C++Builder™ 6 Developer's Guide

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Chapter 5

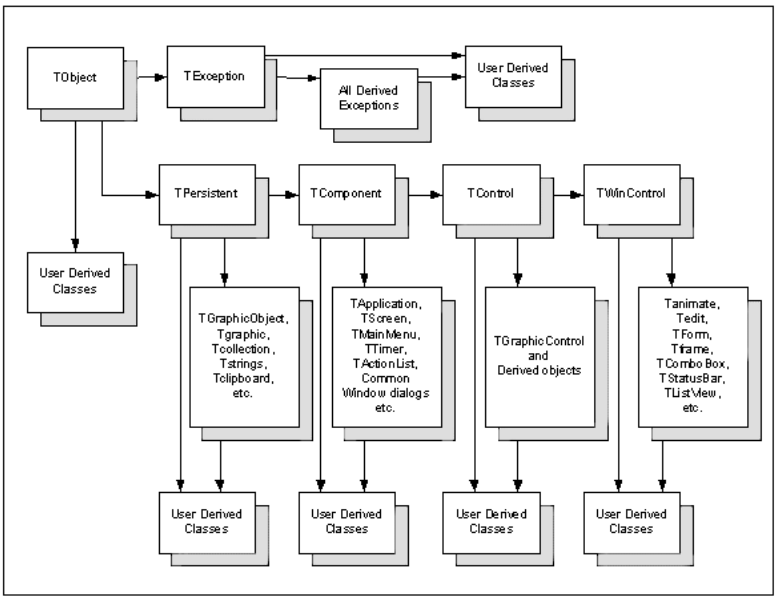
The VCL Explored

Introduction to VCL Architecture

The Visual Component Library (VCL) is the core set of objects C++Builder 6 offers to users on Microsoft Windows-based operating systems. This chapter describes features of the VCL framework and some frequently used components, while the next chapter presents advanced features and components in an attempt to enable readers to draw on the power of VCL in their Windows-based applications. Together, the two chapters cover most of the standard VCL functionality. However, specialized components like database access, Web services, and Internet components are reserved for later chapters where they are covered in depth. To enable developers to port their code between Windows-based operating systems and Linux, C++Builder 6 offers a separate set of components, called CLX, Component Library X-platform (Cross platform), which is the subject of another chapter.

The VCL is a library of classes that encapsulate the Microsoft Windows application programming interface (API) using the object-oriented approach. VCL is architected in such a way that both Delphi (Object Pascal) and C++Builder (C++) users can use it similarly and effectively. In addition to the visual components (as the name suggests), VCL provides powerful non-visual classes to make itself a real rapid application eevelopment (RAD) framework. Refer to the VCL architecture in Figure 5-1 on the following page.

Figure 5-1



VCL is more of a framework rather than just a component library. The features provided and supported by this framework include the following:

- VCL components are based on properties, methods, and events. Properties describe the state of the object at any point of time that can be set during design time and often at run time. Methods operate on these properties to enable the external world to control and manipulate the properties. The events are triggered by either user actions or system actions. Examples of events include those generated by Windows messages or user keystrokes.
- VCL components can be manipulated during design time or during execution time of the application. Windows GUI applications are comprised of forms and components placed on the form. The state of the components and the form at any time can be saved to a form file (*.dfm) and restored in another programming session.
- VCL components encapsulate the Windows API and messages in such a way that the standard Windows message processing architecture is not visible to the developer; rather, a more sophisticated and object-based architecture is presented.
- The VCL framework enables developers to implement custom components for specialized tasks and enhance the functionality of the framework itself. The custom components can also be stored in a repository for later reuse or sharing between developers.

- VCL does not interfere with the standard Windows development architecture. Programmers who wish to use this traditional architecture can still do so. This also means that the core Windows API functions can be called directly, bypassing the VCL framework. Developers can also freely make direct Windows API calls from within a VCL-based application.
- Having originated from Object Pascal, VCL also provides a flavor of Delphi-based objects, in addition to providing full C++ language support. Thus, VCL is a framework that supports two powerful language environments, C++ and Object Pascal. The power of VCL is almost identical between Delphi and C++Builder, although some differences exist in order to preserve the languages' identity and characteristics.
- The set of VCL objects provided with C++Builder include the complete Win32 standard graphical user interface (GUI) controls, Windows standard dialogs, components that support database access in different ways (BDE, ODBC, ADO, and dbExpress), components to develop Internet-based applications, web server applications, web services using XML/SOAP architectures, Borland's DataSnap architecture for supporting multi-tier applications and others. However, users should check with Borland for the specific set of components included in each edition of the product. The descriptions and examples in this book correspond to the richest edition of C++Builder, which is usually the Enterprise edition. Users of other editions of the product are automatically covered, because features of those editions are included in the book by default. This also implies that every example from this book may not work with every edition of the product.
- VCL also permits the use of ActiveX components (developed in other development platforms like Visual Basic, Visual C++, etc.) in VCL-based applications. This is made possible by importing an ActiveX control into the C++Builder environment, which will transform the ActiveX control to a VCL control. The control will then behave like a natural VCL control.
- VCL also permits development of ActiveX controls for use by other development environments like Visual Basic, Visual C++, etc.

VCL Objects

Before we continue discussing VCL architecture, it is necessary to keep in mind a few VCL-specific features with respect to the C++ programming language. In C++, a *class* defines the blueprint of how an object looks and behaves in the programming world, and an *object* is an instance of the class. The state of an object is represented by its instance variables, and the object's methods operate on the instance variables to find or change the state of the object. When an object is created, its existence is governed by two characteristics, its *scope* and *memory allocation*. These two characteristics are interrelated. The scope of an object is visibility (and persistence) with respect to other programming elements. It is beyond this book to discuss more detailed C++-language specifics.

Every object created in the program occupies memory as required by its structure and contents. There are two types of memory chunks available in the system, the *stack* and the *heap*. Objects created on the stack are automatically destroyed when they go out of scope, and objects created on the heap occupy the memory location(s) until explicitly destroyed by the program, even after they go out of scope. Therefore, it is the responsibility of the programmer to keep track of how the objects are being created and destroyed. C++ leaves this responsibility in the hands of the programmer, along with the power of dynamic memory management. The following sample code helps us understand how the objects can be created on the stack and heap, respectively, in C++.

Listing 5-1

```
Class Car {
private:
    int Cylinders;  // instance variable
public:
    Car(void);      // constructor
};
```

The following code creates an object of this class on the stack and assigns a value to its instance variable:

```
Car newCar;
newCar.Cylinders = 4;
```

The following code creates the object on the heap and assigns a value to the instance variable:

```
Car *newCar = new Car();
NewCar->Cylinders = 4;
```

The new operator, as used above, is specific to object-oriented languages like C++, to enable creation and destruction of objects on the heap. Objects created using the new operator must be destroyed when you are finished with them using the delete operator, as shown here:

```
delete newCar;
```

All the VCL objects must be created on the heap, using the new operator, (with the exception of AnsiString, explained later in this section) and must be destroyed using the delete operator. The size of the stack is always limited, compared to the heap. In addition, when objects created on the stack are passed as parameters to functions, new copies of the objects are created on the stack, which may not always be the required way. When objects are created on the heap and the object pointers are passed as parameters to other objects and functions, only these pointers are created on the stack and not the objects. Therefore, it improves performance of the program when objects are created once and accessed by other objects through the object pointers. The performance gain may not be visible in small applications, but complex enterprise-level applications demonstrate this performance improvement. Also, in a complex object-oriented architecture like VCL, an object may not be a simple class; most of the time, an object contains several objects within itself. This object containment may span to many levels in very complex object structures. Therefore, using the heap for dynamic memory usage lets us use the memory more effectively. One of the strengths of the C++ language itself is dynamic memory management. Based on these concepts, it makes perfect sense that VCL mandates the objects be created on the heap.

At first, it may appear to be a difficult task to take responsibility of freeing objects when they are done being used. However, the VCL architecture has a built-in feature that relieves the programmer of this burden to a great extent. All VCL components (visual and non-visual) have a property called Owner, which is another component that takes the responsibility of freeing the components it owns when the owner itself is destroyed. In a VCL-based application, the form owns all components created on it during design time. During run-time creation of components, the owner component pointer has to be passed as a parameter to the constructor. During run time, there is an opportunity for the programmer to define another component other than the form as owner. Thus, run-time creation of components using the new operator does not necessitate their explicit deletion by the programmer, as their owner takes care of this task.

All other VCL objects that are not components by class must be explicitly created using the new operator and explicitly destroyed using the delete operator.

AnsiString

Along with the Win32 String type, C++Builder provides the AnsiString class to create string objects. AnsiString is designed to function like the Delphi long string type. It is not required to create AnsiString objects with the new operator. The AnsiString object grows dynamically to any size as the string grows, and is only limited by the available memory size. The object does not have any properties exposed; rather it has methods (including the constructors) that provide functionality to manipulate the string objects very efficiently.

The AnsiString can be instantiated in two ways as shown below:

```
AnsiString str1                          // will pass by value
AnsiString *str2 = new AnsiString();     // will pass by reference
```

When an AnsiString object is created as shown in the first statement, it is passed by value when passed as a parameter to a method call. When it is created as shown in the second statement, it is passed by reference when passed as a parameter to a method call.

The constructor of the class is overloaded with different signatures. The example only shows the simple constructor without any arguments.

Table 5-1 displays some commonly used methods of this class.

Table 5-1

Method	Description
SubString(int index, int count)	Extracts a substring from the AnsiString objects from a specific position to a specific number of bytes beyond the starting point.
'+' and '+=' operators	Concatenate AnsiString objects.
'=' operator	Assigns one AnsiString object to another.
TrimLeft( )	Trims leading spaces and control characters.
TrimRight( )	Trims trailing spaces and control characters.
Trim( )	Trims both leading and trailing spaces and control characters.

Method	Description
StringOfChar(char ch, int count)	Returns an AnsiString object of desired length containing the same single character.
LowerCase( )	Returns the AnsiString object in all lowercase characters.
UpperCase( )	Returns the AnsiString object in all uppercase characters.
ToInt( )	Converts the AnsiString object to integer and returns as an integer value.
ToDouble( )	Converts the AnsiString object to floating-point value and returns as double value.
Insert(const AnsiString& str, int index)	Inserts an AnsiString object into another AnsiString object at the desired position.
Length( )	Returns the length of string in bytes as an integer value.
IsEmpty( )	Returns a Boolean value indicating whether the string is empty or not.
c_str( )	Returns a character pointer to a null-terminated character array.

The value returned by the c_str() method is only a pointer to the internal data buffer of the AnsiString object. If the character array has to be used later, it is recommended that you create enough buffer to hold the returned value and do string copy. An example is shown below.

```
AnsiString str = "New String";              // create the AnsiString object
char *buffer = new char(str.Length()+1);    // create char buffer enough for the
                                            // string
strcpy(buffer, str.c_str());                // string copy the value to the
                                            // buffer

delete buffer;                              // delete the buffer after using it
```

Notice that the buffer size allocated is 1 character more than the length of the string, in order to accommodate the null terminator for the C-style char array. The value copied to the buffer can be used in all functions that accept a character pointer.

There are other methods of the AnsiString object mentioned within the product manuals that the reader is encouraged to investigate and practice with.

TObject

TObject is the abstract base class from which all VCL objects are derived. This class provides fundamental behavior of an object, like construction, destruction, runtime type information about the class itself, and message handling. Objects that directly descend from this class cannot save their state; they can only be created at run time, be used, and be destroyed. Examples of objects that are very commonly used direct descendents of this class are TException and its descendents TList, TQueue, TStack, TBits, and TStream and its descendents, TPrinter, TRegistry, etc.

The most common situation that many programmers face during development is that they have to perform some task on an object based on the class which instantiated it or the class that is one of its ancestors.

Table 5-2 displays some commonly used methods.

Table 5-2

Method	Description
ClassName( )	Returns the name of the class that the object is an instance of.
ClassNameIs(AnsiString fClassName)	Returns Boolean value indicating whether the object is of the type as identified by the fClassName argument or not.
ClassParent( )	Returns a pointer to the TMetaClass definition of the immediate ancestor class from which the object's class is derived.
InheritsFrom(TClass fAncestorClass)	Returns Boolean value indicating whether the object's class is inherited from the class fAncestorClass or any one of its descendent classes.
InstanceSize( )	Returns the memory (number of bytes) required to instantiate an object of the current class.
ClassType( )	Returns a pointer to the TMetaClass definition of the object. However, it is usually not required to directly access the meta class definition of an object because the methods provided by TMetaClass correspond to the static methods of the TObject class.

Listings 5-2 and 5-3 provide examples of using some of these methods.

Listing 5-2

```
TListBox fListBox = new TListBox(this);
ShortString fClassName = fListBox->ClassName();
```

In this example, fClassName contains the string value "TListBox".

TControl is the immediate ancestor class of TWinControl, which is the immediate ancestor class of TCustomListBox, from which TListBox is derived.

Listing 5-3

```
TListBox fListBox = new TListBox(this);
bool fbool1 = fListBox->InheritsFrom(TWinControl);
bool fbool2 = fListBox->InheritsFrom(TList);
```

In this example, fbool1 contains the value true because of the ancestor relationship explained earlier, and fbool2 contains the value false for the same reason.

Notice that TMetaClass* is a typedef of TClass. Runtime type information (RTTI) is discussed in more depth later in this chapter.

Persistence of Objects: TPersistent Class

One of the key requirements for objects in a component framework is the ability to save their state before the object is destroyed, and to re-create the object loading it from where it was saved earlier. The state information that is stored by the object is its own behavior, as identified by properties assigned and modified during design time. Examples of properties include Caption, Name, Top, Left, Height, and Width. This ability is termed *persistence*. The TPersistent class is directly derived from TObject and adds persistence to the objects, in addition to the basic functionality provided by TObject. Examples of objects that are direct descendents of TPersistent class include TGraphicsObject, TGraphic, TStrings, TClipboard, and TCollection.

Basic VCL Component — TComponent Class

In the simplest terms, a *component* is an object that has the ability to be hosted in the component palette in the IDE. The TComponent class derived from TPersistent incorporates the component behavior, which includes:

- The ability to be hosted in the component palette and be manipulated in the form designer
- The ability to own (and contain) and manage other components
- Enhanced streaming and filing capabilities
- The ability to be converted to an ActiveX object or other COM object

Both visual and non-visual components can co-exist in the component palette. Visual components become part of a GUI application providing visual manipulation of data, whereas non-visual components appear on the screen only during design time and provide functionality that does not require visual representation of data during execution of the application. Though TComponent is the base ancestor class for all components, only non-visual components are directly derived from this class. The visual components must be derived from the TWinControl or TControl class, which are further derived classes of TComponent, depending on whether the component has to behave as a windowed control or not. TWinControl is derived from TControl, which is derived from TComponent.

Non-Visual Components

Some of the commonly used non-visual components include TApplication, TScreen, TTimer, TActionList, common Window dialogs like TOpenDialog (to select a filename to open), TSaveDialog (to select a filename to save a file), TPrinterSetupDialog (to enable printer setup), and TPrintDialog (to select print options). Global instances of TApplication and TScreen objects are available in the application and are explained in detail later in the chapter. Each of the non-visual components provides a service that does not require visual presentation of data. For example, TTimer represents a Windows timer object, which enables the developer to time certain events as required in the application. TActionList maintains a list of actions used with components and controls. It is important to note that non-visual components also may be available in the component palette, to be dropped onto the form during design time; this does not mean that the

component may be visual. The component is available in the component palette for the convenience of the developer, to drop it on the form during design time; but it will not show up on the form during run time. One of the common components designers usually create is a non-visual component that acts like a manager component to manage the behavior of a group of other visual components. TActionList is similar to that.

Visual Components — TControl and TWincontrol Classes and Their Derivatives

A *control* is a component that becomes visible during run time. The control receives input focus if it is a window-based control and will not receive focus if it is not a window-based control but just a graphic image. Receiving focus means the user will be able to interact with the control. Only window-based controls can interact with the users. Graphic-based controls just display a graphic image but will not interact with the user.

