editor for "color" */

instance->exp->common.get_res( RES_DATATYPE_COLOR, NULL, NULL,
                              &instance->def_res_full_color );

/* did we obtain a valid pointer to the full resource editor for "color" ?
*/
```

```
if( instance->def_res_full_color ) {

      /* use the exported convenience functions that were passed for the pixmap
      plugin editor */
      instance->color_editor_exp = *instance->exp;

    /* defined our own apply and closing functions */
    instance->color_editor_exp.common.apply = color_res_apply;
    instance->color_editor_exp.closing = color_res_closing;
    instance->color_editor_handle = instance->def_res_full_color->create(
            (PhABHandle_t) instance, &instance->color_editor_exp, NULL, color, NULL,
            NULL, "the color editor", color, NULL );
}

static int color_res_apply( PhABHandle_t phab, int color, void *value ) {
    PluginFullInstance_t *instance = (PluginFullInstance_t *) phab;

  /* here "instance" is an instance to the full resource pixmap editor */
    .......
    return 1;
}

static int color_res_closing( PhABHandle_t phab ) {
    PluginFullInstance_t *instance = (PluginFullInstance_t *) phab;

    /* here "instance" is an instance to the full resource pixmap editor */
    instance->color_editor_handle = NULL;
    return 1;
}
```

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

create_window(), *destroy()*, *get_area()*, **PhABResExportCommon_t**, *set_state()*, *to_front()*.

PhABResExportCommon_t.*message()*

A function exported by PhAB to display a message dialog

Synopsis:

```
int message (
  char *message,
  char *button1,
  char *button2,
  char *button3,
  int default_button );
```

Arguments:

message	The text that appears in the message dialog.
button1	The text for the first button.
button2	The text for the second button. Set to NULL if you do not require a second button.
button3	The text for the third button. Set to NULL if you do not require a third button.
default_button	The index (1, 2, or 3) of the button with focus when the message dialog is displayed.

Description:

Exported from PhAB in the **`PhABResExportCommon_t`** structure.

This function displays a customizable message dialog.

Returns:

The index of the button the user clicked.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

`PhABResExportCommon_t`

PhABResExportFrugal_t.*open()*

Function exported by PhAB to open the full editor from the frugal editor

Synopsis:

```
void open  ( PhABHandle_t phab )
```

Arguments:

phab	A handle, provided by PhAB as the *phab* argument when the plugin is created with **ResPluginFrugalCreateF_t**.

Description:

This function is exported from PhAB in the **PhABResExportFrugal_t** structure.

Call this function from the frugal editor to display the full editor. For example, the frugal editor might be display only, not allowing the user to change the resource data. However, the frugal editor might contain a button or area which the user can click to open the full editor.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

ResPluginFrugalCreateF_t

PhABResExportCommon_t

Functions exported by PhAB called by a full or frugal editor

Synopsis:

```
typedef struct PhABResExportCommon_ {
                PhABExportApplyF_t *apply;

                PhABExportAllocMemF_t *alloc_mem;
                PhABExportAllocImageF_t *alloc_image;
                PhABExportFreeMemF_t *free_mem;
                PhABExportFreeImageF_t *free_image;

                PhABExportCmpF_t *cmp;
                PhABExportDupF_t *dup;
                PhABExportFreeF_t *free;
                PhABExportGetResF_t *get_res;

                PhABExportMessageF_t *message;

                } PhABResExportCommon_t;
```

Description:

This structure is a superclass for **PhABResExportFrugal_t** and **PhABResExportFull_t**.

The structure has these members:

apply	A pointer to the *apply()* function exported by PhAB.
alloc_mem	A pointer to the *alloc_mem()* function exported by PhAB.
alloc_image	A pointer to the *alloc_image()* function exported by PhAB.
free_mem	A pointer to the *free_mem()* function exported by PhAB.
free_image	A pointer to the *free_image()* function exported by PhAB.
cmp	A pointer to the *cmp()* function exported by PhAB.
dup	A pointer to the *dup()* function exported by PhAB.
free	A pointer to the *free()* function exported by PhAB.
get_res	A pointer to the *get_res()* function exported by PhAB.
message	A pointer to the *message()* function exported by PhAB.

Classification:

Photon

See also:

alloc_image(), *alloc_mem()*, *apply()*, *cmp()*, *dup()*, *free()*, *free_image()*, *free_mem()*, *get_res()*, *message()*, **`PhABResExportFrugal_t`**, **`PhABResExportFull_t`**.

A structure that defines the functions exported by PhAB that can be called by a frugal editor

Synopsis:

```
typedef struct PhABResExportFrugal_ {
        PhABResExportCommon_t common;

        PhABExportOpenF_t *open;
        } PhABResExportFrugal_t;
```

Description:

When a new frugal resource editor is created, it is passed a pointer to this structure, which gives it access to the functions exported by PhAB.

The structure has these members:

common	A **PhABResExportCommon_t** structure that points to functions common to frugal and full editors.
open	A pointer to the *open()* function exported by PhAB.

Classification:

Photon

See also:

open(), **PhABResExportCommon_t**.

PhABResExportFull_t

A structure that defines the functions exported by PhAB that can be called by a full editor

Synopsis:

```
typedef struct PhABResExportFull_ {
        PhABResExportCommon_t common;

        PhABExportClosingF_t *closing;
        PhABExportAnswerChangesF_t *answer_changes;
        PhABExportCreateWindowF_t *create_window;
        PhABExportSetStateF_t *set_state;
        PhABExportToFrontF_t *to_front;
        PhABExportGetAreaF_t *get_area;
        PhABExportDestroyF_t *destroy;
        } PhABResExportFull_t;
```

Description:

When a new full resource editor is created, it is passed a pointer to this structure, which gives it access to the functions exported by PhAB.

The structure has these members:

common	A **PhABResExportCommon_t** structure that points to functions common to frugal and full editors.
closing	A pointer to the *closing()* function exported by PhAB.
answer_changes	A pointer to the *answer_changes()* function exported by PhAB.
create_window	A pointer to the *create_window()* function exported by PhAB.
set_state	A pointer to the *set_state()* function exported by PhAB.
to_front	A pointer to the *to_front()* function exported by PhAB.
get_area	A pointer to the *get_area()* function exported by PhAB.
destroy	A pointer to the *destroy()* function exported by PhAB.

Classification:

Photon

See also:

answer_changes(), *closing()*, *create_window()*, *destroy()*, *get_area()*, **PhABResExportCommon_t**, *set_state()*, *to_front()*.

ResPlugin_t

A structure that defines all the resource editor plugins in a DLL

Synopsis:

```
typedef struct ResPlugin_ {
ResPluginLoadingF_t *loading;
ResPluginUnloadingF_t *unloading;
int n_full_editors;
const ResPluginFullEditor_t* full_editors;
int n_frugal_editors;
const ResPluginFrugalEditor_t* frugal_editors;
} ResPlugin_t;
```

Description:

This structure defines the resource editor plugins in a DLL. An instance of this structure is pointed to by the *tab* member of the **AOInterfaces_t** *interfaces* array.

The members are:

loading	A pointer to a **ResPluginLoadingF_t** function for the DLL, which is executed after the DLL is loaded into PhAB's memory space.
unloading	A pointer to a **ResPluginUnloadingF_t** function for the DLL, which is executed just before the DLL is unloaded from PhAB's memory space.
n_full_editors	The number of entries in the *full_editors* array.
n_frugal_editors	The number of entries in the *frugal_editors* array
full_editors	An array of **ResPluginFullEditor_t** structures. Each structure in the array defines the API for a full resource editor in the DLL.
frugal_editors	An array of **ResPluginFrugalEditor_t** structures. Each structure in the array defines the API for a frugal resource editor in the DLL.

Classification:

Photon

See also:

ResPluginLoadingF_t, **ResPluginFullEditor_t**, **ResPluginFrugalEditor_t**, **ResPluginUnloadingF_t**.

ResPluginAnyChangesF_t

A function you must write to indicate there are changes in the resource editor data

Synopsis:

```
typedef int ResPluginAnyChangesF_t ( ResPluginHandle_t handle )
```

Description:

This function is exported in the **ResPluginFullEditor_t** structure.

This function is called by PhAB to ask the full editor whether it contains changes or not. If there are no changes, the plugin should return RESPLUGIN_NO_CHANGES. If there are changes, the plugin should return RESPLUGIN_CHANGES.

The plugin can also return RESPLUGIN_WAIT if it cannot answer right away. In this case the plugin has to call back later into PhAB, using the *answer_changes()* function. PhAB will not destroy the plugin instance until the call to *answer_changes()* is made. The RESPLUGIN_WAIT can be used in the case where the plugin spawns an external application to edit the resource, as described in the Plugin lifecycle section.

Arguments:

handle	The **ResPluginHandle_t** handle returned when the instance of the editor is created with **ResPluginFullCreateF_t**.

Should return:

This function should return one of:

- RESPLUGIN_NO_CHANGES — there are no changes.
- RESPLUGIN_CHANGES — there are changes
- RESPLUGIN_WAIT — the plugin doesn't know if there are changes or not and it will answer later by calling *answer_changes()*.

Examples:

This sample function is from the complete plugin example at the end of this chapter.

```
static int plugin_full_any_changes( ResPluginHandle_t handle )
{
  PluginFullInstance_t *instance = ( PluginFullInstance_t * ) handle;
  char *p;
  PtGetResource( instance->full_widget, Pt_ARG_TEXT_STRING, &p, 0 );
  if( !strcmp( p, instance->value_master ) ) return RESPLUGIN_NO_CHANGES;
  return RESPLUGIN_CHANGES;
}
```

Classification:

QNX Neutrino

See also:

answer_changes(), **`ResPluginFrugalCreateF_t`**, **`ResPluginFullCreateF_t`**, **`ResPluginFullEditor_t`**.

`ResPluginBlockF_t`

A function you must write to temporarily block input

Synopsis:

```
typedef void ResPluginBlockF_t (
  ResPluginHandle_t handle,
  int block )
```

Description:

This function is exported in the **`ResPluginFullEditor_t`** structure.

This function is called by PhAB to indicate that the plugin should temporary block input to the resource editor (when the *block* parameter is not `0`) or that the plugin should restore the input to the full resource editor (when the *block* parameter is `0`).

When PhAB requests that the resource editor be blocked, you should set the Pt_BLOCKED flag on the window that contains the editor. If the PhAB exported *create_window()* function was used to create the editor's window, then the PhAB exported *set_state()* function should be used with an argument equal to RESPLUGIN_STATE_BLOCKED to block the editor's window or with an argument equal to RES_PLUGIN_STATE_UNBLOCKED to unblock it.

Arguments:

handle
: The **`ResPluginHandle_t`** handle returned when the instance of the editor is created with **`ResPluginFullCreateF_t`**.

block
: Indicates whether the plugin should block or unblock input. It can be:

- `0` — unblock input
- not `0` — block input

Examples:

This sample block function for a full editor is from the complete plugin example at the end of this chapter.

```
static void plugin_full_block( ResPluginHandle_t handle, int block )
{
  PluginFullInstance_t *instance = ( PluginFullInstance_t * ) handle;
  instance->exp->set_state( instance->convenience_handle,
                                  block ?
                                  RESPLUGIN_STATE_BLOCKED :
                                  RESPLUGIN_STATE_UNBLOCKED );
}
```

Classification:

QNX Neutrino

See also:

create_window(), **`ResPluginFrugalCreateF_t`**, **`ResPluginFullEditor_t`**, **`ResPluginFullCreateF_t`**, *set_state()*.

A superclass structure that defines the common elements of a frugal or full resource editor

Synopsis:

```
typedef struct ResPluginCommon_ {
        const char *name;
        ResDatatype_t datatype;
        int datatype_version;

        /* the common functions */
        const ResPluginSetDataF_t *set_data;
        const ResPluginDestroyF_t *destroy;
                } ResPluginCommon_t;
```

Description:

This is a structure that contains elements common to a frugal editor and full editor, and is the superclass for the structures **ResPluginFrugalEditor_t** and **ResPluginFullEditor_t**.

The members are:

name
: Uniquely identifies the plugin in the *frugal_editors* or *full_editors* array. It has to be unique in the array.

datatype
: The type of resource the editor is designed to edit. **ResDatatype_t** is defined as:

```
 typedef enum { RES_DATATYPE_STRING,
RES_DATATYPE_MULTI, RES_DATATYPE_CODE,
RES_DATATYPE_FONT, RES_DATATYPE_COLOR,
RES_DATATYPE_DOUBLE, RES_DATATYPE_NUMERIC,
RES_DATATYPE_CHOICE, RES_DATATYPE_FLAG,
RES_DATATYPE_PATTERN, RES_DATATYPE_LIST,
RES_DATATYPE_PIXMAP, RES_DATATYPE_ALLOC }
ResDatatype_t;
```

datatype_version
: The version of the datatype that this plugin understands. All the datatypes, as described in this document, have the version **1**, defined as the constant RESPLUGIN_DATATYPE_VERSION:

```
#define RESPLUGIN_DATATYPE_VERSION 1
```

Plugins should use this constant as the *datatype_version*. For instance, it means that a **RES_DATATYPE_PIXMAP** editor understands the pixmap type version 1, as described in this chapter. It's possible that in the future there will be changes to some data types. For example, if the definition of **PgColor_t** changed, then RES_DATATYPE_COLOR would require a version 2 editor to handle the changes.

set_data;
: A pointer to the **ResPluginSetDataF_t** function for the resource editor.

destroy;
: A pointer to the **ResPluginDestroyF_t** function for the resource editor.

Classification:

Photon

See also:

`ResPluginDestroyF_t`, **`ResPluginFrugalEditor_t`**, **`ResPluginFullEditor_t`**, **`ResPluginSetDataF_t`**.

ResPluginDestroyF_t

A function you must write to release resources allocated to the plugin

Synopsis:

```
typedef void ResPluginDestroyF_t (ResPluginHandle_t handle )
```

Description:

This function is exported in the **ResPluginCommon_t** structure.

This function is called by PhAB to destroy an instance of the resource editor and free the resources allocated.

If the plugin is a frugal editor, then the plugin's widgets have already been destroyed at this point.

If the plugin is a full editor, then it is the plugin's responsibility to destroy its widgets and window, perhaps by calling *PtDestroyWidget()* with the topmost widget as an argument.

Arguments:

handle The **ResPluginHandle_t** handle returned when the instance of the editor is created with a create function, either **ResPluginFrugalCreateF_t** or **ResPluginFullCreateF_t**.

Examples:

This example destroy function is from the complete plugin example at the end of this chapter.

```
static void plugin_full_destroy( ResPluginHandle_t handle )
{
  PluginFullInstance_t *instance =
    ( PluginFullInstance_t * ) handle;
  instance->exp->destroy( instance->convenience_handle );
  free( instance );
}
```

Classification:

QNX Neutrino

See also:

ResPluginCommon_t, **ResPluginFrugalCreateF_t**, **ResPluginFullCreateF_t**, Resource datatypes.

ResPluginDisableF_t

A function you must write to disable the plugin

Synopsis:

```
typedef void ResPluginDisableF_t ( ResPluginHandle_t handle )
```

Description:

This function is exported in the **ResPluginFullEditor_t** structure

This function is called by PhAB to indicate that the resource editor should change it's appearance so that it looks disabled, or greyed out. The editor should keep a **Cancel** button active even when the content and other buttons are disabled, so that a user can dismiss the window. The content should be changed back to the active state when PhAB sends new data to the editor via a call to the set data function. If the PhAB exported *create_window()* function was used to create the editor's window, then the PhAB exported *set_state()* function should be used the the argument RESPLUGIN_STATE_DISABLED.

Arguments:

handle	The **ResPluginHandle_t** handle returned when the instance of the editor is created with a create **ResPluginFullCreateF_t**.

Examples:

This sample disable function for a full editor is from the complete plugin example at the end of this chapter.

```
static void plugin_full_disable( ResPluginHandle_t handle )
{
  PluginFullInstance_t *instance = ( PluginFullInstance_t * ) handle;
  PtArg_t args[3];
  instance->disabled = 1;
  PtSetArg( &args[0], Pt_ARG_FLAGS, Pt_GHOST|Pt_BLOCKED, Pt_GHOST|Pt_BLOCKED );
  PtSetArg( &args[1], Pt_ARG_CURSOR_TYPE, Ph_CURSOR_NOINPUT, 0 );
  PtSetArg( &args[2], Pt_ARG_CURSOR_OVERRIDE, 1, 0 );
  PtSetResources( instance->full, 3, args );
  PtSetResource( instance->full_widget, Pt_ARG_FLAGS, Pt_GHOST|Pt_BLOCKED,
                Pt_GHOST|Pt_BLOCKED );
  instance->exp->set_state( instance->convenience_handle,
                                  RESPLUGIN_STATE_DISABLED );
}
```

Classification:

QNX Neutrino

See also:

ResPluginFullCreateF_t, **ResPluginFullEditor_t**.

ResPluginFrugalCreateF_t

A function you must write to create an instance of a frugal resource editor

Synopsis:

```
typedef ResPluginHandle_t
ResPluginFrugalCreateF_t (
  PhABHandle_t phab ,
  const PhABResExportFrugal_t *exp,
  const ResPluginFormatData_t *format,
  int n_default,
  const void *default_value,
  PtWidget_t *parent,
  int n,
  const void *value )
```

Description:

This function is exported in the **`ResPluginFrugalEditor_t`** structure.

This function is called to create a new instance of the frugal resource editor.

The plugin should create any necessary widgets inside the container *parent* widget. The plugin must try to create its widget(s) with a transparent background, if possible, and it should anchor it's widgets or attach a resize callback to the *parent* in order to properly display itself when the width of the parent changes. The parent widget will have a non-transparent background.

If necessary, format information is passed by *format* when the plugin instance is created. The format data depends on the data type. For example, for the **`RES_DATATYPE_FLAG`** datatype, *format* provides the plugin with the list of possible flag values, the flag manifests, and the associated masks, if any.

Arguments:

phab	A **`PhABHandle_t`** provided by PhAB, and which should be used as the *phab* argument when the plugin calls any of the functions present in the *exp* table of functions.
exp	A pointer to a **`PhABResExportFrugal_t`** defining the functions exported by PhAB for the frugal editor. You can assume that the *exp* pointer will remain valid during the lifetime of the plugin.
format	A pointer to a **`ResPluginFormatData_t`** structure that describes format information required by the data type. See Resource datatypes for a description of how this structure applies to each datatype.
n_default	Default value for the resource, together with the *default_value* argument.
default_value	Default value for the resource. This pointer is guaranteed to remain valid during the lifetime of the plugin.

parent	The parent container widget for any widgets the resource editor creates.
n	Initial resource data, depending on the data type. See Resource datatypes.
value	Initial resource data, depending on the data type. See Resource datatypes.

Should return:

This function should return a **`ResPluginHandle_t`** plugin handle, or NULL on error. If you return a non-NULL value, this value will be passed as the first argument to all your other functions.

Examples:

This example create function for a frugal editor is from the complete plugin example at the end of this chapter.

```
static ResPluginHandle_t plugin_frugal_create
        ( PhABHandle_t phab , const PhABResExportFrugal_t *exp,
          const ResPluginFormatData_t *format,
          int n_default, const void *default_value,
          PtWidget_t *parent,
          int n, const void *value ) {

  PtArg_t args[2];
  PhRect_t offset = { { -1, -1 }, { -1, -1 } };
  PluginFrugalInstance_t *instance;

  instance = calloc( 1, sizeof( *instance ) );
  if( !instance ) return NULL;

  instance->n_default = n_default;
  instance->default_value = default_value;
  instance->n_master = n;
  instance->value_master = value;

  instance->phab = phab;
  instance->exp = exp;

  PtSetArg( &args[0], Pt_ARG_ANCHOR_OFFSETS, &offset, 0 );
  PtSetArg( &args[1], Pt_ARG_TEXT_STRING, value, 0 );
  instance->frugal = ApCreateWidget( db, "string_frugal", 0, 0, 2, args );
  PtAddCallback( instance->frugal, Pt_CB_TEXT_CHANGED, plugin_frugal_changed, instance );
  return ( ResPluginHandle_t ) instance;
  }
```

Classification:

QNX Neutrino

See also:

`PhABResExportFrugal_t`, **`ResPluginFrugalEditor_t`**, Resource datatypes.

ResPluginFrugalEditor_t

A structure that defines a frugal editor

Synopsis:

```
typedef struct ResPluginFrugalEditor_ {
        /* the common stuff */
        ResPluginCommon_t common;

        /* the frugal editor */
        ResPluginFrugalCreateF_t *create;
        } ResPluginFrugalEditor_t;
```

Description:

This structure defines the elements and functions for a frugal editor required for the *frugal_editors* array of **`ResPlugin_t`**.

`ResPluginFrugalEditor_t` has these members:

common	A **`ResPluginCommon_t`** structure that defines name, datatype, version, and endian string (if required) for a frugal editor, as well as its set data and destroy functions.
create	A pointer to the plugin's **`ResPluginFrugalCreateF_t`** *create()* function.

Classification:

Photon

See also:

`ResPlugin_t`, **`ResPluginCommon_t`**.

ResPluginFullCreateF_t

A function you must write to create an instance of a full resource editor

Synopsis:

```
typedef ResPluginHandle_t
ResPluginFullCreateF_t( PhABHandle_t phab ,
  const PhABResExportFull_t *exp,
  const ResPluginFormatData_t *format,
  int n_default,
  const void *default_value,
  PhArea_t *area,
  char *caption,
  int n,
  const void *value )
```

Description:

This function is exported in the **`ResPluginFullEditor_t`** structure.

This function is called to create a new instance of the full resource editor.

If necessary, format information is passed by *format* when the plugin instance is created. The format data depends on the data type. For example, for the **`RES_DATATYPE_FLAG`** datatype, *format* provides the plugin with the list of possible flag values, the flag manifests, and the associated masks, if any.

The data value is represented by the parameter pair *n* and *value*. How these parameters are passed depends on the data type of the resource. See the description of resource data types for a discussion of how these parameters are passed.

To ensure a consistent look for the full resource editors, PhAB provides a library of functions to support the resource editor's windowing requirements. For example, *create_window()* creates a typical resource editor window, complete with standard Cancel, Default, Apply, and Done buttons. The resource editor needs only to populate a container inside the typical window for its specific editing requirements.

You can choose to use these supporting functions or you can create your own window for the resource editor. You can even spawn an external application, pass it the data, and manage the external application as a resource editor in PhAB. This approach is described in the Plugin lifecycle section.

Arguments:

phab	A **`PhABHandle_t`** provided by PhAB, and which should be used as the *phab* argument when the plugin calls any of the functions present in the *exp* table of functions.
exp	A pointer to a **`PhABResExportFull_t`** defining the functions exported by PhAB for the full editor. You can assume that the *exp* pointer will remain valid during the lifetime of the plugin.
format	A pointer to a **`ResPluginFormatData_t`** structure that describes format information required by the data type.
n_default	Default value for the resource, together with the *default_value* argument.

default_value	Default value for the resource, together with *n_default*. This pointer is guaranteed to remain valid during the lifetime of the plugin.
area	A pointer to a **PhArea_t** representing the full resource editor area. The first time an editor ever runs, PhAB may pass the area argument as NULL, meaning that it has no records about this resource editor, and in this case you should use the area that best fits the editor. After the first time the editor runs, PhAB saves the position and dimensions in **/.ph/phab/abwspace.cfg**, and on subsequent invocations the *area* is taken from the saved value. If you change the default size of the editor window, don't forget to erase your **abwspace.cfg** file so that the new default is used.
caption	A string related to the resource being currently edited. This string can be displayed as the window's title or maybe in a label inside the window.
n	Initial resource data, depending on the data type.
value	Initial resource data, depending on the data type.

Should return:

This function should return a **ResPluginHandle_t** plugin handle, or NULL on error. If you return a non-NULL value, this value is passed as the first argument to all your other functions.

Examples:

This sample create function for a full editor is from the complete plugin example at the end of this chapter.

```
static ResPluginHandle_t plugin_full_create
        ( PhABHandle_t phab , const PhABResExportFull_t *exp,
          const ResPluginFormatData_t *format,
          int n_default, const void *default_value,
          PhArea_t *area, char *caption,
          int n, const void *value )
{
  PluginFullInstance_t *instance;
  PtWidget_t *parent;
  PhRect_t offset = { { 0, 0 }, { 0, 0 } };
  PhArea_t tarea;
  PtArg_t args[1];
  int start = 0, end = n;

  instance = calloc( 1, sizeof( *instance ) );
  if( !instance ) return NULL;

  instance->n_default = n_default;
  instance->default_value = default_value;
  instance->n_master = n;
  instance->value_master = value;

  instance->phab = phab;
  instance->exp = exp;

  if( !area ) {
    PhRect_t rect;
    PhWindowQueryVisible( 0, 0, 0, &rect );
    tarea.pos.x = rect.ul.x + 100;;
    tarea.pos.y = rect.ul.y + 100;
    tarea.size.w = 340;
    tarea.size.h = 150;
    area = &tarea;
    }
  instance->convenience_handle = exp->create_window( phab, area, caption, 0, &parent,
                                                     plugin_full_notify, instance );

  PtSetParentWidget( parent );
  PtSetArg( &args[0], Pt_ARG_ANCHOR_OFFSETS, &offset, 0 );
  instance->full= ApCreateWidgetFamily( db, "string_full_container", 0, 0, 1, args );
  instance->full_widget = PtWidgetChildFront( instance->full );
  PtAddCallback( instance->full, Pt_CB_RESIZE, plugin_full_resize, instance );
  PtAddCallback( instance->full_widget, Pt_CB_TEXT_CHANGED, plugin_full_changed,
                 instance );
  PtAddCallback( instance->full_widget, Pt_CB_ACTIVATE, plugin_full_done, instance );

  PtSetResource( instance->full_widget, Pt_ARG_TEXT_STRING, value, 0 );
  PtTextSetSelection( instance->full_widget, &start, &end );
  PtRealizeWidget( instance->full );

  set_state( instance, value );

  return ( ResPluginHandle_t ) instance;
}
```

Classification:

QNX Neutrino

See also:

create_window(), **PhABResExportFull_t**, **PhArea_t**, **ResPluginFullEditor_t**.

Synopsis:

```
typedef struct ResPluginFullEditor_ {

        /* the common stuff */
        ResPluginCommon_t common;

          /* the full editor */
        ResPluginFullCreateF_t *create;
        ResPluginDisableF_t *disable;
        ResPluginBlockF_t *block;
        ResPluginToFrontF_t *to_front;
        ResPluginAnyChangesF_t *any_changes;
        ResPluginGetChangesF_t *get_changes;
        ResPluginGetAreaF_t *get_area;
        } ResPluginFullEditor_t;
```

Description:

This structure defines the elements and functions for a full editor required for the *full_editors* array of **ResPlugin_t**.

ResPluginFullEditor_t has these members:

common	An instance of the **ResPluginCommon_t** structure that defines the common functions for this plugin.
create	A pointer to the plugin's **ResPluginFullCreateF_t** create function.
disable	A pointer to the plugin's **ResPluginDisableF_t** disable function.
block	A pointer to the plugin's **ResPluginBlockF_t** block function
to_front	A pointer to the plugin's **ResPluginToFrontF_t** to front function.
any_changes	A pointer to the plugin's **ResPluginAnyChangesF_t** any changes function.
get_changes	A pointer to the plugin's **ResPluginGetChangesF_t** get changes function.
get_area	A pointer to the plugin's **ResPluginGetAreaF_t** get area function.

Classification:

Photon

See also:

ResPlugin_t, **ResPluginAnyChangesF_t**, **ResPluginBlockF_t**, **ResPluginCommon_t**, **ResPluginDisableF_t**, **ResPluginFullCreateF_t**, **ResPluginGetAreaF_t**, **ResPluginGetChangesF_t**, **ResPluginToFrontF_t**.

ResPluginGetAreaF_t

A function you must write to retrieve the area occupied by the full resource editor window

Synopsis:

```
typedef void ResPluginGetAreaF_t (
  ResPluginHandle_t handle,
  PhArea_t *area )
```

Description:

This function is exported in the **ResPluginFullEditor_t** structure

This function is called by PhAB to find out the current area of the full resource editor. The plugin should fill in the area pointer with the editor's current area.

Arguments:

handle	The **ResPluginHandle_t** handle returned when the instance of the editor is created with **ResPluginFullCreateF_t**.
area	A pointer to a **PhArea_t** structure you fill in to define the current area of the resource editor.

Examples:

This sample **ResPluginGetAreaF_t** function for a full editor is from the complete plugin example at the end of this chapter.

```
static void plugin_full_get_area( ResPluginHandle_t handle, PhArea_t *area )
{
  PluginFullInstance_t *instance = ( PluginFullInstance_t * ) handle;
  instance->exp->get_area( instance->convenience_handle, area );
}
```

Classification:

QNX Neutrino

See also:

ResPluginFullCreateF_t, **ResPluginFullEditor_t**, **PhArea_t**.

ResPluginGetChangesF_t

A function you must write to get changed resource data

Synopsis:

```
typedef void ResPluginGetChangesF_t (
  ResPluginHandle_t handle,
  int *pn,
  void **pvalue )
```

Description:

This function is exported in the **ResPluginFullEditor_t** structure.

This function is called by PhAB to retrieve changes to resource data from the editor. It is called only after a call to **ResPluginAnyChangesF_t** indicates that there are changes to the resource editor's data.

If the master copy rule applies, PhAB will take this data and make it the new master copy.

Arguments:

handle	The **ResPluginHandle_t** handle returned when the instance of the editor is created with **ResPluginFullCreateF_t**.
pn	A pointer to resource data. The actual data depends on the resource type.
pvalue	A pointer to resource data. The actual data depends on the resource type.

Examples:

This sample **ResPluginGetChangesF_t** function for a full editor is from the complete plugin example at the end of this chapter.

```
static void plugin_full_get_changes( ResPluginHandle_t handle, int *pn, void **pvalue )
{
  PluginFullInstance_t *instance = ( PluginFullInstance_t * ) handle;
  char *p;
  PtGetResource( instance->full_widget, Pt_ARG_TEXT_STRING, &p, 0 );
  *pn = strlen( p );
  *pvalue = strdup( p );
}
```

Classification:

QNX Neutrino

See also:

ResPluginAnyChangesF_t, **ResPluginFullCreateF_t**, **ResPluginFullEditor_t**.

ResPluginLoadingF_t

A function you must write to initialize resources shared between plugins in a DLL

Synopsis:

```
typedef int ResPluginLoadingF_t (
  const char *path )
```

Description:

This function is exported in the **ResPlugin_t** structure

This function is called right after the DLL is loaded into PhAB's address space, and should set up any resources that are common to the plugins found in the DLL. In particular, if you use PhAB to build a database of widgets that are going to be used to create instances of various plugins, you should initialize its **AbContext** structure by calling **ApAddContext(&AbContext, path)**

Since it is possible to have different pathnames that point to the same file, this function may be called more than once, but it's guaranteed that the corresponding **ResPluginUnloadingF_t** unloading function will be called the same number of times.

Arguments:

path	The path to the DLL that contains the plugin.

Should return:

This function should return a non-zero value to indicate a serious failure. This will prevent PhAB from attempting to use the resource editors in the DLL.

Examples:

This example loading function is from the complete plugin example at the end of this chapter.