The TControl class provides the basic functionality of a control and is derived directly from the TComponent class. TControl is the base class for all the visual components. All the visual components that do not receive input focus should be derived from TControl class. Examples of such classes provided by VCL are TGraphicControl class and its derivatives. The primary purpose of most graphic controls is to display text or graphics. In this context, TGraphicControl has a Canvas property to provide ready access to the control's drawing surface and a virtual Paint method is called in response to WM_PAINT messages received by the parent control. VCL controls that descend from TGraphicControl include TBevel, TImage, TPaintBox, TShape, TSpeedButton, TSplitter, and TCustomLabel, from which TDBText and TLabel are derived. TWinControl is another direct descendent of the TControl class and provides base functionality for all controls that need to interact with the user. In addition to being able to receive input focus and interact with the user, the windowed controls can act as parent controls and hence contain other components. Thus, all the visual container objects are windowed controls. They also have a window handle as identified by the Windows operating system. Several specialized (custom) controls are derived from TWinControl as base classes, to provide additional base functionality as needed for the type of control sets. For example, TCustomEdit provides additional base functionality as needed for all edit controls; TCustomComboBox provides additional base functionality as needed for different types of combo boxes; and

TCustomListBox provides additional base functionality as needed for different types of list boxes.

If a specialized (visual) custom control needs to be developed, it must be derived from TWinControl. If a fully functional control needs to be developed, it must be derived from the corresponding custom control (such as TCustomEdit, TCustomComboBox, TCustomListBox, etc.).

The Application — Global TApplication Instance

The C++Builder IDE enables the developer to create many different types of applications. The basic types of applications that the developer usually works with are listed below.

- Windows GUI application
- Windows NT/2000 service application
- Web Server application
- Windows Control Panel application
- Web Snap application
- SOAP server application
- CLX application
- Console application
- Windows Dynamic Link Libraries (DLLs)
- Borland Packages (BPLs)

For the first seven types of applications, C++ Builder IDE automatically creates a global variable named Application. For the last three types of applications, no such variable is created: a console application is a program that executes at the command mode; Windows DLLs are libraries of functions and objects that are called by another application; and Borland packages are Windows DLLs that are exclusively developed for users of Borland C++Builder and Borland Delphi.

The Application variable is intended to provide information to the developer specific to the application itself, and because of its global scope, it is valuable throughout the application. Based on the type of application created through the IDE, the appropriate unit header file containing the Application variable definition is included in the project. Table 5-3 displays the types of applications and the corresponding class name that the Application variable represents.

Table 5-3

Application Type	Application variable description
Windows GUI application	The Application variable contains GUI application properties and is defined as an instance of TApplication class as defined in the Forms.hpp header file.
Windows NT/2000 service application	The Application variable contains properties of a service application and is defined as an object of TServiceApplication class.
Web application	The Application variable contains the properties of a web server application and is defined as an object of one of the derived classes of TWebApplication class, which are TISAPIApplication, TCGIApplication and TApacheApplication. As the names suggest, each of these web application types contains properties specific to the respective type of web application.
Windows Control Panel application	The Application variable contains properties for a control panel application, and is defined as an object of the TAppletApplication class.
WebSnap application and SOAP application	The Application variable contains the properties of one of the TISAPIApplication, TCGIApplication, TApacheApplication, or TApplication classes, depending on whether the web server type is ISAPI DLL, CGI executable, Apache server module, or web application debugger executable, respectively.
CLX application	The Application variable contains the properties of TApplication class as defined in the QForms.hpp header file.

If a Windows DLL instantiates a form object dynamically, then the Application variable is available and accessible even in the DLL-based form application. This is because the Application variable is defined in the Forms.hpp file, but the Application→Run() method should not be called from a DLL-based form application, because a DLL does not execute by itself and only its methods will be executed from another executable program. It should also be noted that applications should not host their main form from within a DLL; if such a behavior is required, it is recommended that the developer use packages rather than DLLs.

Properties, Methods, and Events of TApplication

This section discusses the TApplication class as defined in the Forms.hpp header file, which mainly focuses on Windows GUI applications. Other types of application behavior is discussed in later chapters.

The properties and methods introduced in TApplication reflect the fundamentals established in the Windows operating system to create, run,

sustain, and destroy an application. For this purpose, TApplication encapsulates the behavior providing the functionality as mentioned here:

- Windows message processing
- Context-sensitive online help
- Menu accelerator and key processing
- Exception handling
- Managing the fundamental parts of an application such as MainWindow, WindowClass, etc., as defined by the Windows operating system

When a Windows GUI application is created, the IDE automatically includes the Forms.hpp file. The application may contain more than one form object, but the first form object that is instantiated in the main project cpp file will be the form that is displayed first when executed, and the global Application variable is the one that is defined in the main form. Therefore, in a project containing multiple forms, the developer can easily change the main form by putting the desired form as the first form in the sequence while instantiating the forms using syntax similar to the following.

Listing 5-4

```
#include <vcl.h>
#pragma hdrstop
USERES("Project1.res");
USEFORM("Unit1.cpp", Form1);
USEFORM("Unit2.cpp", Form2);
USEFORM("Unit3.cpp", Form3);
//---------------------------------------------------------------------------
WINAPI WinMain(HINSTANCE, HINSTANCE, LPSTR, int)
{
  try
  {
    Application->Initialize();
    Application->CreateForm(__classid(TForm3), &Form3);
    Application->CreateForm(__classid(TForm2), &Form2);
    Application->CreateForm(__classid(TForm1), &Form1);
    Application->Run();
  }
  catch (Exception &exception)
  {
    Application->ShowException(&exception);
  }
}
```

In this example Form3 will be displayed as the main form of the application. This is a typical example for a VCL GUI application. The first statement is a call to the Application→Initialize() method. This method calls the InitProc procedure pointer, which is NULL by default. The purpose of having this method is to initialize any subsystems such as OLE automation. In order to use the custom initialization, include the header file that defines InitProc procedure pointer, create a custom initialization procedure that assigns a value to this procedure pointer, and add a call to this procedure to the project source code prior to the call to Initialize. Only one instance of InitProc can be defined in an application. If more than one header file assigns a value to InitProc, only the last assignment will work. For projects that do not assign a value to InitProc, the call to Application→Initialize() can be safely deleted from the project source.

The Application→CreateForm(__classid(TForm3), &Form3) statement invokes the Form3's constructor method, because this is when the form object is instantiated. When a new form is added, by default the IDE adds these statements to the project source. If you intend to instantiate only the main form and not the others at this time, the other lines can be deleted from the project source, and the other forms may be instantiated at run time before they are used.

When the Application→Run() method is executed, the program's main message loop begins, and it ends only when the application terminates. This method should not be called from another place in the project.

An application is active if the form or application has focus. An application becomes inactive when a window from a different application is about to become activated. This status is indicated by the property Application→Active. Table 5-4 summarizes the important properties, methods, and events of the TApplication class.

Table 5-4

Property	Description
MainForm	Returns a pointer to the main form of the application (readonly).
Hndl	Returns the window handle of the main form (readonly).
ExeName	Returns the executable file name of the application including the path information (readonly).
HelpFile	Returns the help file name that the application uses to display help. This can be set during design time, using Project | Options or during run time.

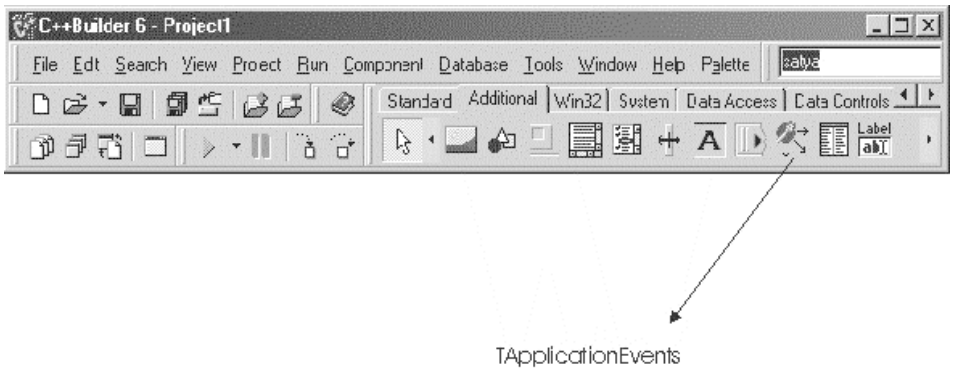
Property	**Description**
CurrentHelpFile	Reads CurrentHelpFile to determine the name of the help file that is currently used by the application when it executes a help command (via the HelpCommand method) or brings up context-sensitive help (via the HelpContext or HelpJump method).
DialogHandle	Provides a mechanism for using non-VCL dialog boxes in a C++Builder application. Use DialogHandle when displaying a modeless dialog box that was created using the CreateDialog Windows API function. Assigning the handle of the modeless dialog box to DialogHandle allows the dialog to see messages from the application's message loop.
Method	**Description**
HandleMessage(), ProcessMessages()	HandleMessage() interrupts execution of the application while Windows processes a message in the Windows message queue before returning control to the application. If the message queue is empty, this method generates an OnIdle event and starts the process of updating the actions in the application. If the application goes idle, this method may take a long time to return. Therefore, do not call this method when waiting for something that is message based while priority actions are also being processed. Instead, call ProcessMessages() when processing more than just messages, to permit Windows to process the messages that are currently in the message queue. ProcessMessages() cycles the Windows message loop until it is empty and then returns control to the application. ProcessMessages() does not let the application go idle. Neglecting message processing affects only the application calling ProcessMessages(), not other applications. In lengthy operations, calling ProcessMessages() periodically allows the application to respond to paint and other messages.
Terminate()	This method calls the Windows API PostQuitMessage function to perform an orderly shutdown of the application. Terminate() is not immediate. Terminate() is called automatically on a WM_QUIT message and when the main form closes.
HelpContext(THelp Context *context)	Brings up the help topic specified by the context parameter from the file specified in the CurrentHelpFile property. HelpContext generates an OnHelp event.
HelpCommand(int Command, int Data)	Provides quick access to any of the Help commands in the WinHelp API. Use HelpCommand to send a command to WinHelp. Before sending the help command to the Windows help engine, HelpCommand generates an OnHelp event on the active form or on TApplication. Finally, the command is forwarded to WinHelp if there is no OnHelp event handler or if the OnHelp event handler indicates that WinHelp should be called.

Method	Description
HelpJump(AnsiString jumpId)	Call HelpJump to bring up a topic identified by its symbolic name. HelpJump displays the topic identified by the JumpID parameter from the file specified in the CurrentHelpFile property. HelpJump generates an OnHelp event either on the active form or on the Application object itself.
Minimize()	Minimizes the application to the task bar.
Restore()	Restores the application to normal status.
ShowException (Exception* e)	Displays a message box for the exceptions that are not caught by the rest of the application code.
Event	**Description**
OnActivate	Provides you the opportunity to perform tasks when the application first starts up.
OnIdle	Provides you the time window to perform any background tasks when the application is not busy.
OnHelp	This event is generated when the application receives a request for help. The HelpContext, HelpCommand, and HelpJump methods generate this event.
OnMessage	Provides the opportunity to interrupt Windows messages.
OnMinimize	Lets you perform tasks when the application main window is minimized.
OnRestore	Lets you perform tasks when the previously minimized application window is restored to the normal state.

Since Application is a global variable, and is not available through the IDE as a component, it is not possible to create the event handlers directly through the Object Inspector; for this reason, C++Builder provides a TApplicationEvents component in the Additional page of the component palette The location of this component on the component palette is shown in Figure 5-2. When you add a TApplicationEvents object to a form, the Application object forwards all events to the TApplicationEvents object. Thus, each event of the TApplicationEvents object is the same as the event with the same name on the Application object. Each form in an application can have its own TApplicationEvents object. Each application event occurs for all the TApplicationEvents objects in the project. To change the order in which the different TApplicationEvents objects receive events, use the Activate() method. To prevent other TApplicationEvents objects from receiving a specific event, use the CancelDispatch() method. This means that in a typical application containing multiple forms, each with a different instance of a TApplicationEvents object, the form that is currently

active can receive the Application object's events first in sequence compared to the other forms, when the Activate() method of TApplicationEvents object is called from the form's OnActivate event handler method. This, however, is not going to prevent other forms from receiving the Application object's events; it is only going to affect the sequence in which they receive the events. However, it is also possible to prevent any of the forms' TApplicationEvents object from receiving the Application object's events by calling CancelDispatch() method of the corresponding TApplicationEvents object.

Figure 5-2



Other Global Variables — TScreen, TMouse, and TClipboard Instances

When a Windows GUI project is created, a global variable Screen of type TScreen is created. The Screen variable encapsulates the state of the screen on which the application is running. Therefore, the Screen variable is useful to capture and set run-time screen state of the application. This variable is defined in the Forms.hpp header file. The properties provided by the Screen variable let the programmer access the screen related system resources such as monitors, cursors, fonts, and resolution, and application-level resources such as forms and data modules instantiated by the application. Most of these are lists of read-only objects, which can be iterated over an upper limit of number of such objects identified by the Screen. Very few of these can be set programmatically, such as current mouse Cursor, IconFont, and HintFont.

For example, when a client application requests data from the server, the cursor may be changed to a different shape (such as the hourglass used by most applications), indicating to the user that the request is being processed. Once the data is displayed, the cursor may be changed back to the

default shape (the shape before it was changed), indicating that the request processing is complete. This is a very useful hint that most Windows-based applications provide to the user to show that the request is in process, the length of time that the request processing is taking, and that the request failed due to a network related problem (in which case the cursor takes an unusually long time to return to the default shape). This is explained here with a code snippet.

Listing 5-5

```
Screen->Cursor = crHourGlass; // indicates that the request is in process.
….
….
….
Screen->Cursor = crDefault;  // indicates that the processing is complete.
```

The first statement changes the cursor to HourGlass mode and the second statement changes it back to default mode (whatever it was before it was changed to the hourglass). The two statements are usually separated by code that makes the data request, receives and displays it in visual controls or does some other processing, displays any messages, etc. In reality, the two statements are contained in different methods of the form or application.

It is possible to allow the forms in the application to be realigned with respect to desktop properties such as screen resolution. TForm descendent objects have a property called Align (derived from the TControl ancestor class), which lets them align themselves (and hence their child components) according to their parent's position. Since the desktop screen is the parent for all the forms within an application, the forms naturally align themselves according to their Align property, whenever the parent resolution or alignment changes. The Screen variable has two methods to control this behavior, DisableAlign() to disable the forms from realigning themselves and EnableAlign() to let them align themselves. These simple methods control the behavior of the entire GUI application; because the forms are parents for their child components, their alignment controls the alignment of the child components. The OnActiveControlChange and OnActiveFormChange events provided by the Screen variable let the program recognize when the active control or active form changes.

Another application-level variable created automatically in a Windows GUI application is Mouse, which is an instance of the TMouse class. The Mouse variable provides properties that expose the mouse characteristics, or how the application can respond to mouse messages. Programs can

check whether a mouse is present, whether the mouse has a wheel, the number of lines that are scrolled with the wheel movement, and whether the drag operation should immediately start when the left button is pressed or after the mouse is moved a certain specified number of pixels after pressing the left button. There are no methods that the programmer should ever call from within an application.

Another useful global object is Clipboard, which is an instance of the TClipboard class. However, this object is not instantiated automatically in an application. Rather, the programmer should call the Clipboard() function defined in the Clipbrd.hpp file, which must be included for applications that need to access the clipboard. When the Clipboard() method is called, an instance of the TClipboard object is returned, and every call to this function from within the application provides access to the same clipboard maintained by Windows. Thus, the global nature of the Windows clipboard is retained and maintained by this method.

The properties and methods of the TClipboard object enable the programmer to copy data into the global Windows clipboard and retrieve it later either in the same application or in another application. Data in different formats can be copied into the clipboard. This is a standard feature that the majority of commercial applications provide to their users. The methods used to copy and retrieve text data are listed below.

Listing 5-6

```
void __fastcall SetTextBuf(char * Buffer);
int __fastcall GetTextBuf(char * Buffer, int BufSize);
```

The SetTextBuf() method sets the character text into the clipboard and GetTextBuf() retrieves the character text from the clipboard. The code to copy a bitmap to the clipboard and retrieve the bitmap from the clipboard to another bitmap object is described in Listings 5-7 (Unit1.cpp) and 5-8 (Unit1.h). To copy the bitmap to the clipboard, the Assign() method of the TClipboard object is used. To copy the bitmap from the clipboard to the bitmap object, the Assign() method of the TBitmap object is used.

Listing 5-7 (unit1.cpp)

```
#include <vcl.h>
#pragma hdrstop

#include "Unit1.h"
//---------------------------------------------------------------------------
#pragma package(smart_init)
```

```
#pragma resource "*.dfm"
TForm1 *Form1;
//---------------------------------------------------------------------------
__fastcall TForm1::TForm1(TComponent* Owner)
    : TForm(Owner)
{
}
//---------------------------------------------------------------------------

void __fastcall TForm1::Button1Click(TObject *Sender)
{
    AnsiString fGraphicFileName = "Graphic1.BMP";
    TFileStream* fGraphicFile = new TFileStream(fGraphicFileName, fmOpenRead);
    Graphics::TBitmap *Bitmap1 = new Graphics::TBitmap();
    try
    {
        Bitmap1->LoadFromStream(fGraphicFile);
        Canvas->Draw(10,10,Bitmap1);
        Clipboard()->Assign(Bitmap1);
    }
    catch (...)
    {
        MessageBeep(0);
    }
    delete Bitmap1;

}
//---------------------------------------------------------------------------
void __fastcall TForm1::Button2Click(TObject *Sender)
{
    Graphics::TBitmap *Bitmap2 = new Graphics::TBitmap();
    try
    {
        Bitmap2->Assign(Clipboard());
        Canvas->Draw(200,200,Bitmap2);
    }
    catch (...)
    {
        MessageBeep(0);
    }
    delete Bitmap2;

}
//---------------------------------------------------------------------------
```

Listing 5-8 (unit1.h)

```
#ifndef Unit1H
#define Unit1H
//---------------------------------------------------------------------------
#include <Classes.hpp>
#include <Controls.hpp>
#include <StdCtrls.hpp>
#include <Clipbrd.hpp>
#include <Forms.hpp>
//---------------------------------------------------------------------------
class TForm1 : public TForm
{
__published:     // IDE-managed Components
    TButton *Button1;
    TButton *Button2;
    void __fastcall Button1Click(TObject *Sender);
    void __fastcall Button2Click(TObject *Sender);
private:         // User declarations
public:          // User declarations
    __fastcall TForm1(TComponent* Owner);
};
//---------------------------------------------------------------------------
extern PACKAGE TForm1 *Form1;
//---------------------------------------------------------------------------
#endif
```

The project contains a form with two buttons, Button1 and Button2. When you click Button1, an image appears at a specific location identified by pixel position (10,10) from the top left corner of the form. At the same time, the image is copied to the clipboard. When you click Button2, the image is copied from the clipboard to another location identified by pixel position (200,200).

The clipboard as provided by VCL has another interesting feature by which the programmer can copy a component from the form to the clipboard, and later copy the component from the clipboard back to the form at some other location. This is one way of creating identical copies of the component with the same set of properties. Listings 5-9 (Unit1.cpp) and 5-10 (Unit1.h) provide an example to illustrate this feature. The application contains a form with GroupBox, DBGrid, Button1, and Button2 components. When you click Button1, The DBGrid component is copied to another location in the form. When you click Button2, the component is copied into the GroupBox. The copy can be done any number of times, but it is important to remember that every time a new copy of the

component is made, it contains the same name as the source component, and hence it is required to change the name of the previously placed component to a different name, because a form cannot have two components with the same name. If this is not done, the program will throw an exception during run time.

Listing 5-9 (unit1.cpp)

```
#include <vcl.h>
#pragma hdrstop

#include "Unit1.h"
//---------------------------------------------------------------------------
#pragma package(smart_init)
#pragma resource "*.dfm"
TForm1 *Form1;
//---------------------------------------------------------------------------
__fastcall TForm1::TForm1(TComponent* Owner)
    : TForm(Owner)
{
  // Register the TButton class so that the clipboard can
  // read and write button objects
   TMetaClass *MetaClass = __classid(TDBGrid);
   RegisterClass(MetaClass);
   count = 1;
   x=20;
   y=20;
}
//---------------------------------------------------------------------------

void __fastcall TForm1::Button1Click(TObject *Sender)
{
  count++;
  // copy the component to the clipboard
  Clipboard()->SetComponent(DBGrid1);
  // It is required to change the name of the
  // source component to different.
  AnsiString fGridName = "DBGrid"+IntToStr(count);
  DBGrid1->Name = fGridName;
  // Now retrieve the component from the clipboard
  // and place it in a different location
  // Note that the the component copied from clipboard
  // contains the name of the source component.
  Clipboard()->GetComponent(this, this);
  x += 10;
  y += 10;
  DBGrid1->Top = y;
  DBGrid1->Left = x;
```

```
}
//---------------------------------------------------------------------------
void __fastcall TForm1::Button2Click(TObject *Sender)
{
  count++;
  // copy the component to the clipboard
  Clipboard()->SetComponent(DBGrid1);
  // It is required to change the name of the
  // source component to different.
  AnsiString fGridName = "DBGrid"+IntToStr(count);
  DBGrid1->Name = fGridName;
  // Now retrieve the component from the clipboard
  // and place it in a different location
  // Note that the the component copied from clipboard
  // contains the name of the source component.
  Clipboard()->GetComponent(this, GroupBox1);
  x += 10;
  y += 10;
  DBGrid1->Top = y;
  DBGrid1->Left = x;

}
//---------------------------------------------------------------------------
```

Listing 5-10 (unit1.h)

```
#define Unit1H
//---------------------------------------------------------------------------
#include <Classes.hpp>
#include <Controls.hpp>
#include <StdCtrls.hpp>
#include <Forms.hpp>
#include <DBGrids.hpp>
#include <Clipbrd.hpp>
#include <Grids.hpp>
//---------------------------------------------------------------------------
class TForm1 : public TForm
{
__published:     // IDE-managed Components
    TGroupBox *GroupBox1;
    TButton *Button1;
    TDBGrid *DBGrid1;
    TButton *Button2;
    void __fastcall Button1Click(TObject *Sender);
    void __fastcall Button2Click(TObject *Sender);
private:        // User declarations
public:         // User declarations
```

```
    __fastcall TForm1(TComponent* Owner);
    int count;
    int x,y;
};
//---------------------------------------------------------------------------
extern PACKAGE TForm1 *Form1;
//---------------------------------------------------------------------------
#endif
```

Getting the RTTI

Earlier in this chapter the TObject class was introduced and we discussed how to make use of its methods to find out about the objects with which we are working. That was an introduction to the runtime type information (RTTI for short), which is the information that the compiler stores about the objects in the application. VCL is a mature architecture in the sense that it provides a very structured and object-oriented approach to the majority of an enterprise's programming needs. One of the features of a mature architecture, in my opinion, is the ability to let the programmer create and dynamically manage the behavior and lifetime of objects during run time. This is provided both by the programming language specification and the framework that implements it. Programmers should know the object characteristics to manage the behavior of objects during run time. VCL makes this easy, due to its strong object hierarchy design. As most of us know, VCL was developed in Object Pascal, and ported a seamless interface to the C++ programming world. The methods used to obtain the runtime type information are defined in the Typinfo.pas Pascal source file; C++ programmers can see the function definitions in the Typinfo.hpp file. This header file must be included in the application if additional information is required from the RTTI.

The following sections discuss some more functions as defined in the RTTI.

Is a specific property published for the object?

If we need to know if a component has published a specific property, we can use the IsPublishedProp() function. This function is overloaded and defined as shown here:

```
bool __fastcall IsPublishedProp(System::TObject* Instance, const AnsiString
      PropName);
bool __fastcall IsPublishedProp(TMetaClass* AClass, const AnsiString PropName);
```

IsPublishedProp() takes two parameters; the first one is a pointer to the object and the second one is the name of the property that we are inquiring about.

```
bool  is_published = IsPublished(ListBox1, "Color");
```

The above statement returns true because Color is a published property of the TListBox component. In this example it is assumed that ListBox1 is an object of TListBox.

What is the kind property?

TTypeKind is an enumeration that defines a list of kinds of properties that the RTTI supports to provide information about. It is defined as shown below:

```
enum TTypeKind { tkUnknown, tkInteger, tkChar, tkEnumeration, tkFloat, tkString,
     tkSet, tkClass, tkMethod, tkWChar, tkLString, tkWString, tkVariant,
     tkArray, tkRecord, tkInterface, tkInt64, tkDynArray };
```

Is a specific property in an object of a specific type?

Another useful function is PropIsType(); its (overloaded) definition is given here:

```
bool __fastcall PropIsType(System::TObject* Instance, const AnsiString
     PropName, TTypeKind);
bool __fastcall PropIsType(TMetaClass* AClass, const AnsiString PropName,
     TTypeKind TypeKind);
```

This function takes three parameters; the first one is a pointer to the object, the second one is the name of the property we are inquiring about, and the third one is the type of property for which we are checking. It returns a boolean value whether the property is of the specified type or not in the object.

```
bool  is_type = PropIsType (ListBox1, "Name", tkSet);
```

The above statement returns false because the Name property of the TListBox component is of type tkString and not tkSet. In this example it is assumed that ListBox1 is an object of TListBox.

What is the type of a specific property in an object?

PropType() is another useful function; its (overloaded) definition is given here:

```
TTypeKind __fastcall PropType(System::TObject* Instance, const AnsiString
      PropName);
TTypeKind __fastcall PropType(TMetaClass* AClass, const AnsiString PropName) ;
```

Is the property stored in the DFM file?

The method IsStoredProp() tells us if the property is stored in the form file (.DFM). Its signature is defined as given here:

```
bool __fastcall IsStoredProp(System::TObject* Instance, const AnsiString
      PropName);
```

How do you get and set property values for an object?

Now we examine what functions will help us get and set the property values for different types of properties. The method GetPropValue() retrieves the property value as a variant and the method SetPropValue() sets the property value from a variant. These methods are defined as given here:

```
Variant __fastcall GetPropValue(System::TObject* Instance, const AnsiString
      PropName, bool PreferStrings);
void __fastcall SetPropValue(System::TObject* Instance, const AnsiString
      PropName, const Variant &Value);
```

These methods take an object pointer and the property name string as the first two parameters. The GetPropValue() method's third parameter is a boolean that indicates if the result is preferred as a string. For example, if the property is of type boolean, and if the result is preferred as a string value, the method returns true or false depending on the value; if not, it returns the value of –1 for true and 0 for false. The SetPropValue() method's third parameter is the value of the property as a variant. These methods can be used to get or set properties whose types are compatible with the variant type.

Two similar methods that operate on variant data types are GetVariantProp() and SetVariantProp(). The signatures of these methods are given here:

```
Variant __fastcall GetVariantProp(System::TObject* Instance, const AnsiString
      PropName);
void __fastcall SetVariantProp(System::TObject* Instance, const AnsiString
      PropName, const Variant &Value);
```

The GetVariantProp() method is different from GetPropValue() in that it does not return the value as a string, whereas the latter does, as discussed above. There is not much of a difference between the SetVariantProp() and SetPropValue() methods.

Get and Set methods that operate on properties of specific types are given here for reference; their usage is self-explanatory from their signatures.

Get and Set Properties of the Ordinal Type

```
int __fastcall GetOrdProp(System::TObject* Instance, const AnsiString PropName);
void __fastcall SetOrdProp(System::TObject* Instance, const AnsiString PropName,
     int Value);
```

Get and Set Properties of the Enum Type

```
AnsiString __fastcall GetEnumProp(System::TObject* Instance, const AnsiString
      PropName);
void __fastcall SetEnumProp(System::TObject* Instance, const AnsiString
      PropName, const AnsiString Value);
```

Get and Set Properties of the Set Type

```
AnsiString __fastcall GetSetProp(System::TObject* Instance, const AnsiString
      PropName, bool Brackets);
void __fastcall SetSetProp(System::TObject* Instance, const AnsiString
      PropName, const AnsiString Value);
```

The value returned by the GetSetProp() function is a comma-delimited string of the values in the set. If the Brackets parameter is set to true, the whole string is enclosed in square brackets. The SetSetProp() function accepts the set values in a comma-delimited string (without square brackets) and populates the set internally.

Get and Set Properties of the Object Type

```
System::TObject* __fastcall GetObjectProp(System::TObject* Instance, const
      AnsiString PropName, TMetaClass* MinClass);
void __fastcall SetObjectProp(System::TObject* Instance, const AnsiString
      PropName, System::TObject* Value);
```

Get and Set Properties of the String Type

```
AnsiString __fastcall GetStrProp(System::TObject* Instance, const AnsiString
      PropName);
void __fastcall SetStrProp(System::TObject* Instance, const AnsiString
      PropName, const AnsiString Value);
```

Get and Set Properties of the Float Type

```
Extended __fastcall GetFloatProp(System::TObject* Instance, const AnsiString
      PropName);
void __fastcall SetFloatProp(System::TObject* Instance, const AnsiString
      PropName, Extended Value);
```

Get and Set Properties of the Int64 Type

```
__int64 __fastcall GetInt64Prop(System::TObject* Instance, const AnsiString
     PropName);
void __fastcall SetInt64Prop(System::TObject* Instance, const AnsiString
     PropName, const __int64 Value);
```

Get and Set Properties of the Method Type

```
Sysutils::TMethod __fastcall GetMethodProp(System::TObject* Instance,
     PPropInfo PropInfo);
void __fastcall SetMethodProp(System::TObject* Instance, PPropInfo PropInfo,
     const Sysutils::TMethod &Value);
```

More on the method types is explained in the chapter that discusses building custom VCL components.

A Closer Look at Forms

Forms provide a visual interface of the Windows GUI application. Form is the highest level of component in the visual component hierarchy. Forms can contain any other type of visual and non-visual VCL components. Forms can also contain ActiveX components developed in other platforms (which is explained in a different chapter). When a form is created in the application using the IDE, C++Builder automatically creates the form in memory by including code in the WinMain() function. The WinMain() function is created in the project's main program file. Every time a new form is added to the application, the IDE adds code to the project's main program and makes the form part of the application, as explained earlier in this chapter. This is the default behavior. It also creates a global

variable for every form with the same name as the form. This global variable is a pointer to an instance of the form object and is used to reference it when the application is running. In applications containing multiple forms, every form is accessible in every other form through this global form variable. However, to make this possible, it is required that the form's header file be included in the other form's program from where it is to be accessed.

If the application contains more than one form, it is not always desirable to have the forms created and kept in memory, as this may cause performance problems for larger applications. Therefore, in such cases, we can create the first form automatically in the project's main program file, and the code that the IDE adds to create the other forms may be safely removed from the WinMain() function. The same thing can be achieved by choosing Project | Options | Forms, and moving the specific form from the Auto-create forms list to the Available forms list. Later, when the other form needs to be displayed, it can be created and displayed at that time. The sample code given here explains how to dynamically create the form and display it.

Listing 5-11

```
if (!Form2)
    Form2 = new TForm2(Application);
if (Form2->Visible == false) {
    Form2->Show();
}
Form2->SetFocus();
```

In this example, we used the global form variable Form2, which is automatically created and defined in the Form2's header file after the TForm2 class definition. This code ensures that the Form2 object is created only if the object does not exist. If the form is not displayed or obscured by other forms or windows, the form's Visible property would be false, in which case the form is displayed using the Show() method. The form may be visible but may not be receiving input focus, in which case the SetFocus() method brings the form to the front and makes it receive the user's input focus. If additional instances of the same form must be displayed at the same time, then additional global variables of the same form class may be declared and instantiated using code similar to the example. The Show() method of the form displays the form in modeless style, which means the input focus may be shifted to other forms of the same application while the form is displayed. However, there may be occasions when it would be

desirable to show a form in the modal style, which means the input focus cannot be shifted to other forms of the same application while this form is displayed; to shift input focus to other forms, the modal form must be closed. To display a form in modal style, the ShowModal() method must be called instead of Show() method. Also, if the form is used for limited functionality, a local variable of the form's instance will also serve the purpose, and the default global variable does not have to be used. If a local variable is used to create the form and the form is displayed modal, then the form's instance can be deleted after the form is closed.