```
static int loaded_count = 0;
static ApDBase_t *db = NULL;

static int plugin_loading( const char *path ) {
  if( loaded_count == 0 && ApAddContext( &AbContext, path ) )
    return -1;

  db = ApOpenDBase( ABM_string_db );
  ++loaded_count;
  return 0;
  }
```

Classification:

QNX Neutrino

See also:

ApAddContext(), **ResPlugin_t**, **ResPluginUnloadingF_t**.

A function you must write to set the resource data in the editor

Synopsis:

```
typedef void ResPluginSetDataF_t(
  ResPluginHandle_t handle,
  int n,
  const void *value,
  const ResPluginFormatData_t *format )
```

Description:

This function is exported in the **ResPluginCommon_t** structure.

This function is called by PhAB to set a data value in the plugin editor, after the plugin instance is created.

The data value is represented by the parameter pair *n* and *value*. How these parameters are passed depends on the data type of the resource. See the description of resource data types for a discussion of how these parameters are passed.

For some datatypes, PhAB will guarantee that it is safe for the plugin to look at the content pointed to by *value*, not only for the duration of this function, but beyond that. That pointer is called PhAB's "master copy" and it is guaranteed to stay a valid pointer until the next call to the function.

If necessary, format information is passed by *format* when the plugin instance is created. The format data depends on the data type. For example, for the **RES_DATATYPE_FLAG** datatype, *format* provides the plugin with the list of possible flag values, the flag manifests, and the associated masks, if any.

In some circumstances, the format data might change for the same plugin instance. In this case PhAB calls the set data function again with a new *format* structure.

Arguments:

handle	The **ResPluginHandle_t** handle returned when the instance of the editor is created with a create function, either **ResPluginFrugalCreateF_t** or **ResPluginFullCreateF_t**.
n	Resource data, depending on the data type. See Resource datatypes.
value	Resource data, depending on the data type. See Resource datatypes.
format	A pointer to a **ResPluginFormatData_t** structure that describes format information required by the data type. See Resource datatypes for a description of how this structure applies to each datatype.

Examples:

This sample function is from the complete plugin example at the end of this chapter.

```
static void plugin_frugal_set_data( ResPluginHandle_t handle, int n, const void *value,
                                    const ResPluginFormatData_t *format )
{
  PluginFrugalInstance_t *instance =
  ( PluginFrugalInstance_t * ) handle;
  instance->n_master = n;
  instance->value_master = value;
  PtSetResource( instance->frugal, Pt_ARG_TEXT_STRING, value, 0 );
}
```

Classification:

QNX Neutrino

See also:

`ResPluginCommon_t`, **`ResPluginFrugalCreateF_t`**, **`ResPluginFullCreateF_t`**, Resource datatypes.

ResPluginToFrontF_t

A function you must write to bring the resource editor window to front

Synopsis:

```
typedef void ResPluginToFrontF_t ( ResPluginHandle_t handle )
```

Description:

This function is exported in the **ResPluginFullEditor_t** structure.

This function is called by PhAB to indicate that the plugin should bring the full editor's window to the front.

Arguments:

handle	The **ResPluginHandle_t** handle returned when the instance of the editor is created with **ResPluginFullCreateF_t**.

Examples:

This sample function is from the complete plugin example at the end of this chapter.

```
static void plugin_full_to_front( ResPluginHandle_t handle )
{
  PluginFullInstance_t *instance = ( PluginFullInstance_t * ) handle;
  instance->exp->to_front( instance->convenience_handle );
}
```

Classification:

QNX Neutrino

See also:

ResPluginFrugalCreateF_t, **ResPluginFullCreateF_t**, **ResPluginFullEditor_t**.

ResPluginUnloadingF_t

A function you must write to release resources shared between plugins in a DLL

Synopsis:

```
typedef void ResPluginUnloadingF_t( void )
```

Description:

This function is exported in the **ResPlugin_t** structure.

This function is called before the DLL is unloaded from PhAB's address space, and should release resources set up in the **ResPluginLoadingF_t**loading function.. Since the loading function may have been called more than once, there is a corresponding call to the unloading function for each successful call to the loading function.

Examples:

This example unloading function is from the complete plugin example at the end of this chapter.

```
static int loaded_count = 0;
static ApDBase_t *db = NULL;

static void plugin_unloading( void ) {
  if( -- loaded_count == 0 ) {
    ApCloseDBase( db );
    db = NULL;
    ApRemoveContext( &AbContext );
    }
  }
```

Classification:

QNX Neutrino

See also:

ResPlugin_t, **ResPluginLoadingF_t**.

PhABResExportFull_t.*set_state()*

A function exported by PhAB to set the state of a window created by create_window()

Synopsis:

```
int set_state  (
  PhabResWindowHandle_t wnd,
  ResFullWindowState_t state );
```

Arguments:

wnd
: The window handle returned by **PhABExportCreateWindowF_t** *create_window()*.

state
: The render action to take. Can be one of:

- RESPLUGIN_STATE_DISABLED — the plugin has no data applied.
- RESPLUGIN_STATE_MATCH_DEFAULT — the plugin data matches the default value for that resource.
- RESPLUGIN_STATE_MATCH_MASTER — the plugin data matches PhAB's value for that resource.
- RESPLUGIN_STATE_MATCH_DEFAULT_MASTER — indicates that the plugin data matches both the default value and PhAB's value for that resource.
- RESPLUGIN_STATE_NO_MATCH — indicates that the data inside the plugin doesn't match either the default value or PhAB's value for that resource.
- RESPLUGIN_STATE_BLOCKED — indicates that the plugin is blocked (has no input).
- RESPLUGIN_STATE_UNBLOCKED — indicates that the plugin is unblocked (has input).

Description:

This function is exported from PhAB in the **PhABResExportFull_t** structure.

You can call this function from a full resource editor to render the window created in *create_window()* in a certain state.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

create_window(), *destroy()*, *get_area()*, *get_res()*, **`PhABResExportFull_t`**, *to_front()*.

`PhABResExportFull_t`.*to_front()*

A function exported by PhAB to bring to the front a window created by create_window()

Synopsis:

```
void to_front  (
  PhabResWindowHandle_t wnd )
```

Arguments:

wnd	The window handle returned by **`PhABExportCreateWindowF_t`** *create_window()*.

Description:

This function is exported from PhAB in the **`PhABResExportFull_t`** structure.

Call this function from the full resource editor to bring its window to the front.

Classification:

Photon

Safety	
Interrupt handler	No
Signal handler	No
Thread	No

See also:

create_window(), *destroy()*, *get_area()*, *get_res()*, **`PhABResExportFull_t`**, *set_state()*.

Chapter 11
Resource editor plugin examples

This chapter contains examples of using the PhAB plugin API to create resource editors. There are two examples:

- Sample string editor — an example frugal and full editor for a string resource type
- Sample external editor — an example of using ped as an external resource editor

A string editor

The following is an example resource editor plugin for editing a string resource. This is taken from the actual PhAB source code. Not shown is the PhAB project which contains this source file and implements the widgets within a picture module.

```
#include <Pt.h>
#include <Ap.h>


/* Local headers */
#include "rstring.h"
#include "abimport.h"
#include "proto.h"

static int plugin_loading( const char *path );
static void plugin_unloading( void );
static void plugin_frugal_set_data( ResPluginHandle_t handle, int n,
    const void *value, const ResPluginFormatData_t *format );
static void plugin_full_set_data( ResPluginHandle_t handle, int n,
    const void *value, const ResPluginFormatData_t *format );
static void plugin_frugal_destroy( ResPluginHandle_t handle );
static void plugin_full_destroy( ResPluginHandle_t handle );
static ResPluginHandle_t plugin_frugal_create
        ( PhABHandle_t phab , const PhABResExportFrugal_t *exp,
          const ResPluginFormatData_t *format,
          int n_default, const void *default_value,
          PtWidget_t *parent,
          int n, const void *value );
static ResPluginHandle_t plugin_full_create
        ( PhABHandle_t phab , const PhABResExportFull_t *exp,
          const ResPluginFormatData_t *format,
          int n_default, const void *default_value,
          PhArea_t *area, char *caption,
          int n, const void *value );
static void plugin_full_disable( ResPluginHandle_t handle );
static void plugin_full_block( ResPluginHandle_t handle, int block );
static void plugin_full_to_front( ResPluginHandle_t handle );
static int plugin_full_any_changes( ResPluginHandle_t handle );
static void plugin_full_get_changes( ResPluginHandle_t handle, int *pn, void **pvalue );
static void plugin_full_get_area( ResPluginHandle_t handle, PhArea_t *area );
static void plugin_full_notify( ResPluginAction_t action, void *data );

/* callbacks */
static int plugin_frugal_changed( PtWidget_t *widget, void *data, PtCallbackInfo_t *cbinfo );
static int plugin_full_resize( PtWidget_t *widget, void *data, PtCallbackInfo_t *cbinfo );
static int plugin_full_changed( PtWidget_t *widget, void *data, PtCallbackInfo_t *cbinfo );
static int plugin_full_done( PtWidget_t *widget, void *data, PtCallbackInfo_t *cbinfo );
static void set_state( PluginFullInstance_t *instance, char *value );

static ResPluginFullEditor_t full_editors[1] =
    {
        {
        {   "string",
            RES_DATATYPE_STRING,
            RESPLUGIN_DATATYPE_VERSION,
            plugin_full_set_data,
            plugin_full_destroy },
        plugin_full_create,
        plugin_full_disable,
        plugin_full_block,
        plugin_full_to_front,
        plugin_full_any_changes,
        plugin_full_get_changes,
        plugin_full_get_area
        }
    };

static ResPluginFrugalEditor_t frugal_editors[1] =
    {
        {
        {   "string",
            RES_DATATYPE_STRING,
            RESPLUGIN_DATATYPE_VERSION,
            plugin_frugal_set_data,
            plugin_frugal_destroy },
        plugin_frugal_create,
        }
    };

static ResPlugin_t tab = {
    plugin_loading,
    plugin_unloading,
    1,
    full_editors,
    1,
    frugal_editors
    };

AOInterface_t string_interfaces[] = {
    { "PhAB Resource Editors", RESPLUGIN_VERSION, &tab },
    { 0, 0, 0 }
    };


static int loaded_count = 0;
static ApDBase_t *db = NULL;

static int plugin_loading( const char *path ) {
  if( loaded_count == 0 && ApAddContext( &AbContext, path ) )
    return -1;

  db = ApOpenDBase( ABM_string_db );
  ++loaded_count;
  return 0;
    }

static void plugin_unloading( void ) {
  if( -- loaded_count == 0 ) {
    ApCloseDBase( db );
    db = NULL;
    ApRemoveContext( &AbContext );
    }
    }

static ResPluginHandle_t plugin_frugal_create
        ( PhABHandle_t phab , const PhABResExportFrugal_t *exp,
          const ResPluginFormatData_t *format,
          int n_default, const void *default_value,
          PtWidget_t *parent,
          int n, const void *value ) {

    PtArg_t args[2];
    PhRect_t offset = { { -1, -1 }, { -1, -1 } };
    PluginFrugalInstance_t *instance;

    instance = calloc( 1, sizeof( *instance ) );
    if( !instance ) return NULL;

    instance->n_default = n_default;
    instance->default_value = default_value;
    instance->n_master = n;
    instance->value_master = value;

    instance->phab = phab;
    instance->exp = exp;