Listing 5-12

```
TForm2* localForm2 = new TForm2(Application);
localForm2->ShowModal();
delete localForm2;
```

Creating Forms in a DLL

Real-world enterprise-level applications usually contain a main form hosting the main menu, and other forms serving each of the menu items in the main menu. This is typical of many applications. In such a case, there will be as many forms in the application as there are menu items or subitems. There are applications hosting forms anywhere from 10 to 100 or even more. In such a scenario, it is certainly not advisable to create and instantiate all the forms in the main application program at one time, for a few reasons. The first and foremost reason is the amount of memory required to hold so many forms at one time. To hold about 100 forms simultaneously, the client machines require a large amount of memory. The second reason is that usually in an enterprise application serving several functions, the user or users do not perform all the functions in the application. What I mean is that only a small subset of functions (from the complete set of functions provided by the application) would be used by an individual or a group of individuals, which is usually controlled by the user and profile management functions of the application. Therefore, it is also not required to make all the form objects available in the application at one time. This prompts anyone with enough Windows development experience to create DLLs for each individual form. That is certainly the option we are going to discuss in this section. Windows DLLs (dynamic-link libraries) are libraries of functions or objects that can be called or instantiated only when required, and also share the same address space as the main calling application. They are, therefore, not independent applications and cannot be executed on their own, as they do not run in their own address space.

In the typical scenario discussed here, one or more forms may be compiled into a single DLL (as desired by the application architect), and the form should be instantiated from the main form of the application. An example is presented here to help the reader understand how this can be achieved. The example presents the main pieces of code that are required to create and execute a form from a DLL. The process of creating a DLL-based application is thoroughly explained in a different chapter. Create a Windows DLL application using the DLL wizard. The wizard creates a program with the DllEntryPoint() function alone. I made a few additions to the program. I added the CreateForm()function, which takes a pointer to a component object as an input parameter, which we use in the function to serve as the owner for the form being created by the DLL. I also added an #include statement to include a header file FormDll.h (refer to Listing 5-13) and created the header file. The DLL wizard does not create a header file for the program.

Listing 5-13 (FormDll.cpp)

```
#include <vcl.h>
#include <windows.h>
#pragma hdrstop
//---------------------------------------------------------------------------
//   Important note about DLL memory management when your DLL uses the
//   static version of the RunTime Library:
//
//   If your DLL exports any functions that pass String objects (or structs/
//   classes containing nested Strings) as parameter or function results,
//   you will need to add the library MEMMGR.LIB to both the DLL project and
//   any other projects that use the DLL.  You will also need to use MEMMGR.LIB
//   if any other projects which use the DLL will be performing new or delete
//   operations on any non-TObject-derived classes which are exported from the
//   DLL. Adding MEMMGR.LIB to your project will change the DLL and its calling
//   EXE's to use the BORLNDMM.DLL as their memory manager.  In these cases,
//   the file BORLNDMM.DLL should be deployed along with your DLL.
//
//   To avoid using BORLNDMM.DLL, pass string information using "char *" or
//   ShortString parameters.
//
//   If your DLL uses the dynamic version of the RTL, you do not need to
//   explicitly add MEMMGR.LIB as this will be done implicitly for you
//---------------------------------------------------------------------------
#include "FormDll.h"
#pragma argsused
int WINAPI DllEntryPoint(HINSTANCE hinst, unsigned long reason, void*
lpReserved)
{
    return 1;
```

```
}
//---------------------------------------------------------------------------
void __stdcall CreateForm(TComponent* Owner)
{
    dllForm = new TDllDemoForm (Owner);
    dllForm->Show();
}
//---------------------------------------------------------------------------
```

The header file is given in Listing 5-14.

Listing 5-14 (FormDll.h)

```
#ifndef DllH
#define DllH

#include "DllForm.h"
TDllDemoForm* dllForm;
extern "C" __declspec(dllexport) __stdcall void CreateForm(TComponent *Owner);
//---------------------------------------------------------------------------

#endif
```

The header file contains the function prototype of the CreateForm() function using the __declspec(dllexport) declaration, and also includes the header file for the form's class definition and creates a global variable of the DLL form. The __declspec(dllexport) declarator statement is required when statically linking the DLL to the main executable program.

When the DLL is compiled, the FormDll.dll and FormDll.lib files are created.

The DLL form may be invoked from the main form in two ways: by static linking and by dynamic linking. To link the DLL statically to the main executable program, follow these steps:

- Create the main executable program project. The project file in the example is DllStaticDemo.cpp and the main form name is StaticMain.cpp.
- Add the FormDll.lib file to the project.
- In the StaticMain.cpp file, include the FormDll.h header file. This is where the manually created DLL header file is required.
- The StaticMain.cpp program main form contains a button to initiate the DLL calling function.

- Compile the program and execute. When the button on the main form is clicked, the DLL form is displayed. Every click to the button instantiates a new copy of the DLL form.

In this example, we linked the DLLs library file to the main program and hence it is called static linking. When a DLL is statically linked, the small footprint of the DLL (in the form of the library file) is included in the main program and remains in memory throughout the application's execution. The actual DLL form is loaded when the first call is made to the function. The application takes care of loading the DLL file into memory, and remains in memory until the application terminates.

Listings 5-15 and 5-16 provide the cpp and header files, respectively, for the main executable program performing the static linking of the DLL.

Listing 5-15 (StaticMain.cpp)

```
//---------------------------------------------------------------------------

#include <vcl.h>
#pragma hdrstop

#include "StaticMain.h"
#include "FormDll.h"
//---------------------------------------------------------------------------
#pragma package(smart_init)
#pragma resource "*.dfm"
TForm1 *Form1;
//---------------------------------------------------------------------------
__fastcall TForm1::TForm1(TComponent* Owner)
    : TForm(Owner)
{
}
//---------------------------------------------------------------------------
void __fastcall TForm1::Button1Click(TObject *Sender)
{
    CreateForm(this);
}
//---------------------------------------------------------------------------
```

Listing 5-16 (StaticMain.h)

```
//---------------------------------------------------------------------------

#ifndef StaticMainH
#define StaticMainH
//---------------------------------------------------------------------------
```

```
#include <Classes.hpp>
#include <Controls.hpp>
#include <StdCtrls.hpp>
#include <Forms.hpp>
//---------------------------------------------------------------------------
class TForm1 : public TForm
{
__published:     // IDE-managed Components
    TButton *Button1;
    void __fastcall Button1Click(TObject *Sender);
private:        // User declarations
public:         // User declarations
    __fastcall TForm1(TComponent* Owner);
};
//---------------------------------------------------------------------------
extern PACKAGE TForm1 *Form1;
//---------------------------------------------------------------------------
#endif
```

A DLL may also be loaded dynamically into memory by using the Windows LoadLibrary() function, then obtaining a pointer to the function to be called, and calling the function dynamically using the function pointer. The system loads the DLL into memory only when the first call to LoadLibrary() is made for that DLL. Every call to LoadLibrary() increments a usage counter internally by the operating system. A loaded library may be unloaded with the FreeLibrary() call to the same DLL. Every call to FreeLibrary() decrements the usage counter of that library. When the usage counter reaches zero, the operating system automatically unloads the DLL from memory. Therefore, the programmer can have control over the process of loading and unloading the DLL from the memory and hence manage the memory more effectively. Also, there is no need to link the import library file (.lib file) to the project; all we need is the DLL file and signature of the function to call.

To link the DLL dynamically to the main executable program, perform the following steps:

- Create the main executable program project. The project file in the example is DllDemo.cpp and the main form name is MainForm.cpp.
- The MainForm.cpp program's main form contains a button to initiate the DLL calling function, and a label to display a message if DLL loading fails.

- Compile the program and execute. When the button on the main form is clicked, the DLL form is displayed. Every click to the button instantiates a new copy of the DLL form.

Listings 5-17and 5-18 provide the cpp and header files, respectively, for the main executable program performing the dynamic linking of the DLL.

Listing 5-17 (MainForm.cpp)

```
//---------------------------------------------------------------------------

#include <vcl.h>
#pragma hdrstop

#include "MainForm.h"
//---------------------------------------------------------------------------
#pragma package(smart_init)
#pragma resource "*.dfm"
TDLLDemoMainForm *DLLDemoMainForm;
//---------------------------------------------------------------------------
__fastcall TDLLDemoMainForm::TDLLDemoMainForm(TComponent* Owner)
    : TForm(Owner)
{
    Label1->Caption = "";   // set the message label to null
}
//---------------------------------------------------------------------------
void __fastcall TDLLDemoMainForm::Button1Click(TObject *Sender)
{
    typedef void (*CALLEDFUNCTION) (TComponent* Owner);
    CALLEDFUNCTION DllFunctionPtr;
    AnsiString fDllName = "FormDll.dll";
    AnsiString fFunctionName = "CreateForm";
    AnsiString fMessage;
    char fDllNameStr[50];

    strcpy(fDllNameStr, fDllName.c_str());
    HINSTANCE DLLInst = NULL;
    DLLInst = LoadLibrary(fDllNameStr);
    if (DLLInst) {
        DllFunctionPtr = (CALLEDFUNCTION)
GetProcAddress(DLLInst,fFunctionName.c_str());
        if (DllFunctionPtr) DllFunctionPtr(this);
        else {
            fMessage = "Could not obtain pointer for function ";
            fMessage += fFunctionName;
            fMessage += " in DLL ";
            fMessage += fDllName;
            Label1->Caption = fMessage;
        }
```

```
    }
    else {
        fMessage = "Could not load DLL ";
        fMessage += fDllName;
        Label1->Caption = fMessage;
    }
}
//---------------------------------------------------------------------------
```

Listing 5-18 (MainForm.h)

```
//---------------------------------------------------------------------------

#ifndef MainFormH
#define MainFormH
//---------------------------------------------------------------------------
#include <Classes.hpp>
#include <Controls.hpp>
#include <StdCtrls.hpp>
#include <Forms.hpp>

//---------------------------------------------------------------------------
class TDLLDemoMainForm : public TForm
{
__published:     // IDE-managed Components
    TButton *Button1;
    TLabel *Label1;
    void __fastcall Button1Click(TObject *Sender);
private:        // User declarations
public:         // User declarations
    __fastcall TDLLDemoMainForm(TComponent* Owner);
};
//---------------------------------------------------------------------------

extern PACKAGE TDLLDemoMainForm *DLLDemoMainForm;
//---------------------------------------------------------------------------
#endif
```

Since the CreateForm() function calls the Show() method of the DLL form rather than the ShowModal() method, it may be noted that the DLL form would be displayed in modeless style. Hence, the programmer has less direct control of when the form would be closed, and thus in the case of dynamic linking of the DLL, the programmer should resort to other methods (out of the scope of this book) to determine when to call the FreeLibrary() function in order to unload the DLL programmatically. However, if the FreeLibrary() function is not called, the system unloads the

DLL automatically when the main application terminates execution. It should be noted that an application loading forms from DLLs must contain its own main form (or have it in a package file), and that form should not be loaded from a DLL itself.

There is one way we can ensure that the form unloads itself from the memory: write an OnClose event handler for the form as shown below:

```
void __fastcall TForm1::FormClose(TObject *Sender, TCloseAction &Action)
{
    Action = caFree;
}
```

The statement that assigns the value caFree to the Action parameter instructs the form to unload itself from memory and free the memory allocated for it.

Characteristics of a Form

Forms are inherited from the TForm class. Every time a form is added to the project, the IDE performs a series of tasks:

- Creates a subclass of the TForm class, and automatically names it TForm1, TForm2, etc., depending on the last created form index. The form's class definition is stored in a header file.
- Creates a global instance variable of the form in the header file.
- Creates a form definition file with the DFM file extension (DFM stands for Delphi ForM file), which preserves the visual presentation of the form as an image. However, the file's contents may be viewed in graphical form or as text.
- Creates the main program file for the form with the CPP extension with an empty constructor. This is the file where the form's behavior is implemented as event handler.

Form is a container of components. In the hierarchy of an application's components, Form is the highest level of visual container in a Windows GUI application. By default, every component that is placed on the form by the designer is contained and owned by the form. The form has the responsibility of destroying the component when the form itself is destroyed; however, during run-time creation of components by the programmer, another component may be set as owner for the new component. The parent-child relationship of forms is different from ownership of components by the form. The differences are listed below:

- While ownership is a property introduced in the VCL at the TComponent level and relates to the responsibility of the owner component to destroy the owned component, the parent-child relationship is defined at the TWinControl level. The parent always represents a windowed control of a child, which can be windowed or non-windowed, and the parent is responsible for saving the state of the control when the form is saved.
- A control that can behave as a parent of another control can also be its owner, but a component that is the owner of another component does not always have to be its parent.

Most of the form's behavior is introduced at the TCustomForm. The form's properties, methods, and events describe and control the following behavioral aspects of its contents:

- The type of form — whether it is a single document interface (SDI) form, a multiple document interface (MDI) parent form, MDI child form, etc.
- The display characteristics of the form — such as modal, modeless, resizable, Windows dialog type, iconized style, normal style, maximized to occupy the entire desktop, etc.
- Display position of the form on the desktop when executed
- The lifetime management of the components
- Provides direct access to the drawing area of the form to allow custom drawing by the programmer.
- Lets the programmer access its components individually or collectively and change some of their properties through the Components array property. To access the properties defined in TComponent class or its ancestors, the individual elements of the Components array can be used directly. However, to properly identify and access the properties of components derived from TComponent, the elements of the Components array must be cast to the appropriate component type, using the dynamic_cast operator.
- Ability to reorganize its controls during run time. The controls can be rearranged at different positions or can be regrouped dynamically, creating new visual containers at run time.
- Lets the programmer interact with the form at several stages during its lifetime through the event handlers. The event handlers can

be assigned dynamically at run time to the methods compiled into the code.

The individual properties, methods, and events are not discussed here, as they are readily available to the developer in the online manuals.

Frames in the VCL

Frame is a VCL control that was introduced by Borland in Delphi 5 and C++Builder 5. Like a form, it is a container of other components. It uses the same ownership mechanism as forms for automatic instantiation and destruction of the components on it, and the same parent-child relationships for synchronization of component properties. In the VCL architecture, a frame may be considered to be an intermediate component between forms and panels. Both forms and panels are containers; forms are self-sufficient units whereas panels are not self-sufficient units. Frames are self-sufficient units without independent existence.

The characteristics that make frames distinct in the VCL architecture are listed here:

- The frame has no independent existence in an application during run time, but a form does. This means that a frame cannot be displayed on its own. It has to be contained within a form or another frame or any hierarchy of frames, but ultimately it is displayed only through forms. In this respect, it behaves like a customized component.
- The frame can be considered a self-sufficient container. This means that the frame alone can be created in a single unit and can contain other components. This gives the programmer the ability to create complex component groups within the project, even without creating and registering them to the component palette. Once a frame is created with required components, the frame can be included in any project and reused.
- Frames can also be added to the component palette or object repository for frequent reuse in multiple projects. This would increase the productivity. With the mouse on the frame, click the right mouse button, and from the menu of options displayed, choose Add to Palette to add the frame to the component palette. In this case, you are asked to enter a name to the frame component, choose a palette page where this component should be

hosted, and change the icon if desired. If you choose Add to Repository to add the frame component to the repository, you are asked to provide information such as title, description, author of the frame component, and the repository page that should host the component.

- Using frames to contain resources like images would reduce the resource requirements to a great extent, particularly when the project contains repeated use of the same image like a company logo or background image displayed on every form.

Using Frames in a Project

As described earlier, the use of frames in a VCL project serves multiple purposes. For whatever purpose we use the frames, the steps involved are the same. For demonstration purposes, we will discuss a small example of creating a frame that contains a bitmap image as a background image in the application.

- Create a VCL GUI application. This will automatically add a form to the project. Let's name the project FrameDemo.bpr, the form MainForm.cpp, and the form class named FrameDemoForm.
- Add a frame unit to the project by choosing File | New | Frame. On the frame, drop a TImage component, assign a bitmap file to the Picture property, set the Stretch property to true and set the Align property of the image object to AlClient so that the picture occupies the entire client area of the frame. Save the frame unit as FrameUnit.cpp. The frame should look similar to Figure 5-3.

Figure 5-3

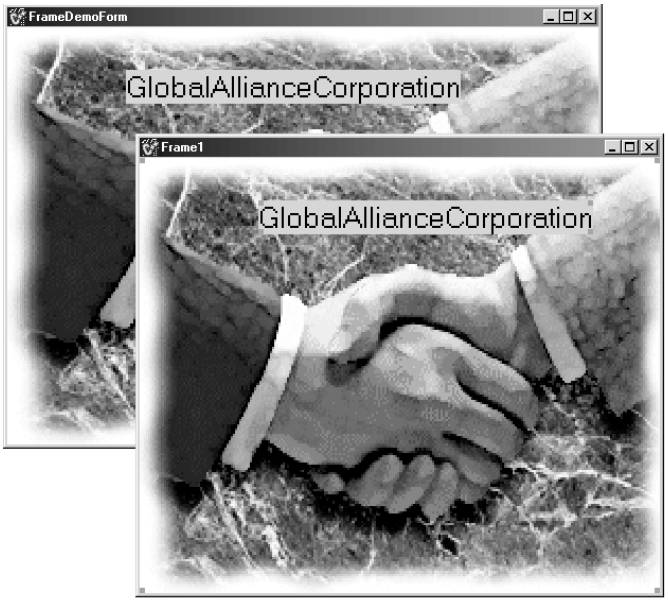
- Now drop a frame object from the component palette Standard page. Whenever we try to drop a frame object from the component palette to the form, the system displays a list of all the frames (to choose from) defined in the project so far. At this time, the system displays Frame1. Choose Frame1 and click OK.
- The frame object created in the earlier step would be dropped onto the form. To set this as a background image in the project, set the Align property of the frame to AlClient. The form appears as shown in Figure 5-4.

Figure 5-4

- Now open the FrameUnit and add a TLabel object. Set its Caption property to any string, say, "Global Alliance Corporation." Set the font size to 20 so that the label appears in big type.
- Notice that when the contents of the frame are changed, the changes automatically appear in the form instantaneously. This can be seen in Figure 5-5 at the top of the next page.

  This is a property exhibited exclusively by the frames. When the defining frame class (which is inherited from TFrame) undergoes changes in its contents, the object instances are automatically updated by the IDE with the new changes. In this example we worked with only one instance of the TFrame derived class, but the principle works with any number of instances created at the time.

Figure 5-5



- This example also demonstrates an interesting feature relevant to frames: only one copy of the picture resource is compiled into the program in the FrameUnit.dfm file. The MainForm.dfm does not contain the binary resource. Imagine how compact the program would be with projects involving many forms, each having the same background image. The form (.dfm) files may be examined in text mode to notice this behavior.

Visual and Non-Visual Containers

Container is the term that applies to objects that have the ability to contain other objects. An example is the TListBox object, which contains a list of strings displayed in a visual list box. Here, the TListBox object acts like a container and each of the AnsiString objects is contained within the container. A container object may also be contained in another container object. TList is a non-visual container that maintains a list of pointers to any type of objects. Therefore, the TListBox object (which is a container itself) may be contained within a TList object by storing its pointer as an item in the TList container or TObjectList object. For a C++ programmer who does not use a framework like the VCL, the only containers available are through the use of STL (Standard Template Library), which is the subject of another chapter in this book. The current chapter discusses the container objects provided by the VCL framework. Since the subject of

containers is huge with regards to the types of containers as provided in the VCL, attention will be given to some of these classes, and the reader is encouraged to refer to the manuals on the others.

TStrings

TStrings is a container class that maintains a collection of strings and a collection of corresponding object pointers. This is a base class and contains pure virtual methods. Therefore, the class cannot be directly used to instantiate an object; rather a descendent class must be used. Examples of its descendents are TStringList (non-visual) object, which has implemented all the properties and methods of the base class or Items property of TListBox (visual) object.

The Add method lets you add a string item to the list, and the AddObject method lets you add an object with an associated string (e.g., object name). The Strings property is an array of the strings, and the Objects property is an array of object pointers. Both these arrays are accessed by an index which varies from zero to one less than the number of items in the list. To add an object to the list, first the object has to be created and then the pointer is passed along as a parameter to the method call.

Signatures of these methods are given here:

```
int __fastcall Add(const AnsiString S);
int __fastcall AddObject(const AnsiString S, System::TObject* AObject);
```

Both the methods return the index of the added string (and object). When the list is destroyed, the strings are destroyed but the associated objects are not because the string list object does not own them. They have to be destroyed by the developer, separately. In some programming circumstances, it may even be necessary to destroy the objects before the pointers to these objects are destroyed along with the string list (if the list is the only place where the pointers are stored). Otherwise, the object pointers may not be available to access the objects for the purpose of destroying. However, if the objects assigned to the string list are owned by another component, then the owner component takes care of destroying the objects and the developer does not have to worry about it; this is particularly the case with objects created at design time using the IDE.

When the objects are accessed using the Objects property, the pointer returned references an object of type TObject. Hence, it is necessary to typecast the object to the appropriate type before using it, as shown in Listing 5-19.

Listing 5-19

```
// the statements that create a string list and assign an object to it
TStringList *st = new TStringList();        // create a string list
St->AddObject(ListBox1àName, ListBox1);     // assign a Listbox to the list
. . . . . .
. . . . . .
. . . . . .
TListBox lb = (TListBox)st->Objects[I];    // to access the list box object
AnsiString lbName = st->Strings[I]; // to access the corresponding string object
```

Table 5-5 summarizes the most commonly used properties and methods of the string list object.

Table 5-5

Property	**Description**
Count	Returns the number of items in the list.
CommaText	Returns the string list object contents as comma separated text.
Text	Returns the contents of the string list object as text, separating individual items with a carriage return and linefeed.
Strings	Contains an array of AnsiString objects.
Objects	Contains an array of objects.
Names	Contains an array of names if the string list contains strings of name-value pairs.
Values	Contains an array of values if the string list contains strings of name-value pairs.
Method	**Description**
Insert(int index, AnsiString s)	Inserts a string into the string list object at the specified location.
n0 InsertObject(int index, AnsiString s, TObject object)	Inserts a string and the associated object into the string list object at the specified location.
Delete(int index)	Deletes an item located at the specified index position from the string list object. If an object is associated with the item in the list, the reference of the object is also deleted from the list (the object itself is not deleted).
Move(int currIndex, int newIndex)	Moves the string (and the associated object, if any) located at currIndex position to the newIndex position.
Exchange(int index1, int index2)	Swaps the positions of strings (and any associated objects) located in the positions index1 and index2.

Method	Description
IndexOf(AnsiString str)	Returns the index position of the associated string. If the specified string does not exist in the list, -1 is returned.
LoadFromFile(AnsiString file)	Loads the string list object contents from the specified file. The individual strings must be separated in the file by carriage return and linefeed characters. Only strings are loaded from the file and not the associated objects.
SaveToFile(AnsiString file)	Saves the string list object contents to the specified file. The individual strings are separated in the file, by carriage return and linefeed characters. Only strings are saved to the file and not the associated objects.
LoadFromStream(TStream *stream)	Loads the string list object contents from the specified stream object. The stream object is a descendent of the TStream class. The stream object should have been created by the SaveToStream method.
SaveToStream(TStream *stream)	Saves the string list object contents to the specified stream object. The stream object is a descendent of the TStream class. The programmer has to create the stream object that is passed as an argument to this method. After using the stream object, the programmer has to explicitly delete it.
BeginUpdate() and EndUpdate()	These methods help the TStrings object track when the list object is being updated and when the update is complete, respectively. Descendents of TStrings class may use this information to hold and start repainting the portion of screen where the visual data is being updated in order to avoid flicker during update process.

Another interesting feature of the TStrings object is its ability to store name-value pairs as individual name and value lists associated with their string. This is very useful for storing property values read from a property file. An example is shown here:

```
userid=satya
password=kolachina
```

If strings of this type are stored as items in the list, the string userid=satya is stored as an item in the list. The complete string can be accessed from the Strings property, the value userid can be accessed from the Names property, and the value satya can be accessed from the Values property.

TListView

The visual component TListView is an example of a component that contains containers within another container. The list view object is used to display rows and columns of data, preferably in display mode, as the name suggests (to display editable rows and columns, TStringGrid and TDBGrid objects may be used). The individual items of a list view object are instances of the TListItem object. The list of these objects is contained in the TListItems object and is identified by the Items property of the list view. The TListItems object has methods to add, delete, insert items, clear the list, etc. The list also has the methods BeginUpdate() and EndUpdate(), which, unlike in the case of TStrings class, themselves disable and enable screen painting of the list view object to avoid screen flicker during update process. Each of the items in the list is a TListItem, which in turn has a property called SubItems, an instance of TStrings, to contain strings that appear as subitems to the main list item. It is also important to note that the individual instances of TListItem object are owned by the TListItems object, which in turn is owned by the TListView instance. Because of this hierarchy of ownership, when the topmost object is deleted, it takes the responsibility of deleting the components it owns, and this responsibility is carried forward by the hierarchy of components in the object. This is one of the features that makes VCL a strong architecture, relieving the programmer from the task of destroying the objects.

TList and TObjectList

It was mentioned earlier that the TList object maintains a list of object pointers. In this context, I wish to provide more detail here. The objects stored in the TList object can be any descendents of TObject. The features provided by TList include the following:

- Maintains a list of object pointers
- The number of items in the list are indicated by the Count property.
- The Delete(int index) method deletes the object pointer at specified index, and Remove(void *ptr) deletes the object pointer ptr.
- Deleting an item from the list does not destroy the original object; only the object pointer is lost. In fact, if the list is the only location where the pointer is stored, it is advised that you destroy the object before deleting the item from the list. Otherwise, the

programmer would lose the object pointer and cannot destroy the object later.

- Similarly, destroying the TList object itself does not destroy the objects whose pointers are contained in the list.
- The list can contain NULL pointers. To delete all the null pointers from the list, the Pack() method must be called.

The TObjectList object descends from TList object and adds more control to the programmer as follows:

- Objects whose pointers are contained in the TObjectList object can be owned by the list object, which can take the responsibility of destroying them when they are deleted from the list or when the list object is itself destroyed. This is controlled by the boolean property OwnsObjects, which, when set to true, leaves the responsibility of destroying the owned objects to the list object.
- The Remove(TObject *ptr) method has been overridden in TObjectList to accept a pointer to the TObject class rather than a void pointer, which is the case with the TList object.
- Call Extract(void *item) to remove an object from the list without freeing the object itself. After an object is removed, all the objects that follow it are moved up in index position and Count is decremented.

Streams and Streaming

One of the best features of the VCL is the ability to save the object's state to a stream and retrieve it later from the stream. There are many VCL objects that provide this feature through the functions SaveToStream(TStream *stream) and LoadFromStream(TStream *stream). TStream is the base class for VCL-style streams. Do not confuse VCL streams with C++ IOStreams. The VCL functionality is always available on top of whatever standard C++ language provides.

TStream defines all the base functionality of a stream that can read from or write to various kinds of storage media, such as disk files, dynamic memory, and so on. Stream objects permit applications to seek an arbitrary position in the stream for either reading or writing. It is the responsibility of the programmer to interpret the data read, by mapping to the appropriate object's structure or data layout. In simple terms, any object's contents can be saved to a stream, provided methods similar to

that mentioned above are made available by the respective component writers. The main features of streams are data access from an arbitrary position in the stream and unified data access technique without regard to the storage media of the stream. The descendent class that derives from TStream takes care of the media access techniques, and hence it is the responsibility of the component writers and not the application programmers.

TStream also introduces methods that work in conjunction with components and files for loading and saving components in simple and inherited forms. These methods are called automatically by global routines that initiate component streaming. They can also be called directly to initiate the streaming process. These are ReadComponent, ReadComponentRes, WriteComponent, and WriteComponentRes.

Two important properties of the TStream object are Position and Size. Position indicates the current location of the stream pointer (similar to file pointer) from the beginning of the stream. Size indicates current memory (in bytes) of the stream. Methods that load (or add) contents to the stream set the size of the stream internally; setting this value explicitly has no effect. When the TStream (descendent) object is created, Size is 0 and Position is 0. As data is added, the size grows, and the current pointer location moves away from the beginning of the stream. After the data is added and before it is read, the stream pointer has to be set to the beginning (or any appropriate location in the stream) explicitly by the programmer; otherwise, access violations occur. When data is read from the stream from a location by a specific number of bytes, it only means that the data is copied from the stream to another memory location by a specified number of bytes, and the stream pointer is moved forward by the same number of bytes; data is not removed from the stream. To read the same set of bytes, move the stream pointer back by the same number of bytes and do another read. To clear the contents of the stream object, the descendent class must implement a corresponding method.

The descendents of TStream as defined in the VCL are explained below. The purpose of these stream objects may be different based on their design, but they all share the same streaming features explained above.

- TFileStream — This stream object makes it easy to read from and write to a disk file. Component writers can implement methods to save the components' status to disk file and rebuild the component status back from the disk file. There is a Seek(int offset, Word origin) method that must be used to position the stream pointer at an appropriate location before the read or write operation begins. In

fact, some of the VCL components currently support this feature (along with some third-party vendor components).

- TMemoryStream — This stream object makes it easy to read from and write to a memory stream. By saving components' status to memory stream, application developers can develop uniform and unique logic to save the component status and transmit across the network to other computers, where the receiving applications can restore the components if they know the object structure that the stream contains. This can be used as a simple alternate method to transfer objects across the network without bothering to learn complex architectures like DCOM and CORBA. (This is explained in a later chapter in more detail.) However, component writers have to implement methods to save the object status to the memory stream. Some of the VCL components currently support this feature (along with some third-party vendor components).
- TStringStream — This stream object provides file-like access to create string objects, as opposed to more structured AnsiString object. It is useful as an intermediary object that can hold text as well as read it from or write it to another storage medium.
- TWinSocketStream — This stream object provides services that allow applications to read from or write to socket connections. Socket connections are of two types: blocking and non-blocking. In non-blocking socket connections, the read or write across the socket is performed asynchronously, and hence the events are fired only when the socket is ready for read or write and data is awaiting at the port. But in case of blocking connections, the read and write occur synchronously and the client application cannot do anything else as long as the read or write operation is in progress or waiting. Since the reading process cannot wait indefinitely until the socket is ready for reading with data at the port, the TWinSocketStream object provides a waiting feature with a time-out mechanism; it is required to read over the blocking socket. More on sockets is explained later in another chapter.
- TBlobStream — This stream object is designed to enable reading and writing BLOB field data in a database table. BLOB field in a table is designed to hold binary large objects including pictures or large memos. Every time BLOB field data is read from a table or written to the table, it is necessary to create a TBlobStream object to enable this read or write operation. There are two ways to

create this stream object. Using the new operator and passing two arguments (the BLOBField object and the stream access mode) to the constructor creates an instance of the TBlobStream object to operate on the specific BLOBField of the table. The second way is to call the CreateBlobField method on the TTable object and provide the same two parameters. In either case, the stream object is instantiated and it is the programmer's responsibility to delete the object after use. It is also important to keep in mind that there is no terminating character that identifies the end of a BLOB stream data, and hence the parameter count (which is an integer value) must be supplied with the exact number of bytes to be transferred.

- TOleStream — This stream object reads and writes information over a streaming interface that is provided by an OLE object.