    PtSetArg( &args[0], Pt_ARG_ANCHOR_OFFSETS, &offset, 0 );
    PtSetArg( &args[1], Pt_ARG_TEXT_STRING, value, 0 );
    instance->frugal = ApCreateWidget( db, "string_frugal", 0, 0, 2, args );
    PtAddCallback( instance->frugal, Pt_CB_TEXT_CHANGED, plugin_frugal_changed,
        instance );
    return ( ResPluginHandle_t ) instance;
    }

static void plugin_frugal_set_data( ResPluginHandle_t handle, int n,
    const void *value, const ResPluginFormatData_t *format )
{
    PluginFrugalInstance_t *instance = ( PluginFrugalInstance_t * ) handle;
    instance->n_master = n;
    instance->value_master = value;
    PtSetResource( instance->frugal, Pt_ARG_TEXT_STRING, value, 0 );
}


static int plugin_frugal_changed( PtWidget_t *widget, void *data,
    PtCallbackInfo_t *cbinfo ) {
    PluginFrugalInstance_t *instance = ( PluginFrugalInstance_t * ) data;
    char *p;
    PtGetResource( widget, Pt_ARG_TEXT_STRING, &p, 0 );
    instance->n_master = strlen( p );
    instance->value_master = strdup( p );
    if( instance->exp->common.apply( instance->phab, instance->n_master,
        instance->value_master ) ) {
        /* we matched the default */
        free( instance->value_master );
        instance->value_master = instance->default_value;
        instance->n_master = instance->n_default;
        }
    return Pt_CONTINUE;
    }

static void plugin_frugal_destroy( ResPluginHandle_t handle )
{
    free( ( PluginFrugalInstance_t * ) handle );
}


static ResPluginHandle_t plugin_full_create
        ( PhABHandle_t phab , const PhABResExportFull_t *exp,
          const ResPluginFormatData_t *format,
          int n_default, const void *default_value,
          PhArea_t *area, char *caption,
          int n, const void *value )
{
    PluginFullInstance_t *instance;
    PtWidget_t *parent;
    PhRect_t offset = { { 0, 0 }, { 0, 0 } };
    PhArea_t tarea;
    PtArg_t args[1];
    int start = 0, end = n;

    instance = calloc( 1, sizeof( *instance ) );
    if( !instance ) return NULL;

    instance->n_default = n_default;
    instance->default_value = default_value;
    instance->n_master = n;
    instance->value_master = value;

    instance->phab = phab;
    instance->exp = exp;

    if( !area ) {
        PhRect_t rect;
        PhWindowQueryVisible( 0, 0, 0, &rect );
        tarea.pos.x = rect.ul.x + 100;;
        tarea.pos.y = rect.ul.y + 100;
        tarea.size.w = 340;
        tarea.size.h = 150;
        area = &tarea;
        }
    instance->convenience_handle = exp->create_window( area, caption, 0, &parent,
        plugin_full_notify, instance );

    PtSetParentWidget( parent );
    PtSetArg( &args[0], Pt_ARG_ANCHOR_OFFSETS, &offset, 0 );
    instance->full= ApCreateWidgetFamily( db, "string_full_container", 0, 0, 1, args );
    instance->full_widget = PtWidgetChildFront( instance->full );
    PtAddCallback( instance->full, Pt_CB_RESIZE, plugin_full_resize, instance );
    PtAddCallback( instance->full_widget, Pt_CB_TEXT_CHANGED, plugin_full_changed, instance );
    PtAddCallback( instance->full_widget, Pt_CB_ACTIVATE, plugin_full_done, instance );

    PtSetResource( instance->full_widget, Pt_ARG_TEXT_STRING, value, 0 );
    PtTextSetSelection( instance->full_widget, &start, &end );
    PtRealizeWidget( instance->full );

    set_state( instance, value );

    return ( ResPluginHandle_t ) instance;
}

static void plugin_full_destroy( ResPluginHandle_t handle )
{
    PluginFullInstance_t *instance = ( PluginFullInstance_t * ) handle;
    instance->exp->destroy( instance->convenience_handle );
    free( instance );
}

static void plugin_full_disable( ResPluginHandle_t handle )
{
    PluginFullInstance_t *instance = ( PluginFullInstance_t * ) handle;
    PtArg_t args[3];
    instance->disabled = 1;
    PtSetArg( &args[0], Pt_ARG_FLAGS, Pt_GHOST|Pt_BLOCKED, Pt_GHOST|Pt_BLOCKED );
    PtSetArg( &args[1], Pt_ARG_CURSOR_TYPE, Ph_CURSOR_NOINPUT, 0 );
    PtSetArg( &args[2], Pt_ARG_CURSOR_OVERRIDE, 1, 0 );
    PtSetResources( instance->full, 3, args );
    PtSetResource( instance->full_widget, Pt_ARG_FLAGS, Pt_GHOST|Pt_BLOCKED,
        Pt_GHOST|Pt_BLOCKED );
    instance->exp->set_state( instance->convenience_handle, RESPLUGIN_STATE_DISABLED );
}

static void plugin_full_block( ResPluginHandle_t handle, int block )
{
    PluginFullInstance_t *instance = ( PluginFullInstance_t * ) handle;
    instance->exp->set_state( instance->convenience_handle,
        block ? RESPLUGIN_STATE_BLOCKED : RESPLUGIN_STATE_UNBLOCKED );
}

static int plugin_full_any_changes( ResPluginHandle_t handle )
{
    PluginFullInstance_t *instance = ( PluginFullInstance_t * ) handle;
    char *p;
    PtGetResource( instance->full_widget, Pt_ARG_TEXT_STRING, &p, 0 );
    if( !strcmp( p, instance->value_master ) ) return RESPLUGIN_NO_CHANGES;
    return RESPLUGIN_CHANGES;
}

static void plugin_full_get_changes( ResPluginHandle_t handle, int *pn, void **pvalue )
{
    PluginFullInstance_t *instance = ( PluginFullInstance_t * ) handle;
    char *p;
    PtGetResource( instance->full_widget, Pt_ARG_TEXT_STRING, &p, 0 );
    *pn = strlen( p );
    *pvalue = strdup( p );
}

static void plugin_full_get_area( ResPluginHandle_t handle, PhArea_t *area )
{
    PluginFullInstance_t *instance = ( PluginFullInstance_t * ) handle;
    instance->exp->get_area( instance->convenience_handle, area );
}

static void plugin_full_to_front( ResPluginHandle_t handle )
{
    PluginFullInstance_t *instance = ( PluginFullInstance_t * ) handle;
    instance->exp->to_front( instance->convenience_handle );
```

```
}

static void plugin_full_set_data( ResPluginHandle_t handle, int n, const void *value,
    const ResPluginFormatData_t *format ) {
    PluginFullInstance_t *instance = ( PluginFullInstance_t * ) handle;
    int start = 0, end = n;

    PtSetResource( instance->full_widget, Pt_ARG_TEXT_STRING, value, 0 );
    PtTextSetSelection( instance->full_widget, &start, &end );

    instance->n_master = n;
    instance->value_master = value;
    set_state( instance, value );
    if( instance->disabled ) {
        PtArg_t args[3];
        instance->disabled = 0;
        PtSetArg( &args[0], Pt_ARG_FLAGS, 0, Pt_GHOST|Pt_BLOCKED );
        PtSetArg( &args[1], Pt_ARG_CURSOR_TYPE, Ph_CURSOR_INHERIT, 0 );
        PtSetArg( &args[2], Pt_ARG_CURSOR_OVERRIDE, 0, 0 );
        PtSetResources( instance->full, 3, args );
        PtSetResource( instance->full_widget, Pt_ARG_FLAGS, 0, Pt_GHOST|Pt_BLOCKED );
        }
    }

static int plugin_full_resize( PtWidget_t *widget, void *data, PtCallbackInfo_t *cbinfo ) {
    PtContainerCallback_t *cb = cbinfo->cbdata;
    if( cb->old_dim.w != cb->new_dim.w || cb->old_dim.h != cb->new_dim.h ) {
        PluginFullInstance_t *instance = ( PluginFullInstance_t * ) data;
        PhDim_t dim;
        PhPoint_t pos;
        /* center the instance->full_widget */
        PtWidgetDim( instance->full_widget, &dim );
        pos.x = ( cb->new_dim.w - dim.w ) / 2;
        pos.y = ( cb->new_dim.h - dim.h ) / 2;
        PtSetResource( instance->full_widget, Pt_ARG_POS, &pos, 0 );
        }
    return Pt_CONTINUE;
    }

static int plugin_full_changed( PtWidget_t *widget, void *data, PtCallbackInfo_t *cbinfo ) {
    PluginFullInstance_t *instance = ( PluginFullInstance_t * ) data;
    char *p;
    PtGetResource( widget, Pt_ARG_TEXT_STRING, &p, 0 );
    set_state( instance, p );
    return Pt_CONTINUE;
    }


static void get_value_and_apply( PluginFullInstance_t *instance ) {
    char *p;
    PtGetResource( instance->full_widget, Pt_ARG_TEXT_STRING, &p, 0 );
    instance->n_master = strlen( p );
    instance->value_master = strdup( p );
    if( instance->exp->common.apply( instance->phab, instance->n_master,
        instance->value_master ) ) {
        /* we matched the default */
        free( instance->value_master );
        instance->value_master = instance->default_value;
        instance->n_master = instance->n_default;
        }
    }


static int plugin_full_done( PtWidget_t *widget, void *data, PtCallbackInfo_t *cbinfo ) {
    PluginFullInstance_t *instance = ( PluginFullInstance_t * ) data;
    get_value_and_apply( instance );
    instance->exp->closing( instance->phab );
    instance->exp->destroy( instance->convenience_handle );
    free( instance );
    return Pt_CONTINUE;
    }

static void plugin_full_notify( ResPluginAction_t action, void *notify_data ) {
  PluginFullInstance_t *instance = ( PluginFullInstance_t * ) notify_data;
  switch( action ) {
    case RESPLUGIN_ACTION_APPLY: {
            if( instance->state != RESPLUGIN_STATE_MATCH_MASTER &&
                instance->state != RESPLUGIN_STATE_MATCH_DEFAULT_MASTER ) {
                get_value_and_apply( instance );
        set_state( instance, instance->value_master );
                }
      }
      break;
    case RESPLUGIN_ACTION_CLOSE: {
      instance->exp->closing( instance->phab );
      instance->exp->destroy( instance->convenience_handle );
      free( instance );
      }
      break;
    case RESPLUGIN_ACTION_DEFAULT: {
      PtSetResource( instance->full_widget, Pt_ARG_TEXT_STRING,
        instance->default_value, 0 );
      set_state( instance, instance->default_value );
      }
      break;
    }
  }


static void set_state( PluginFullInstance_t *instance, char *value ) {
    if( !strcmp( value, instance->default_value ) ) {
        if( strcmp( value, instance->value_master ) )
            instance->state = RESPLUGIN_STATE_MATCH_DEFAULT;
        else instance->state = RESPLUGIN_STATE_MATCH_DEFAULT_MASTER;
        }
    else {
        if( strcmp( value, instance->value_master ) )
            instance->state = RESPLUGIN_STATE_NO_MATCH;
        else instance->state = RESPLUGIN_STATE_MATCH_MASTER;
        }
    instance->exp->set_state( instance->convenience_handle, instance->state );
    }
```

An external editor

The following is an example of using an external application as a resource editor in PhAB. We will use **ped** to edit the *Pt_ARG_TEXT_STRING* resource for the **PtButton** widget.

To use this example, compile the two files listed below, **external_multi.h** and **external_multi.c**, into a DLL named **external_multi.so**.Copy the **external_multi.so** file into the **plugins/resource** directory below the location that contains PhAB's executable (usually **/usr/photon/appbuilder/plugins/resource**).Edit the **res_editors.def** in the PhAB executable directory to contain the lines:

```
e=external_multi
p=
F=multi@external_multi.so
```

Edit the file **def_res.def** in the same directory to contain the line:

```
external_multi
```

Edit the **ptpalette.pal** file in the same directory to specify **external_multi** as the resource editor for *Pt_ARG_TEXT_STRING* for the **PtButton** widget. To do this, in the **PtButton** section of the file, change the *Pt_ARG_TEXT_STRING* line to:

```
r=Pt_ARG_TEXT_STRING,Button  Text,3011,3002,0,multi/external_multi,NULL
```

Code listing for `external_multi.h`

```
#ifndef __ALREADY_INCLUDED_H
#define __ALREADY_INCLUDED_H

#include <photon/res_plugin_api.h>
#include <aoi/aoi.h>

#include <pthread.h>

typedef struct {
  int n_master;
  void *value_master;
  int n_default;
    void *default_value;

    PhABHandle_t phab;
    PhABResExportFull_t *exp;

    int pid, phab_waiting;
    char *path;
    pthread_t monitor;
  } PluginFullInstance_t;

#endif
```

Code listing for `external_multi.c`

```
#include <Pt.h>
#include <stdio.h>
#include <sys/stat.h>
#include <sys/netmgr.h>
#include <time.h>
#include <signal.h>


/* Local headers */
#include "external_multi.h"

static int plugin_loading( const char *path );
static void plugin_unloading( void );
static void plugin_full_set_data( ResPluginHandle_t handle, int n, const void *value,
                                  const ResPluginFormatData_t *format );
static void plugin_full_destroy( ResPluginHandle_t handle );
static ResPluginHandle_t plugin_full_create
        ( PhABHandle_t phab , const PhABResExportFull_t *exp,
          const ResPluginFormatData_t *format,
          int n_default, const void *default_value,
          PhArea_t *area, char *caption,
          int n, const void *value );
static void plugin_full_disable( ResPluginHandle_t handle );
static void plugin_full_block( ResPluginHandle_t handle, int block );
static void plugin_full_to_front( ResPluginHandle_t handle );
static int plugin_full_any_changes( ResPluginHandle_t handle );
static void plugin_full_get_changes( ResPluginHandle_t handle, int *pn, void **pvalue );
static void plugin_full_get_area( ResPluginHandle_t handle, PhArea_t *area );


static void child_exit( int sig );
static void *monitor_f( void * data );
static void get_changes_from_file( PluginFullInstance_t *instance, int *pn,
                                   char **value );
static void apply_from_file( PluginFullInstance_t *instance );
static void emit_wm_event( PluginFullInstance_t *instance, unsigned long event_type );
static void was_file_changed( PluginFullInstance_t *instance, int *modification_time );

static ResPluginFullEditor_t full_editors[1] =
    {
        {
        {   "multi",
            RES_DATATYPE_MULTI,
            RESPLUGIN_DATATYPE_VERSION,
            plugin_full_set_data,
            plugin_full_destroy },
        plugin_full_create,
        plugin_full_disable,
        plugin_full_block,
        plugin_full_to_front,
        plugin_full_any_changes,
        plugin_full_get_changes,
        plugin_full_get_area
        }
    };

static ResPlugin_t tab = {
    plugin_loading,
    plugin_unloading,
    1,
    full_editors,
    0,
    NULL
    };

AOInterface_t interfaces[] = {
    { "PhAB Resource Editors", RESPLUGIN_VERSION, &tab },
    { 0, 0, 0 }
    };


static int plugin_loading( const char *path ) {
    signal( SIGCHLD, child_exit );
    return 0;
    }

static void plugin_unloading( void ) {
    }

static ResPluginHandle_t plugin_full_create
        ( PhABHandle_t phab , const PhABResExportFull_t *exp,
          const ResPluginFormatData_t *format,
          int n_default, const void *default_value,
          PhArea_t *area, char *caption,
          int n, const void *value )
{
    PluginFullInstance_t *instance;
    FILE *fp;
    char path[PATH_MAX];
    time_t t;
    char *argv[3];

    time( &t );

    /* put the data in a file */
    sprintf( path, "/tmp/%ld.txt", (long) t );
    fp = fopen( path, "w" );
    if( !fp ) return NULL;
    if( value ) fwrite( (char*)value, 1, n, fp );
    fclose( fp );

    instance = calloc( 1, sizeof( *instance ) );
    if( !instance ) return NULL;

    instance->n_default = n_default;
    instance->default_value = default_value;
    instance->n_master = n;
    instance->value_master = value;
    instance->phab = phab;
    instance->exp = exp;

    argv[0] = "ped";
    argv[1] = path;
    argv[2] = NULL;
    instance->pid = spawnp( argv[0], 0, NULL, NULL, argv, NULL );
    if( instance->pid == -1 ) {
        free( instance );
        unlink( path );
        return NULL;
        }

    instance->path = strdup( path );
    pthread_create( &instance->monitor, NULL, monitor_f, (void*) instance );

    return ( ResPluginHandle_t ) instance;
}

static void plugin_full_destroy( ResPluginHandle_t handle )
{
    PluginFullInstance_t *instance = ( PluginFullInstance_t * ) handle;

    if( instance->pid != -1 ) {
        /* the child process is still alive, but the data inside has been asked
           for already */
        kill( instance->pid, SIGTERM );
        }

    pthread_cancel( instance->monitor );
    pthread_detach( instance->monitor );

    unlink( instance->path );
    free( instance->path );
    free( instance );
}

static void plugin_full_disable( ResPluginHandle_t handle )
{
    PluginFullInstance_t *instance = ( PluginFullInstance_t * ) handle;

    /* the changes inside the editor has already been taken into account */

    /* close the external application if still open */
    /* we need to do this because we cannot put a new data into the external
       application ( ped ), without re-spawing it */
    if( instance->pid != -1 ) {
        kill( instance->pid, SIGTERM );
        instance->pid = -1;

        pthread_cancel( instance->monitor );
        pthread_detach( instance->monitor );
        }

    /* we have a disabled instance ( the instance pointer still valid ),
       but the pid and monitor have been destroyed */
}

static void plugin_full_block( ResPluginHandle_t handle, int block )
{
}

static int plugin_full_any_changes( ResPluginHandle_t handle )
{
    PluginFullInstance_t *instance = ( PluginFullInstance_t * ) handle;

    if ( instance->pid == -1 ) return RESPLUGIN_NO_CHANGES;
    else {
        emit_wm_event( instance, Ph_WM_TOFRONT );
        emit_wm_event( instance, Ph_WM_CLOSE );
        instance->phab_waiting = 1;
        return RESPLUGIN_WAIT;
        }
}
```

```
static void plugin_full_get_changes( ResPluginHandle_t handle, int *pn, void **pvalue )
{
    PluginFullInstance_t *instance = ( PluginFullInstance_t * ) handle;

    /* the changes are in the instance->path */
    get_changes_from_file( instance, pn, ( char ** ) pvalue );
}

static void plugin_full_get_area( ResPluginHandle_t handle, PhArea_t *area )
{
    /* not used, let the external editor memorize/restore its own area */
}

static void plugin_full_to_front( ResPluginHandle_t handle )
{
    PluginFullInstance_t *instance = ( PluginFullInstance_t * ) handle;
    emit_wm_event( instance, Ph_WM_TOFRONT );
}

static void plugin_full_set_data( ResPluginHandle_t handle, int n, const void *value,
                                  const ResPluginFormatData_t *format ) {
    PluginFullInstance_t *instance = ( PluginFullInstance_t * ) handle;
    FILE *fp;

    instance->n_master = n;
    instance->value_master = value;

    /* re-spawn the external application and the monitor thread */
    fp = fopen( instance->path, "w" );
    if( value ) fwrite( (char*)value, 1, n, fp );
    fclose( fp );

    instance->pid = spawnl( P_NOWAIT, "ped", "ped", instance->path, NULL );
    pthread_create( &instance->monitor, NULL, monitor_f, (void*) instance );
    }


static void child_exit( int sig ) {
    int status;
    wait( &status );
    }

static void *monitor_f( void * data ) {
    PluginFullInstance_t *instance = ( PluginFullInstance_t * ) data;
    int mod = 0;

    for( ; ; ) {

        /* check if instance->pid still exists */
        if( kill( instance->pid, 0 ) == -1 ) {
            /* the child has exited */
            instance->pid = -1;
            if( instance->phab_waiting ) {
                int n, answer;
                char *value;
                get_changes_from_file( instance, &n, &value );
                if( n == instance->n_master && !memcmp( value,
                                                         instance->value_master,
                                                         n ) )
                    answer = RESPLUGIN_NO_CHANGES;
                else answer = RESPLUGIN_CHANGES;

                PtEnter( Pt_EVENT_PROCESS_ALLOW );
                instance->exp->answer_changes( instance->phab, answer, n, value );
                /* the answer_changes() is implying that the editor has been closed */
                PtLeave( Pt_EVENT_PROCESS_ALLOW );
                }
            else {

                /* check the modification time on the file again,
                   because maybe the user did a Exit->Save or not->Save */
                was_file_changed( instance, &mod );

                PtEnter( Pt_EVENT_PROCESS_ALLOW );
                instance->exp->closing( instance->phab );
                PtLeave( Pt_EVENT_PROCESS_ALLOW );
                }

            unlink( instance->path );
            free( instance->path );
            free( instance );
            pthread_detach( pthread_self() );
            return NULL;
            }

        /* check if the instance->path has changed */
        was_file_changed( instance, &mod );

        delay( 200 );
        }

    pthread_detach( pthread_self() );
    return NULL;
    }

static void was_file_changed( PluginFullInstance_t *instance, int *modification_time ) {
    struct stat st;
    if( stat( instance->path, &st ) == 0 ) {
        if( *modification_time != st.st_mtime ) {

            if( *modification_time ) {
                /* the file was changed - call into phab with the apply method */
                apply_from_file( instance );
                }

            *modification_time = st.st_mtime;
            }
        }
    }

static void get_changes_from_file( PluginFullInstance_t *instance, int *pn,
                                   char **value ) {
    FILE *fp;
    int n;
    char *v;

    fp = fopen( instance->path, "r" );
    if( !fp ) return;

    fseek( fp, 0, SEEK_END );
    n = ftell( fp );
    fseek( fp, 0, SEEK_SET );

    v = malloc( n + 1 );
    fread( v, 1, n, fp );
    v[ n ] = 0;

    fclose( fp );