Graphic Objects

Using Windows GDI (Graphical Device Interface) directly to include graphics in their applications requires programmers themselves to manage graphics resources directly. There is such a wide variety of display devices and their driver software provided by different vendors that the Windows operating system should support the graphic output display. Windows graphics device context is designed to handle the intricacies of different devices and provide a unique interface for the Win32 programmer. Win32 help defines a device context as a structure that defines a set of graphic objects and their associated attributes, and the graphic modes that affect output. The graphic objects include a pen for line drawing, a brush for painting and filling, a bitmap for copying or scrolling parts of the screen, a palette for defining the set of available colors, a region for clipping and other operations, and a path for painting and drawing operations. In its simplest definition, the device context is a block of memory containing the data structure as defined earlier, and managed by the GDI. Before we do any operation on drawing graphics, it is necessary to obtain a handle to the device context from Windows. The direct Win32 function call to get a device context is something like this:

```
HDC hdc = CreateDC (DriverName, DeviceName, Output, lpInitData);
```

The return value of this function is a handle to the device context. After obtaining the device context, the programmer then uses its resources to perform necessary drawing tasks. After finishing with it, the device context should be released back to Windows.

VCL has made this task very simple by providing a set of objects to manage these resources. By using these objects, the programmer does not have to bother to manage the resources. The interface that VCL provides is through the Canvas property of the specific component, which handles the drawing tasks. The Canvas property is an instance of the TCanvas class, which is a direct descendent of the TPersistent class.

TCanvas

TCanvas provides an abstract drawing space for objects that must render their own images. The properties and methods of this object are exposed to the programmer through the Canvas property of the specific component that the programmer is working with. It is the responsibility of the component writers to expose the Canvas property. The TCustomControl and TGraphicControl classes include the Canvas property in their ancestor class, so that component writers can provide the drawing canvas to their users. Controls derived from TCustomControl provide the Canvas property to windowed controls (i.e., controls able to receive input focus). Controls derived from TGraphicControl provide the Canvas property to non-windowed controls (i.e., controls that do not receive input focus). Since standard windowed controls like the button, check box and edit control are part of Windows, they know how to draw themselves, and do not need to descend from TCustomControl; hence, they are derived directly from TWinControl (which is also the ancestor of TCustomControl).

The important properties of TCanvas object are Pen, Brush, and Font, which are instances of TPen, TBrush, and TFont, respectively. They are the graphic objects that provide different styles, colors, etc., that affect the appearance of the drawing. Accessing the Canvas property of a VCL control opens a channel of drawing capabilities to the programmer. There is a chapter on programming graphics (including Microsoft's DirectX library) later in this book that discusses these topics in more detail.

Summary

We began the chapter with an overview of the VCL architecture and discussed the features of the VCL framework, followed by an introduction to the VCL objects and how the VCL's component ownership concept helps the programmer in destroying objects.

Then AnsiString was given a prominent place in the discussion due to its profound use and importance in VCL-based applications. Then followed a

discussion on classes that formulate the core VCL foundation for visual and non-visual components.

A discussion of global application-level variables and components was included due to their importance in the VCL applications; these are Application, Screen, Mouse, and Clipboard instances, since these are used and required in any general VCL application, no matter the type of application we are writing (however, there are exceptions where some of these are not used in some type of applications).

We continued to discuss the RTTI in more detail, and observed the method signatures that help the programmer use these methods in retrieving runtime type information.

The discussion continued on forms and frames in more detail, with code examples to dynamically create form instances at run time. We provided screen shots for a Frames project, where frame inheritance was explained. Following this was presented a discussion on VCL containers, focusing on string lists and object lists.

VCL streams was the next topic in which we discussed the streaming concept supported by VCL, and how powerful these objects are in different aspects of the application, like file streams, memory streams, and socket streams. The last topic of the chapter was an introduction on the graphics support in the VCL.

Some of these topics were discussed in detail, and some were mentioned only briefly. Some of the topics are discussed in more detail in other chapters.

The following chapter discusses advanced VCL features.

Chapter 6

Advanced VCL Features

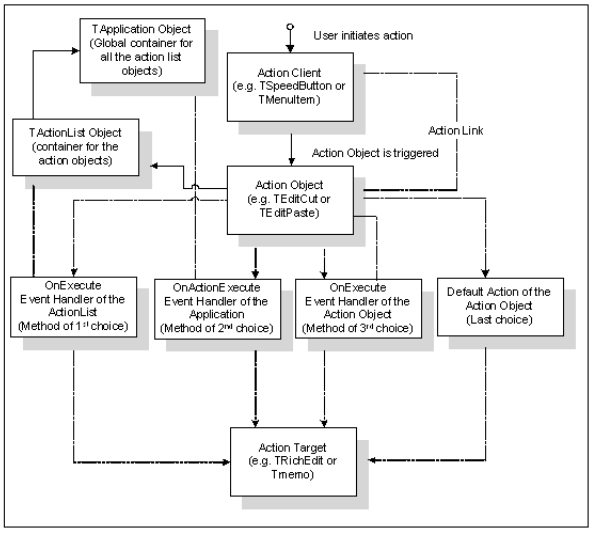
Introduction

The previous chapter provided readers with an introduction to VCL features to enable them to feel comfortable in writing VCL applications. This chapter focuses on some of the advanced and additional VCL topics that are required in typical Windows applications, including the SYSUTILS and FILECTRL units. In the VCL architecture, these units provide very useful routines and objects that are needed to interact with the operating system.

Actions and Action Lists

Action objects in VCL characterize the application's response to the most common user inputs like clicking a mouse or a button or selecting an item from the main menu. Programmers usually come across situations where they have to provide the same system response to multiple user actions. The C++Builder IDE lets us assign the same event handler to multiple events. But there is a more structured and automated way of doing this task in the VCL — using Action objects. Let us first identify the different objects that VCL provides us to work with actions. Figure 6-1 describes the basic elements that form part of the action triggering mechanism, and the typical sequence of events that occur when Action objects are used in the application.

Figure 6-1



Action Clients

The VCL controls that receive user input and initiate the linked action objects are called action clients. These controls have the Action property, which is a TAction object or one of its descendents. When the Action property of the action client is assigned to a valid Action object, an action link is established internally. An action link is an instance of TActionLink or one of its descendents. It is this action link that connects the Action object properties with the corresponding action client properties. The application programmer never uses the action link class directly. The Action object internally uses the action link. Component writers who wish to extend the action link behavior to other controls may create descendents of TActionLink. The VCL controls that behave like action clients include TSpeedBtn, TMenuItem, TButton, TBitBtn, TCheckBox, TRadioButton, and TForm.

Action Objects and the TAction Class

The TAction class represents the basic action that can be assigned to an action client. In fact, one action can be assigned to more than one action client. Doing so would enable all the action clients to initiate the same TAction object, and thus to behave identically.

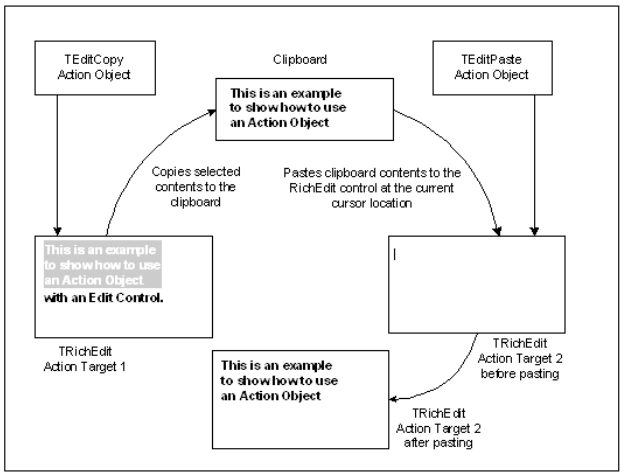
Types of Action Objects

There are two types of action objects that can be used in conjunction with action clients: standard actions and custom actions. Standard actions are predefined within the VCL framework and come with built-in functionality that can be used right away in your applications. These are instances of TAction descendent classes, such as TEditCut and TEditPaste. TEditCut and TEditPaste are descendents of TEditAction, which is further derived from TAction. The standard actions are grouped into categories of related tasks, such as the Edit category, which contains the standard actions relevant to edit controls, and the Format category, which contains the standard actions relevant to the formatting features of rich text. Table 6-1 provided at the end of this section describes the standard actions and their categories, as available in the VCL in C++Builder 6. Custom actions are TAction instances that are assigned to the action clients but require the appropriate event handler to be implemented by the programmer. It is very easy to use either standard actions or custom actions.

Action Targets

Action targets are those controls upon which the action objects act. If the action object performs one of the edit functions, then the action targets are descendents of TCustomEdit class, such as TEdit, TRichEdit, and TMemo. In this case, a TEditCopy action object copies the selected text from the target edit control and stores it in the clipboard, and a TEditPaste action object pastes the clipboard contents at the current cursor location in the target edit control. This cycle of actions is described pictorially in Figure 6-2.

Figure 6-2



If we use standard action objects of the VCL, then for every category of actions the set of action clients and the set of action targets are predetermined. For example, the standard actions in the Edit category are designed to work with TSpeedBtn and TMenuItem, but not with TButton and TBitBtn action clients. The corresponding action targets are the Edit controls that are descendents of the TCustomEdit class. Similarly, if we use the standard actions in the Window category, then the corresponding action target must be the parent form of a multiple document interface (MDI) application; these standard actions disable themselves if the action target is not the parent form of an MDI application or if it does not contain MDI children.

If we use custom action objects, then we need to write OnExecute event handlers for the action object, or for the Action List object that contains the action object, or for the application that contains the action object.

Action List Object

The Action List object is an instance of the TActionList class. It is a container of action objects. Action List is a non-visual VCL component that is dropped from the Standard page of the component palette. It is one of the two ways that C++Builder 6 supports the use of action objects. The other method is using the Action Manager and is discussed in the next section. It is easy to turn all the actions in an Action List object off or on by setting the State property to asSuspended or asNormal, respectively.

Using Standard Action Objects

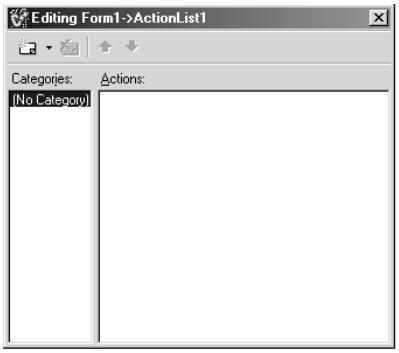
Let us write a sample application that uses the standard action objects. Follow these steps:

- Create a new Application project in the C++Builder 6 IDE.
- From the Standard page of the component palette, drop the ActionList component.
- From the Win32 page of the component palette, drop an ImageList component onto the form. Double-click the ImageList component, add at least one image to the list, and click the OK button to close the ImageList. The image we are going to add in the list here is not necessarily going to be used to display the button images. We are just making sure that the image list is not empty. Select the ActionList component and set its Images property to the ImageList component just created. Doing so will enable the ActionList to

automatically assign default button images to the standard action objects (only). The Images property must be set before choosing any standard actions in the ActionList component.

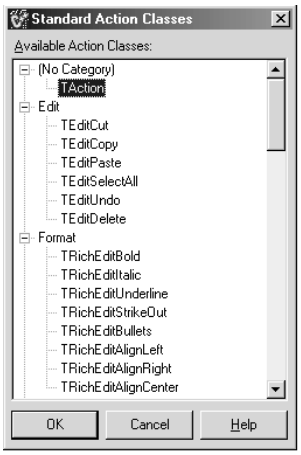
- Double-click the ActionList component on the form to display the ActionList editor. It should look like Figure 6-3.

Figure 6-3



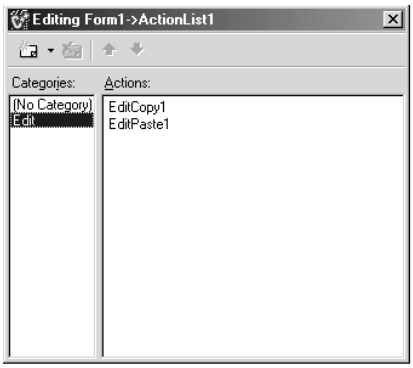
- Keeping the mouse pointer on the ActionList editor, click the right mouse button. A popup menu appears.
- Choose New Standard Action from the menu. The Standard Action Classes list is displayed as shown in Figure 6-4.

Figure 6-4



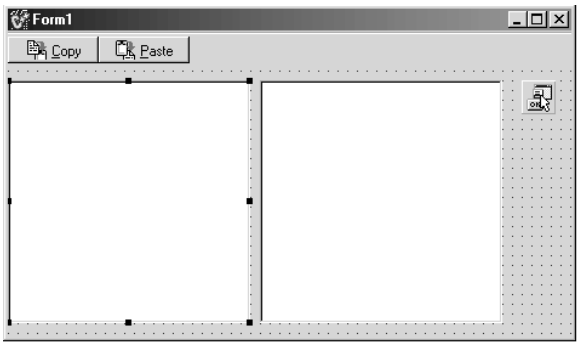
- From the list, choose TEditCopy and TEditPaste from the Edit category and click OK.
- The selected action objects and their category are created and displayed in the Action List Editor, as shown in Figure 6-5.

Figure 6-5



- From the Win32 page of the component palette, drop one ToolBar component and two RichEdit components. The ToolBar component automatically aligns itself to the top of the form. Manually align both the TRichEdit components and set their width and height both equal to 200 pixels in the Object Inspector. Double-click the Lines property of each of the RichEdit components and clear the values from the editor so that the components have no initial data in the client window.
- From the Additional page of the component palette, drop two SpeedBtn components onto the ToolBar. In the Object Inspector, set their Width property to 75 pixels so that the components appear wider. Set the Action property of the first SpeedBtn component to EditCopy1 and the second SpeedBtn component to EditPaste1. After assigning the Action property, each of the SpeedBtn components shows its respective Caption text, which is obtained from the action objects.
- At this time the form appears as shown in Figure 6-6. Save the project and compile.

Figure 6-6



- Run the executable. It looks like a small text editor application without much functionality other than copying the selected content of the edit window and pasting it back in another edit window. Initially the Copy button appears disabled. This button is enabled only after selecting text in an edit control. Since the edit controls are clear initially, type some text and test the Copy and Paste functionality as in a traditional text editor. Two edit controls are placed on the form to show you that the action objects automatically know their action target once you select the text to be copied or identify the location to paste the contents.

How Does the Application Find the Action Target for an Action Object?

The application follows a sequential order to find the action target. If no action target is found suitable for the action, then nothing happens. The sequence is as follows:

- The active control is the first potential action target.
- If the active control is not the right action target, then the application looks at the ActiveForm of the Screen.
- Finally the controls on the ActiveForm are searched, if the form itself is not an action target.

Using Custom Action Objects

Let us write a sample application to demonstrate the use of custom action objects. Perform the following tasks to create the sample application:

- Create a new Application project in the C++Builder 6 IDE.
- From the Standard page of the component palette, drop the Action List component.
- Double-click the dropped component on the form. The Action List Editor is displayed and looks like Figure 6-3, as discussed in the previous example.
- Keeping the mouse pointer on the Action List editor, click the right mouse button. A popup menu appears.
- Choose New Action from the menu. A new instance of TAction object is created in the list and displayed. Every time we choose New Action, a new instance is created. Each of these instances

represents a generic action object, which needs to be handled programmatically. For this sample application, let us limit ourselves to writing the action handler method for only one action object.

- From the Standard page of the component palette, drop two Button components onto the form. Set the Action property of both the Button objects to the same action object that we just created in the previous step.
- Double-click the OnExecute() event handler of the action object in the Object Inspector, and write the small piece of code as shown in Listing 6-1.
- Compile the project and execute the application. When you click either of the buttons, you get the same result. Figure 6-7 displays the result screen.

Listing 6-1

```
void __fastcall TForm1::Action1Execute(TObject *Sender)
{
    Application->MessageBox("You executed the custom action handler",
        "Action Message", MB_OK);
}
```

Figure 6-7

The point I am trying to make here is that you can provide the same action result through different channels. In this respect, any combination of Action Client objects can share the same action handler. By now, you may have also noticed that whenever the action object is assigned to the Action property of one or more action clients, the caption of the Action object is copied to the caption of Action Client. In fact, it is not just the

Caption property alone that is copied; rather, all the corresponding properties are copied. Since the Caption property is visible, we have noticed it; the others happen to not be visible. This copying of properties is handled by the Action Link object (which is an instance of TActionLink or its descendent) as discussed earlier in this section. However, the properties that are copied from the action objects may be overridden in the action clients either during design time or during run time.

How Does VCL Identify the Appropriate Action Handler for an Action?

Now let us examine the criteria that VCL follows to identify the appropriate action handler method for an action. Whether we use custom actions or standard actions, we are free to write our own action handler method for the Action object. When the user clicks an action client, VCL follows a dispatching sequence to find out the correct event handler to handle the action. An action handler method can be written at one or more of three different levels: ActionList level, Application level, and Action object level.

The OnExecute() method at the ActionList level and Action object level, and OnActionExecute() method at the Application level represent the event handlers for the action object. The dispatching sequence is: Action List object, Application object, and Action object. The following rules are applied while executing the action handler at all these levels:

- If an action handler is defined at only one of these levels, VCL just executes that action handler
- If an action handler is defined at more than one level, it tries to execute them all in the dispatching sequence mentioned above, provided the action handler at a previous execution level lets it continue to the next level. By this, I mean that if we set Handled = true at the previous execution level, the next level event handler is not executed, since we are satisfied with the previous event handler. If we do not set Handled = true explicitly, or if we set Handled = false explicitly, the next level event handler is executed if we wrote that event handler. A simple example is that if we wrote all three event handlers and we did not set Handled = true in any of them, all the event handlers would be executed in the dispatching sequence.
- Another parameter to the OnExecute (or OnActionExecute) method is a pointer to the TBasicAction object. This parameter helps us in writing single event handlers (at Action List and

Application levels) to handle more than one Action object by explicitly writing blocks of code for each Action object, as shown in Listing 6-2. This feature and the previous one together give us ample flexibility to control the Action objects' functionality.

- The scope of applicability of action handler functionality includes all the Action objects contained within the action handler level. However, one or more contained Action objects may be explicitly included in (or excluded from) the scope as mentioned in the previous paragraph.
- If we write a custom action handler at any one of the levels and an Action object falls within the scope of this action handler, the action handler functionality overrides any default functionality carried by the Action object (usually when the Action object is one of the standard actions).

Listing 6-2

```
void __fastcall TForm1::ActionList1Execute(TBasicAction *Action, bool &Handled)
{
    if (Action == Action1)
        Application->MessageBox("You executed the custom action handler",
        "Action List Message", MB_OK);
        Handled = true;
    }
}
```

Table 6-1

VCL Standard Actions Available in C++Builder 6		
Category	**Standard Actions**	**Description and Default Action**
Edit	TEditCut, TEditCopy, TEditPaste, TEditSelectAll, TEditUndo, TEditDelete	The Action objects in this category provide the standard edit actions. They are used with edit control targets that are derived from TCustomEdit. TEditAction is the base class for the descendent Action objects that override the ExecuteTarget method.

VCL Standard Actions Available in C++Builder 6		
Category	**Standard Actions**	**Description and Default Action**
Format	TRichEditBold, TRichEditItalic, TRichEditUnderline, TRichEditStrikeOut, TRichEditBullets, TRichEditAlignLeft, TRichEditAlignRlght, TRichEditAlignCenter	The Action objects in this category provide the standard text formatting features to rich text edit objects. TRichEditAction is the base class for the descendent Action objects that override the ExecuteTarget and UpdateTarget methods to implement the formatting feature.
Help	THelpContents, THelpTopicSearch, THelpOnHelp, THelpContextAction	The Action objects in this category provide the standard help functionality and can be used on any target. THelpAction is the base class for the descendents that each override the ExecuteTarget method to pass the command onto a help system.
Window	TWindowClose, TWindowCascade, TWindowTileHorizontal, TWindowTileVertical, TWindowMinimizeAll, TWindowArrange	The Action objects in this category provide standard window actions. The target control for these action objects is the parent form of an MDI application. The actions are executed on the MDI child windows. TWindowAction is the base class for the descendents that each override the ExecuteTarget method to implement the respective action.
File	TFileOpen, TFileSaveAs, TFilePrintSetup, TFileRun, TFileExit	The Action objects in this category are used to initiate the specific actions on the files, such as initiating the respective dialog or running an executable file (File Run action) or closing the application (File Exit action).
Search	TSearchFind, TSearchFindNext, TSearchFindReplace, TSearchFindFirst	The Action objects in this category provide text search functions on the target edit control. TSearchAction is the base class for the descendents that each override the ExecuteTarget method to display a modeless dialog. This dialog enables the user to enter search criteria as provided by the action.
Tab	TPreviousTab, TNextTab	The Action objects in this category provide the functionality to move the current page to the previous or next page. The target controls for these objects are descendents of TCustomTabControl, such as TPageControl and TTabControl. TTabAction is the base class for the descendents that each override the ExecuteTarget method to perform the necessary action.

VCL Standard Actions Available in C++Builder 6		
Category	**Standard Actions**	**Description and Default Action**
List	TListControlCopySelection, TListControlDeleteSelection, TListControlSelectAll, TListControlClearSelection, TListControlMoveSelection, TStaticListAction, TVirtualListAction	The target control for the Action objects in this category is a list control, such as ListBox, ListView, etc. The target control is identified by the ListControl property. Some of these Action objects require a destination list control object, identified by the Destination property. When a Destination list control is also used, the source list control is identified by the ListControl property. The functionality of these objects is explained here. For simplicity's sake the TListControl prefix is omitted. SelectAll selects all the items in the source list control. ClearSelection deselects all the selected items. CopySelection copies all the selected items from the source list control to the destination list control. MoveSelection moves all the selected items from the source list control to the destination list control. DeleteSelection deletes the selected items from the target list control. The TListControlAction is the base class for all the above descendent action classes in this category that each override the ExecuteTarget method to provide the respective functionality. StaticListAction supplies a static list of items created at design time to the list control. VirtualListAction supplies items dynamically to the list control, as coded in the OnGetItem event handler. TCustomListAction is the base class for the TStaticListAction and TVirtualListAction objects.
Dialog	TOpenPicture, TSavePicture, TColorSelect, TFontEdit, TPrintDlg	The Action objects in this category provide some Windows common dialogs in addition to those provided in the File category. The names of these objects are self-explanatory as to the actions that they support.

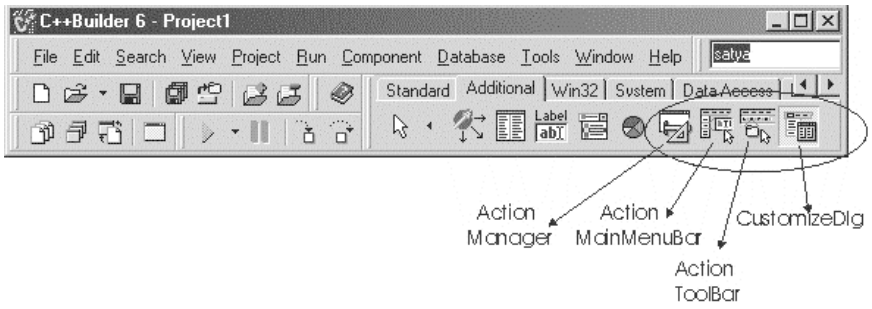
VCL Standard Actions Available in C++Builder 6		
Category	**Standard Actions**	**Description and Default Action**
Internet	TBrowseURL, TDownLoadURL, TSendMail	TBrowseURL launches the default browser to open a page at the specified URL using the URL property. TDownLoadURL starts downloading the file at the specified URL and periodically generates OnDownloadProgress events so that the users can be given feedback about the progress of the download process. The URL property indicates the file to be downloaded. TURL action is the base class for these actions. Controls linked to the TSendMail action object cause the application to send a MAPI mail message containing the message specified in the Text property.
Dataset	TDataSetFirst, TDataSetPrior, TDataSetNext, TDataSetLast, TDataSetInsert, TDataSetDelete, TDataSetEdit, TDataSetPost, TDataSetCancel, TDataSetRefresh	The Action objects in this category provide record navigation features in descendents of TDataSet component. The dataset component must be associated to a TDataSource component and the DataSource property of the Action objects must be set to this TDataSource component. Each of these Action objects provides action that corresponds to the dataset method with a similar name. The corresponding Action Client is disabled if a particular action is not relevant in a situation. For example, TDataSetFirst action object corresponds to the First() method of the dataset component. If the dataset is already pointing to the first record, then this action is not relevant at this time and hence the action client that is connected to the TDataSetFirst action object is disabled. The same concept applies to all the action objects. TDataSetAction is the base class for the action objects in this category that override the ExecuteTarget method to provide the respective functionality.
Tools	TCustomizeActionBars	This action object is used in conjunction with the ActionManager to provide run-time customization of action objects.

Visual Components That Render Action Objects

In C++Builder 6, new VCL components have been added to extend the Action object functionality to visually design menus and toolbars at both design time and run time. Figure 6-8 shows the component palette page containing these components. These components are:

- ActionManager
- ActionMainMenuBar
- ActionToolBar
- CustomizeDlg

Figure 6-8



ActionMainMenuBar is an instance of the TActionMainMenuBar class that contains the action client items and behaves very similarly to the TMainMenu object. ActionToolBar is an instance of the TActionToolBar class and renders the action client items as tool buttons. Both of these new container objects are linked to an ActionManager object, which is an instance of the TActionManager class. The ActionManager object houses all the action client items that are contained in ActionMainMenuBar as well as ActionToolBar. The action client items may be standard action objects or custom action objects. To add an ActionMainMenuBar component to the ActionManager, we have to drop the component onto the form that contains the ActionManager component. Later when we assign the ActionManager's Action objects to the ActionMainMenuBar, the VCL automatically creates a link from ActionMainMenuBar to ActionManager. We can add an ActionToolBar component to the ActionManager the same way we added the ActionMainMenuBar component, or we can add it through the ActionManager component itself as explained in the following steps.

The following procedure demonstrates the process of building a small Windows WordPad kind of application with a minimal amount of coding.

- Create a new Application project in the C++Builder 6 IDE. Save it anywhere on your hard disk with project and unit names of your choice.
- From the Additional page of the component palette, drop an ActionManager component and an ActionMainMenuBar component onto the form. The ActionMainMenuBar component automatically aligns itself to the top of the form. In the Object Inspector, set the following properties to make sure that the menu bar displays all four borders:

```
EdgeBorders->ebLeft = true;
EdgeBorders->ebTop = true;
EdgeBorders->ebRight = true;
EdgeBorders->ebBottom = true;
```

- From the Win32 page of the component palette, drop an ImageList component onto the form. Double-click the ImageList component, add at least one image to the list, and click OK to close the ImageList. The image we are going to add in the list here is not necessarily going to be used to display the button images. We are just making sure that the image list is not empty.
- Select the ActionManager component and set its Images property to the ImageList component created in the previous step. Doing so will enable the ActionManager to automatically assign default button images to the standard action objects. However, if we add any custom action objects to the ActionManager, no images are automatically set; we have to do it manually. In this example we only use standard action objects.
- Now double-click the ActionManager component. The ActionManager property editor, shown in Figure 6-9, appears. The property editor has three tab pages. Choose the Toolbars tab page, and click the New button twice. Two ActionToolBar components are created (named ActionToolBar1 and ActionToolBar2) on the form and are listed in the property editor.

Figure 6-9

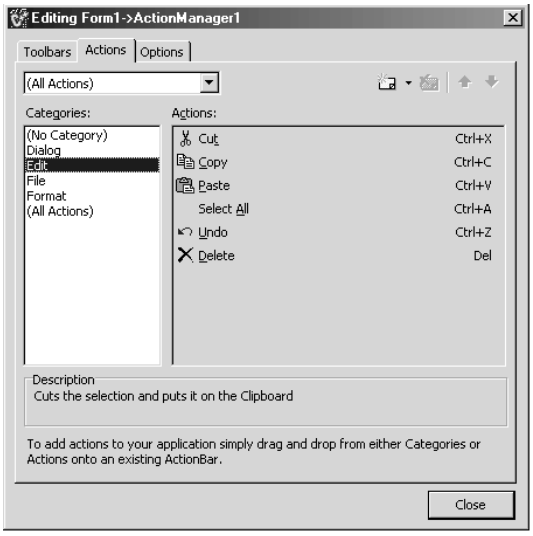
- Now select the Actions tab in the property editor.
- In the Object Inspector, set the following properties for both ActionToolBar components to make sure that the toolbars display all four borders:

```
EdgeBorders->ebLeft = true;
EdgeBorders->ebTop = true;
EdgeBorders->ebRight = true;
EdgeBorders->ebBottom = true;
```

- Keeping the mouse pointer on the ActionList editor, click the right mouse button. A popup menu appears. Choose New Standard Action from the menu. The Standard Action Classes list is displayed as shown in Figure 6-4. This is the same list that we saw in an earlier example.
- From the list of standard actions, choose all the action objects under the three categories File, Edit, and Format and the PrintDlg item from the Dialog category. More than one item can be selected from this list by pressing the Shift or Ctrl key and selecting the appropriate item. The selected items are highlighted. After completing the selection, click the OK button, which closes this list and adds the selected items to the Actions tab page of the ActionManager property editor.
- Now you can browse through the action objects added to the list. You may notice that the property editor automatically assigned the appropriate images to the action objects; since we assigned a

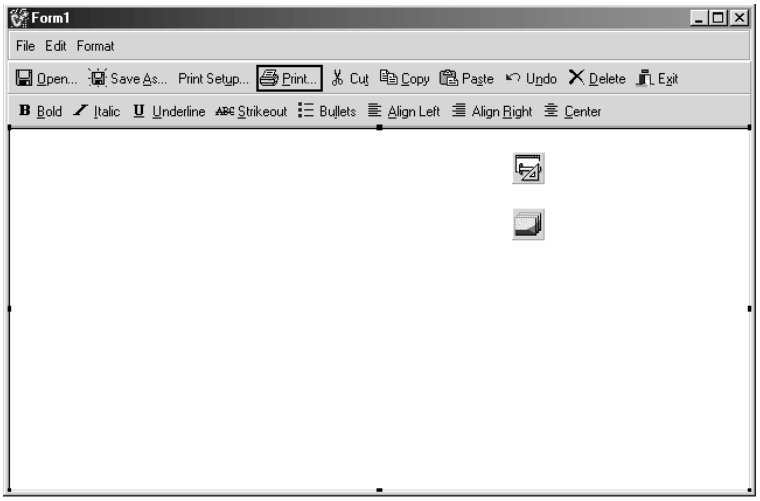
non-empty ImageList object to the ActionManager, we indicated to the VCL that we wish to use default images for the action clients. You may also notice that the default shortcut keys are assigned to the action objects. At this time, the property editor should look like Figure 6-10.

Figure 6-10



- Now the fun starts. Let us fill the menu bar and toolbars we created earlier. This can be done with a simple drag-and-drop operation. We can select action items individually or as a complete category, depending on how we wish to place the items on the menu bar and toolbars. In this example I place the items in a specific order; you may choose a different order. The drag-and-drop is achieved by selecting the desired item (action item or action category), holding the left mouse key, moving the mouse pointer to the menu bar or toolbar, and releasing the left mouse key.
- I place the File, Edit, and Format categories in the menu bar in the same order. Then I place the PrintDlg item from the Dialog category as a subitem in the File menu, below the Print Setup item.
- I place selected items from the File, Edit, and Dialog categories on the first toolbar. I finally place selected items from the Format category on the second toolbar. Please refer to Figure 6-11 to check the order.

Figure 6-11



- From the Win32 page, drop a RichEdit component onto the form, and set its Align property to alClient. Using the Object Inspector, clear the Lines property of the RichEdit component, so that the edit window looks clean.
- In the Object Inspector, set the following properties for the FileOpen1 action object to make sure that we work only with text files:

```
Dialog->DefaultExt = TXT;
Dialog->Filter = Text files (*.TXT)|*.TXT;
```

  Repeat the step for the FileSaveAs1 action object.