    *pn = n;
    *value = v;
    }

static void apply_from_file( PluginFullInstance_t *instance ) {
    int n;
    char *values;

    get_changes_from_file( instance, &n, &values );
    instance->n_master = n;
    instance->value_master = values;

    PtEnter( Pt_EVENT_PROCESS_ALLOW );
  if( instance->exp->common.apply( instance->phab, instance->n_master,
      instance->value_master ) ) {
    /* we matched the default */
    free( instance->value_master );
    instance->value_master = instance->default_value;
    instance->n_master = instance->n_default;
    }
    PtLeave( Pt_EVENT_PROCESS_ALLOW );
    }

static PhConnectId_t get_connect_id( pid_t pid )
{
   PhConnectInfo_t buf;
   PhConnectId_t id = 0;

   while ((id = PhGetConnectInfo(id, &buf)) != -1
          && (buf.pid != pid ||
                         ND_NODE_CMP(buf.nid, ND_LOCAL_NODE)))
      ++id;

   return id;
}

static void emit_wm_event( PluginFullInstance_t *instance, unsigned long event_type ) {
    PhWindowEvent_t event;
    PhConnectId_t connection_id;

    connection_id = get_connect_id( instance->pid );

    memset( &event, 0, sizeof (event) );
    event.event_f = event_type;
    PtForwardWindowTaskEvent( connection_id, &event );
    }
```

Appendix A

Miscellaneous Widget-Building Tips

Here are some general widget-building tips (in no particular order):

- Never call *PgSetRegion()*.
- Never call *PtDamageWidget()* from a Draw method.
- Never call *Pg...* functions from anywhere except the Draw method.
- You don't need to call *PtDamageWidget()* after calling *PtRealizeWidget()*.
- In the modify functions, don't call the widget's Extent method directly. Instead, set Pt_WIDGET_RESIZE in the widget's *Pt_ARG_FLAGS* resource; the widget library will calculate the widget's extent and perform any visual cleanup at the appropriate time.
- If you must calculate the extent immediately, call *PtExtentWidget()*, not your widget's Extent method.
- Use *PtSetResources()* to set the resources of subordinate (procreated) widgets.
- Avoid calling *PgFlush()* — the library will call it automatically when required.
- Never call *PtBkgdHandlerProcess()* from a Draw method.
- It's generally best to create subordinate children in your Defaults method; this way they can be modified as needed via resources before being realized. Another upside to this is that the widgets exist at the time the parent is being realized.

  When creating the widgets in methods from Initialization to Connect, the widgets don't exist at the time of realization and may be skipped. In this case, you need to have a Realized method in which you realize the children you want visible.

  It's also important to have an Unrealized method in which you destroy the subordinates *or* you must check to make sure you don't already have the subordinates in your Initialization method. Failing to do either of these will likely produce a memory leak.
- If you have an Extent method, it must actually calculate the extent of the widget. It's a fairly common mistake to do lots of dimension, layout, and area calculations and then forget to actually set the widget's extent. Setting the extent is usually accomplished via calling:

  ```
  PtSuperClassExtent( PtBasic "or another superclass", widget);
  ```
- If your widget's subordinate children aren't being displayed, check the widget's resize policy (*Pt_ARG_RESIZE_FLAGS*). This resource indicates whether or not the widget's size is adjusted based on the size and location of its children.
- If you have a Draw method defined, make sure you call *PtClipRemove()* if you called *PtClipAdd()* earlier in the function. Don't adjust the draw offset via *PgSetTranslation()* because the translation is already set up before your Draw function is called. If you really do want to change the translation, change it back before exiting your Draw method.

Appendix B

What's New

In this appendix. . .

This appendix describes what's new in the Widget Building Guide in each release.

- What's new in Photon for QNX Neutrino 6.3.0 Service Pack 1
- What's new in Photon for QNX Neutrino 6.3
- What's new in Photon for QNX Neutrino 6.2.1
- What's new in Photon for QNX Neutrino 6.2.0

What's new in Photon for QNX Neutrino 6.3.0 Service Pack 1

Two new functions:

- *PtGetCallbackList()*
- *PtInvokeCallbackType()*

What's new in Photon for QNX Neutrino 6.3

Resource editor plugin API

The chapters dealing with the resource editor plugin API are new. These chapters are:

- Creating custom resource editors
- The resource editor API
- Resource editor plugin example

The new function *PtFindResouce()* replaces *PtFindResourceRecord()*, which is deprecated.

Binding Widgets into PhAB — There is a new **`ushort`** resource type.

What's new in Photon for QNX Neutrino 6.2.1

Errata

PtWidgetAbove()	Corrected the description.

What's new in Photon for QNX Neutrino 6.2.0

Overview

- Anchoring is now done by **`PtWidget`** instead of **`PtContainer`**.

Anatomy of a Widget

- The section on **`PtResourceRec_t`** resource records includes new *mod_f* special values (Pt_CHANGE_CANVAS and Pt_CHANGE_CANVAS_REDRAW) and a new *arg_value* type (Pt_ARG_IS_IMAGE).
- Widget classes now include a textual description. See "Widget class resource table."
- *PtContainerChildRedirect()* no longer exists; use the Pt_SET_CHILD_REDIRECT_F manifest in your widget's class-creation function instead. See "Container widget anatomy."

Creating a List Widget

- The prototypes have changed for *PtSuperClassGenListMouse()* and *PtSuperClassGenListSelect()*.

Creating a Tree Widget

- When expanding an item, the Tree Item State method returns zero to permit the expansion, or a nonzero value to prevent it — *PtGenTreeExpand()* returns this value. When collapsing an item, the Tree Item State method returns a nonzero value if the item is destroyed, or zero if the item still exists — *PtGenTreeCollapse()* returns this value (the prototype has changed).
- *PtGenTreeAddAfter()* and *PtGenTreeAddFirst()* now return 0 on success, or -1 if the item is already in a tree.
- *PtGenTreeFreeItems()* now returns 0 on success, or -1 if the items are still in a tree.

Binding Widgets into PhAB

The method for binding widgets into PhAB has changed. If PhAB can open the shared object for your widget, it can display your widget correctly, and you can work with them "live."

Widget Building Library API

New functions:

- *PtAnchorDeregister()* — replaces *PtContainerDeregister()*.
- *PtAnchorRegister()* — replaces *PtContainerRegister()*.
- *PtResizeCanvas()* — similar to *PtAttemptResize()*, but easier to use.
- *PtContainerChildRedirect()* no longer exists; use the Pt_SET_CHILD_REDIRECT_F manifest in your widget's class-creation function instead. See "Container widget anatomy" in the Anatomy of a Widget chapter.
- *PtGetAnchoredExtent()* no longer exists; anchors are handled by the widget library.
- *PtInvokeResizeCallbacks()* is now a **`void`** function. It assumes that the widget passed to it is a container.

Miscellaneous Widget-Building Tips

Various tips have been added.

Glossary

accelerator

See **hotkey**.

activate

A widget is usually *activated* when you release a mouse button while pointing at an **armed** widget.

active window

The window that currently has **focus**.

anchor offset

The distance between the edges of a widget and the parent widget it's anchored to.

anchor

A constraint mechanism used to manage what happens to a widget when its parent is expanded or contracted. For example, a pane that's anchored to the sides of a window expands or contracts as the window's size is changed.

application region

A **region** that belongs to a Photon application (as opposed to a Photon system process, such as the window manager, graphics drivers, etc.). An application region is usually placed behind the **device region**. Also called a **window region**.

argument list

An array of type `PtArg_t` used when setting and getting widget resources.

arm

A widget is usually *armed* when you press a mouse button while pointing at it.

backdrop

An image that's displayed as a background on your screen.

backdrop region

A region placed behind all windows to display a background image.

balloon

A small box that pops up to define or explain part of the user interface. A balloon is displayed when the pointer pauses over a widget.

bitmap

A color picture consisting of one or more **bitplanes**.

bitplane

An array of bits representing pixels of a single color in a **bitmap**.

blit

An operation that moves an area of a graphics context (e.g. the screen) to another area on the same or a different context.

callback

A **callback function** or a **callback resource**.

callback function

Code connecting an application's user interface to its code. For example, a callback is invoked when you press a button.

callback resource

A **resource** that specifies a list of functions and their client data to be called when a certain action occurs.

canvas

The part of a widget that's used for drawing. For `PtWidget`, this is the area inside the widget's borders. For `PtBasic` and its descendants, the canvas is the area inside the widget's border and **margins**. Other widgets, such as `PtLabel`, may define additional margins.

class

See **widget class**.

class hierarchy

The relationships between all of the widget classes.

client data

Any arbitrary data the application may need to provide to a callback function.

clipping list

An array of rectangles used to restrict output to a particular area.

clipping rectangle

A rectangle used to restrict output to a particular area.

CMY value

A color expressed as levels of cyan, magenta, and yellow.

CMYK value

A color expressed as levels of cyan, magenta, yellow, and black.

code-type link callback

In a PhAB application, an application function that's called when a widget's callback list is invoked.

color depth

The number of bits per pixel for a screen or pixmap.

Common User Access

See **CUA**.

compose sequence

A sequence of key presses that can be used to type a character that might not appear on the keyboard.

console

One of nine virtual screens on the **desktop**. Also called a **workspace**.

consume

When a widget has processed an event and prevents another widget from interacting with the event, the first widget is said to have **consumed** the event.

container

A widget that can have other widgets as children. For example, `PtWindow`, `PtGroup`, and `PtOSContainer`.

cooked event

A key or pointer event that has been assigned a location in the Photon event space. Also called a **focused event**.

CUA

Common User Access — a standard that defines how you can change focus by using the keyboard.

current item

The item in a list or tree widget that will be selected (or perhaps unselected) when you press Enter or Space. It's typically drawn with a blue dotted line around it when its widget has focus.

cursor

An indicator of a position on a screen, such as a **pointer** or an insertion point in a text field.

damaged

Whenever a widget needs to be redisplayed due to a change in the window (e.g. the widget is changed, moved, or **realized**), it's said to be *damaged*.

dead key

A key that, when pressed, doesn't produce a symbol, but initiates a **compose sequence**.

default placement

The placement of a region when no siblings are specified. The opposite of **specific placement**.

desktop

The virtual screen, consisting of nine **consoles** or **workspaces**.

device region

The **region** located in the middle of the **event space**, with **application regions** behind it and **driver regions** in front of it (from the user's point of view).

dialog module

A PhAB **module** similar to a **window module**, except that a dialog module can have only one instance per process.

direct-color

A color scheme in which each pixel is represented by an RGB value. Contrast **palette-based**.

disjoint parent

A disjoint widget that's the ancestor of another widget.

disjoint widget

A widget that can exist without a parent. If a disjoint widget has a parent, it can exist outside its parent's canvas. For example, `PtWindow`, `PtMenu`, and `PtRegion` are disjoint widgets, but `PtButton`, `PtBkgd`, and `PtRect` aren't.

A disjoint widget owns regions that aren't children of its parent's regions. Any clipping set by the parent of a disjoint widget isn't applied to the disjoint widget. The regions of disjoint widgets are sensitive and opaque to expose events.

dithering

A process whereby pixels of two colors are combined to create a texture or a blended color.

draw context

A structure that defines the flow of the draw stream. The default draw context emits draw events to graphics drivers. **Print contexts** and **memory contexts** are types of draw contexts.

draw stream

A series of tokens that are dispatched via draw events and can be collected by a rendering engine such as a graphics driver.

driver region

A **region** created by a driver, usually placed in front of the **device region**.

encapsulation driver

A program that displays Photon graphical output inside another windowing system such as the X Window System.

event

A data structure that represents an interaction between you and an application or between applications. Events travel through the event space either toward you or away (i.e. toward the **root region**).

event compression

The merging of events such that the application sees only their latest values. The application doesn't have to process many unnecessary events.

event handler

A callback function that lets an application respond directly to Photon events, such as dragging events.

event mask

A set of event types that are of interest to an **event handler**. When one of these events occurs, the event handler is invoked.

event space

An abstract, three-dimensional space that contains regions — from the root region at the back to the graphics region at the front. You sit outside the event space, looking in from the front. Events travel through the event space either toward the root region or toward you.

exported subordinate child

A widget created by a container widget (as opposed to an application) whose resources you can access only through the parent.

exposure

Typically occurs when a **region** is destroyed, resized, or moved. Expose events are sent to applications to inform them when the contents of their regions need to be redisplayed.

extent

A rectangle that describes the outermost edges of a widget.

File Manager

The Photon File Manager (PFM), an application used to maintain and organize files and directories.

focus

A widget that has *focus* will receive any key events collected by its window.

focus region

A region placed just behind the **device region** by the **Photon Window Manager** that lets it intercept key events and direct them to the **active window**.

focused event

A key or pointer event that has been assigned a location in the Photon event space. Also called a **cooked event**.

folder

In the Photon File Manager, a metaphor for a directory.

GC

See **graphics context**.

geometry negotiation

The process of determining the layout for a widget and its descendants, which depends on the widget's layout policy, any size set for the widget, and the dimensions and desired positions of each of the widget's children.

global header file

A header file that's included in all code generated by PhAB for an application. The global header file is specified in PhAB's Application Startup Information dialog.

graphics driver

A program that places a region that's sensitive to draw events on the user's side of the device region, collects draw events, and renders the graphical information on the screen.

graphics context (GC)

A data structure that defines the characteristics of primitives, including foreground color, background color, line width, clipping, etc.

Helpviewer

A Photon application for viewing online documentation.

hotkey

A special key or keychord that invokes an action (such as a menu item) without actually selecting a widget. Also called an **accelerator**. Contrast **keyboard shortcut**.

hotspot

The part of the pointer that corresponds to the coordinates reported for the pointer (e.g. the intersection of crosshairs, or the tip of the arrow of the basic pointer).

HSB

Hue-Saturation-Brightness color model.

HSV

Hue-Saturation-Value color model.

icon module

A PhAB module that associates icons with an application.

image

A rectangular array of color values, where each element represents a single pixel. See also **direct-color** and **palette-based**.

initialization function

In a PhAB application, a function that's called before any widgets are created.

input driver

A program that emits, and is the source of, key and/or pointer events.

input group

A set of input and output devices. There's typically one input group per user.

input handler (or input-handling function)

A function that's hooked into Photon's main event-processing loop to handle messages and **pulses** sent to the application by other processes.

instance

A concrete example of an abstract class; for example, "Lassie" is an instance of the class "dog." In Photon, an instance is usually a widget instance; for example, a pushbutton is an instance of the `PtButton` widget class. When an instance of a widget is created, the initial values of its **resources** are assigned.

instance name

In PhAB, a string that identifies a particular instance of a widget so that you can access the instance in your application's code.

instantiation

The action of creating an **instance** of a widget class in an application.

internal link

A PhAB mechanism that lets a developer access a PhAB module directly from an application's code.

Image Viewer

A Photon application (`pv`) that displays images.

key modifier

A flag in a key event that indicates the state of the corresponding **modifier key** when another key was pressed.

keyboard driver

A program that gets information from the keyboard hardware, builds Photon key events, and emits them towards the root region.

keyboard shortcut

A key that selects a menu item. The shortcut works only if the menu is displayed. Contrast **hotkey**.

language database

A file that contains the text strings used in a PhAB application; a language database makes it easier to create multilingual applications with PhAB's language editor.

link callback

A mechanism that connects different parts of a PhAB application. For example, a link callback can be invoked to display a dialog when a button is pressed.

margin

The area between a widget's border and **canvas**.

memory context

A **draw context** in which Photon draw events are directed to memory for future displaying on the screen, as opposed to a printer (**print context**) or to the screen directly (the default draw context).

menu module

A PhAB module used to create a menu.

method

A function that's internal to a widget class and invoked under specific conditions (e.g. to draw the widget). Methods are provided as pointers to functions in widget class records.

modifier key

A key (such as Shift, Alt, or Ctrl) used to change the meaning of another key.

module

An object in PhAB that holds an application's widgets. PhAB modules include windows, menus, icons, pictures, and dialogs.

module-type link callback

A link callback that displays a PhAB module.

mouse driver

A program that gets information from the pointer hardware, builds Photon raw pointer events, and emits them towards the root region.

opaque

The state of a region with regard to events. If a region is *opaque* to an event type, any event of that type that intersects with the region has its rectangle set adjusted to clip out the intersecting area. The region prevents the event from passing through.

palette

An array of colors. A **hard palette** is in hardware; a **soft palette** is in software.

palette-based

A color scheme in which each pixel is represented by an index into a palette. Contrast **direct-color**.

PDR

See **Press-drag-release**.

PFM

See **Photon File Manager**.

PhAB

Photon Application Builder. Visual design tool that generates the code required to implement a user interface.

phditto

A utility that accesses the Photon workspace on a remote node. See also **ditto**.

Phindows

Photon in Windows. An application that accesses a Photon session from a Microsoft Windows environment.

Photon File Manager (PFM)

An application used to maintain and organize files and directories.

Photon Manager or server

The program that maintains the Photon event space by managing regions and events.

Photon Terminal

An application (`pterm`) that emulates a character-mode terminal in a Photon window.

Photon Window Manager (PWM)

An application that manages the appearance of window frames and other objects on the screen. For example, the window manager adds the resize bars, title bar, and various buttons to an application's window. The window manager also provides a method of focusing keyboard events.

picture module

A PhAB module that contains an arrangement of widgets that can be displayed in another widget or used as a widget database.

pixmap

A **bitmap** or **image**.

plane mask

A mask used to restrict graphics operations to affect only a subset of color bits.

point source

A single-point **rectangle set** used as the source of an event.

pointer

An object on the screen that tracks the position of a pointing device (e.g. a mouse, tablet, track-ball, or joystick). Photon has several pointers indicating various states: Basic, Busy, Help, Move, Resize, I-beam, No-input.

Press-drag-release (PDR)

A method of selecting a menu item by pressing down a mouse button while pointing to a menu button, dragging until the desired item is highlighted, and releasing the mouse button.

print context

A **draw context** in which Photon draw events are directed to a file, as opposed to the screen (the default draw context) or to memory (**memory context**).

printer driver

A program that converts Photon draw stream format into a format suitable for a printer, including PostScript, Hewlett-Packard PCL, and Canon.

procreated widget

A widget created by another widget (as opposed to an application), such as the `PtList` and `PtText` created by a `PtComboBox`. Also known as a **subordinate child**.

pterm

A Photon Terminal; an application that emulates a character-mode terminal in a Photon window.

pulse

A small message that doesn't require a reply; used for asynchronous communication with a Photon application.

pv

See **Image Viewer**.

PWM

See **Photon Window Manager**.

raw event

An input event that hasn't been assigned a location in the Photon event space. Also called an **unfocused event**.

raw callback

A function that lets an application respond directly to Photon events such as dragging events. Also called an **event handler**.

realize

To display a widget and its descendants, possibly making them interactive.

rectangle set

An array of nonoverlapping rectangles associated with an event.

region

A rectangular area within the Photon event space that's used by an application for collecting and emitting events.

resize policy

A rule that governs how a widget resizes itself when its contents change.

resource

An attribute of a widget, such as fill color, dimensions, or a callback list.

root region

The region at the very back of the Photon event space.

sensitive

The state of a region with regard to events. If a region is *sensitive* to a particular type of event, the region's owner collects a copy of any such event that intersects with the region.

setup function

A function that's called after a PhAB module is created.

shelf

An application that attaches areas to the outside edge of the screen. You can add plugins to customize these areas, such as a taskbar, launcher, clock, and magnifier.

Snapshot

A Photon application for capturing images of the screen.

specific placement

The placement of a region when one or more siblings are specified. The opposite of **default placement**.

subordinate child

A widget created by another widget (as opposed to an application), such as the `PtList` and `PtText` created by a `PtComboBox`. Also known as a **procreated widget**.

table-of-contents (TOC) file

In the Photon **Helpviewer**, a file that describes a hierarchy of help topics.

taskbar

A shelf plugin that displays icons representing the applications that are currently running.

tile

A data structure used to build linked lists of rectangles, such as a list of the damaged parts of an interface.

topic path

Help information identified by a string of *titles* that are separated by slashes.

topic root

A topic path that's used as a starting point for locating help topics.

topic tree

A hierarchy of help information.

translation file

A file containing translated strings for a PhAB application. There's one translation file per language supported by the application.

unfocused event

See **raw event**.

Unicode

The ISO/IEC 10646 16-bit encoding scheme for representing the characters used in most languages.

UTF-8

The encoding for **Unicode** characters, where each character is represented by one, two, or three bytes.

widget

A component (e.g. a pushbutton) in a graphical user interface.

widget class

A template for widgets that perform similar functions and provide the same public interface. For example, `PtButton` is a widget class.

widget database

In PhAB, a module containing widgets that can be copied at any time into a window, dialog, or other container.

widget family

A hierarchy of widget *instances*. For example, a window and the widgets it contains.

widget instance

See **instance**.

window frame region

A region that PWM adds to a window. It lets you move, resize, iconify, and close the window.

Window Manager

See **Photon Window Manager**.

window module

A PhAB module that's instantiated as a `PtWindow` widget.

window region

A region that belongs to an application window.

work procedure

A function that's invoked when there are no Photon events pending for an application.

workspace

See **console**.

workspace menu

A configurable menu that's displayed when you press or click the right mouse button while pointing at the background of the desktop.

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