  Notice that I am not enclosing the string values in double quotes, because I am setting these properties in the Object Inspector. However, you have to enclose any strings with double quotes to set string values during run time.
- Now let us write a few event handlers to complete this project. Since we are using standard action objects, you may immediately question why we have to write event handlers. The Windows common dialogs are a little more than just copy, paste, or formatting text. Each of the dialogs that we have used in this application needs some programming to react to the user's choices. We have to write event handlers to tell the VCL what to do when the user makes choices or enters values in the dialog boxes. Also if we need to incorporate extra functionality beyond what is provided by the standard action objects, we have to write code. But recall that if

we write action object event handlers, then we would be losing the default action functionality provided by the VCL.

- To keep the coding simple, we will create event handlers for just three of the actions: FileOpen1, FileSaveAs1, and PrintDlg1. Each of these action objects has a Dialog property, which represents the corresponding Windows common dialog object provided by the VCL. Each of these Windows common dialogs have an Execute() method, which returns true if the user clicked the OK button and false if the user clicked the Cancel button. But we are not using these dialogs directly; rather, we are invoking them through the action objects. The action objects provide OnAccept() and OnCancel() event handlers corresponding to the true and false conditions. Therefore we have to implement the OnAccept() event handlers for the three dialogs to tell the VCL what to do in response to user inputs. I also created a custom member method PrintText(TCanvas* Canvas) in the main form class, which writes text lines from the RichEdit component to the printer's canvas, and this method is invoked by the OnAccept() event handler of the PrintDlg1. I am not discussing more on the code here. Please refer to Listing 6-3 for the cpp file of the unit and Listing 6-4 for the corresponding header file.
- Compile the project and execute. You will wonder how we were able to create a simple text editor with reasonable functionality so quickly. Please note that the print function we have incorporated here is not complete. More needs to be worked on to add features like controlling page size, inserting page breaks, etc.

Listing 6-3 (Unit1.cpp)

```
//---------------------------------------------------------------------------

#include <vcl.h>
#pragma hdrstop

#include "Unit1.h"
//---------------------------------------------------------------------------
#pragma package(smart_init)
#pragma resource "*.dfm"
TForm1 *Form1;
//---------------------------------------------------------------------------
__fastcall TForm1::TForm1(TComponent* Owner)
        : TForm(Owner)
{
```

```
}
//---------------------------------------------------------------------------

void __fastcall TForm1::FileOpen1Accept(TObject *Sender)
{
        AnsiString fileName = FileOpen1->Dialog->FileName;
        RichEdit1->Lines->Clear();
        RichEdit1->Lines->LoadFromFile(fileName);
}
//---------------------------------------------------------------------------
void __fastcall TForm1::FileSaveAs1Accept(TObject *Sender)
{
        AnsiString fileName = FileSaveAs1->Dialog->FileName;
        RichEdit1->Lines->SaveToFile(fileName);
}
//---------------------------------------------------------------------------
void __fastcall TForm1::PrintDlg1Accept(TObject *Sender)
{
    TPrinter *APrinter = Printer();
    APrinter->Copies = PrintDlg1->Dialog->Copies;
    int i;
    for (i=0; i < APrinter->Copies; i++) {
        APrinter->BeginDoc();
        PrintText(APrinter->Canvas);
        APrinter->EndDoc();
    }
}
//---------------------------------------------------------------------------
void __fastcall TForm1::PrintText(TCanvas *Canvas)
{
    int i, x;
    AnsiString S("Text String");       // sample text to determine text height
    x = Canvas->TextHeight(S);
    for (i=0; i < RichEdit1->Lines->Count; i++) {
        S = RichEdit1->Lines->Strings[i];
        Canvas->TextOut(1, x * i, S);
    }
}
//---------------------------------------------------------------------------
```

Listing 6-4 (Unit1.h)

```
//---------------------------------------------------------------------------

#ifndef Unit1H
#define Unit1H
//---------------------------------------------------------------------------
#include <Classes.hpp>
```

```
#include <Controls.hpp>
#include <StdCtrls.hpp>
#include <Forms.hpp>
#include <ActnCtrls.hpp>
#include <ActnList.hpp>
#include <ActnMan.hpp>
#include <ActnMenus.hpp>
#include <ToolWin.hpp>
#include <ImgList.hpp>
#include <ExtActns.hpp>
#include <StdActns.hpp>
#include <ComCtrls.hpp>
//---------------------------------------------------------------------------
class TForm1 : public TForm
{
__published:     // IDE-managed Components
        TActionManager *ActionManager1;
        TActionMainMenuBar *ActionMainMenuBar1;
        TImageList *ImageList1;
        TActionToolBar *ActionToolBar1;
        TActionToolBar *ActionToolBar2;
        TEditCut *EditCut1;
        TEditCopy *EditCopy1;
        TEditPaste *EditPaste1;
        TEditSelectAll *EditSelectAll1;
        TEditUndo *EditUndo1;
        TEditDelete *EditDelete1;
        TRichEditBold *RichEditBold1;
        TRichEditItalic *RichEditItalic1;
        TRichEditUnderline *RichEditUnderline1;
        TRichEditStrikeOut *RichEditStrikeOut1;
        TRichEditBullets *RichEditBullets1;
        TRichEditAlignLeft *RichEditAlignLeft1;
        TRichEditAlignRight *RichEditAlignRight1;
        TRichEditAlignCenter *RichEditAlignCenter1;
        TFileOpen *FileOpen1;
        TFileSaveAs *FileSaveAs1;
        TFilePrintSetup *FilePrintSetup1;
        TFileRun *FileRun1;
        TFileExit *FileExit1;
        TPrintDlg *PrintDlg1;
        TRichEdit *RichEdit1;
        void __fastcall FileOpen1Accept(TObject *Sender);
        void __fastcall FileSaveAs1Accept(TObject *Sender);
        void __fastcall PrintDlg1Accept(TObject *Sender);
private:     // User declarations
public:      // User declarations
        __fastcall TForm1(TComponent* Owner);
        void __fastcall PrintText(TCanvas *Canvas);
```

```
};
//---------------------------------------------------------------------------
extern PACKAGE TForm1 *Form1;
//---------------------------------------------------------------------------
#endif
```

Since we have seen the ActionManager in action, now we can talk more about it. This component stores all the necessary information to effectively re-create the action-based user interface. The contents of the component can be saved to a stream object (such as a memory stream or file stream) and be retrieved later to dynamically create the user interface. The benefits of object streamability should be familiar; we can create multiple user interfaces and dynamically change them at run time, or we can pass the user interface layout from one process to another (even across the network) and enable a remote application to dynamically generate and display its user interface.

The last component in this set, CustomizeDlg, is an instance of TCustomizeDlg class. When connected to an ActionManager object through its ActionManager property, all the action objects created during design time will be available to the user for customization. The user cannot create new toolbars and new action items at run time, but will be able to customize all components created during design time. This includes making the action clients and toolbars visible or invisible, removing the action clients from the toolbars, and changing the order of appearance of the action clients on the toolbars.

Windows Common Dialogs

In the previous section we had the opportunity to work with some of the Windows common dialogs. I now take the opportunity to discuss them in detail. A dialog is a window that intercepts the application execution and asks the user for additional input. During the normal flow of application execution, it sometimes becomes necessary that the application stop unless the user provides additional information, such as selecting specific system resources. For example, when the user wants to print the active document to the printer, and selects the corresponding menu option, the application has to know which printer (among the installed ones) receives the document for printing. Often dialogs are displayed modally, because the user cannot continue with the application unless the dialog is closed. C++Builder 6 comes with VCL objects for Windows common dialogs as listed here.

- The TColorDialog component displays a Windows dialog box for selecting colors. When the Execute() method is called, the dialog is activated and appears on the screen. The user closes the dialog by clicking OK or Cancel. The Execute() method returns true if the user made a choice or false if no choice was made.
- The TFindDialog component displays a modeless dialog window that prompts the user for a search string. When the Execute() method is called, the dialog is activated and displayed on the screen, and a Boolean value of true is returned. When the user clicks the Find Next button, the FindText property is set to the search string that the user entered. The dialog remains open until the user clicks the Cancel button. Since the dialog is modeless, the user is able to get back to the application (usually a document) while the dialog is displayed; this enables the user to repeatedly execute the search function by clicking the Find Next button.
- The TFontDialog component displays a Windows dialog box for selecting a font (and style) from the list of fonts loaded in the system. When the Execute() method is called, the dialog is activated and appears on the screen. The user closes the dialog by clicking either the OK or Cancel button. The Execute() method returns true if the user made a choice or false if no choice was made.
- The TOpenDialog component displays a Windows dialog box to open a disk file. When the Execute() method is called, the dialog is activated and appears on the screen. The user closes the dialog by clicking either the OK or Cancel button. The Execute() method returns true if the user made a choice or false if no choice was made. The selected (or entered) filename is available in the FileName property. The Filter property controls what type of filenames must be displayed in the list. The DefaultExt property sets the default file extension if the user does not specify it.
- The TPrintDialog component displays a Windows dialog box to send print jobs to the printer (selected from a list). The dialog compiles the list of printers depending on the drivers installed on the machine. When the Execute() method is called, the dialog is activated and appears on the screen. The user closes the dialog by clicking either the Print or Cancel button. The Execute() method returns true if the user clicked Print and false if the user clicked Cancel.

- The TPrinterSetupDialog component displays a dialog box to select a printer (from a list) and set its configuration options. When the Execute() method is called, the dialog is activated and appears on the screen. The user closes the dialog by clicking either OK or Cancel. The Execute() method configures the printer and returns true if the user made a choice or false if no choice was made.
- The TReplaceDialog is a special version of TFindDialog that prompts the user for both a search string and a replace string. The ReplaceText property holds the new text that replaces the old text, and its value is set from the value entered by the user, after the user clicks the Replace button or ReplaceAll button.
- The TSaveDialog component displays a Windows dialog box to save a file to disk. When the Execute() method is called, the dialog is activated and appears on the screen. The user closes the dialog by clicking either OK or Cancel. The Execute() method returns true if the user made a choice or false if no choice was made. The selected (or entered) filename is available in the FileName property. The Filter property controls what type of filenames must be displayed in the list. The DefaultExt property sets the default file extension if the user does not specify it.

The TCommonDialog class encapsulates most of the functionality of the Windows common dialogs, and the descendent classes add new properties and methods or override methods in the base class to provide the necessary functionality.

If you wish to write your own version of a Windows common dialog, it is recommended that you descend from TCommonDialog in order to avoid the complexity of writing the component from scratch.

Windows Drag and Drop

Drag and drop is a very useful feature provided by the Windows operating systems. The mouse is used as an agent to coordinate the drag-and-drop operation between the two entities, the source and the target objects. The source object is the one being dragged when the mouse button is held, and the target object is the one on which the source is dropped when the mouse button is released. The drag-and-drop operation enables the application user to transfer (or copy) data elements from the source to the target without any data entry involved, thus improving user productivity

and hence usability of the application. Drag and drop is considered to be one of the most useful GUI design principles. However, it should be used where it is appropriate to use. The properties and methods supporting drag and drop are introduced in the TControl object and are available in all the descendent objects.

Properties and Methods of the Source Object

For the control to act as a drag source, the following property must be set:

```
DragKind = dkDrag;
```

To enable dragging to start automatically when the mouse's left button is held, the DragMode property must be set to dmAutomatic. To manually control the drag operation, the property must be set to dmManual, which is the default value. If DragMode is set to dmManual, then the dragging operation starts when the BeginDrag() method is called in the OnMouseDown() event. The definitions of these methods are given here.

```
void __fastcall BeginDrag(bool Immediate, int Threshold);
```

If the Immediate parameter is true, the dragging starts immediately after the user presses the left mouse button. If the Immediate parameter is false, the dragging starts after the mouse is moved Threshold number of pixels after pressing the left button.

```
typedef void __fastcall (__closure *TMouseEvent)(System::TObject* Sender,
      TMouseButton Button, Classes::TShiftState Shift, int X, int Y);
__property TMouseEvent OnMouseDown = {read=FOnMouseDown, write=FOnMouseDown};
```

The Sender parameter is the drag source object. TMouseButton indicates whether the mouse button is the left, right, or middle button. TShiftState indicates the state of the Alt, Ctrl, and Shift keys and the mouse buttons. X and Y are the pixel coordinates of the mouse pointer in the client area of the Sender. In this event handler, we can access the source object, the pressed mouse button, and the position coordinates of the mouse pointer, and hence the contents of the source object.

Event Handlers for the Drop Target

The control that is going to accept the dropped control is called the drop target or drag target. In the true sense of accepting a dropped control, it means that the drop target control is willing to take the data passed by the source control. For the drop target, there are no properties to be set or

methods to be called; we just have to implement two event handlers, OnDragOver and OnDragDrop.

When the mouse is moving over any control after capturing the drag source, the OnDragOver event handler is fired for that control. If we do not implement the OnDragOver event handler for a control, the drag operation goes to waste automatically without dropping the object anywhere. Therefore, we implement the OnDragOver event handler for the drop target control. This event handler has several parameters; the Source parameter is the control that is being dragged (if it is a simple drag) or a custom drag object (if we implement a custom drag object), the Sender parameter is the control for which we are implementing the event handler, X and Y are the mouse positional coordinates, and Accept is a Boolean parameter that is true by default. If we set the parameter Accept to true, the control acts as a drop target and accepts the dropped object. If we set Accept to false or if we do not implement this event handler, the control does not accept the drag source.

In the OnDragDrop event handler we write the code to unpack (obtain) the values from the Source object, and do whatever we intended to do in the drag-and-drop operation.

Custom Drag Objects

When the source control is dropped on a target, the source control is sent as the Source parameter in the target event handlers that receive the dragged object. At times we may face circumstances such as having to implement dragging from multiple controls and dropping on a single target, having to implement drag and drop across controls hosted in separate DLLs or the main EXE file of the same application, or implementing custom drag images other than the default ones provided in C++Builder 6. The point I am trying to make here is that there may be complex drag-and-drop situations for which the default behavior of the source control object may not be sufficient. To accommodate such circumstances, the VCL lets us implement custom drag objects through the TDragObject class and its descendents. If we intend to use this object, we have to implement the OnStartDrag event handler. Its definition is given below:

```
typedef void __fastcall (__closure *TStartDragEvent)(System::TObject* Sender,
      TDragObject* &DragObject);
__property TStartDragEvent OnStartDrag = {read=FOnStartDrag,
      write=FOnStartDrag};
```

Notice that the TDragObject object is one of the parameters to this event handler. If we implement this event handler, it is triggered when the user starts the drag operation. We create an instance of TDragObject object or one of its descendent classes (as required), and set it to the DragObject parameter. Then the Source parameter in the target event handlers will be this DragObject and not the control that is initiating the drag operation. If we use the TDragObject class itself, we may be doing minimal customization, but we can descend a class from this base class and add more customization. Another feature of this class is that its Instance property returns the module handle of the executable (DLL or EXE) that contains this object.

The TDragControlObject and TDragControlObjectEx classes are notable descendents of the TDragObject class. They can be used to drop a control other than the control being dragged. We can instantiate an object of these classes by passing the control to be dropped as a parameter to the constructor. Both of these classes provide the same functionality, but differ in one characteristic: if we use TDragControlObject (or its descendent), we will have to free its object after finishing with it, while if we use TDragControlObjectEx (or its descendent), we do not have to free its object.

Let us work through an example to demonstrate customizing drag and drop. The following steps illustrate this:

- Create a new VCL application. The IDE automatically creates the project and unit files. Save the project and unit files with names of your choice and in a directory of your choice. I named the project CustomDragAndDrop.bpr and the unit file CustDrag.cpp.
- On the form drop three drag source controls: one TListBox component, one TEdit component, and one TBitBtn component. The idea is to demonstrate dragging data items from different source controls.
- For each of these objects, set the DragMode property to dmManual. This will give us the opportunity to demonstrate implementation of manual drag.
- Then drop a second TListBox component, which acts like the drop target.
- Create a descendent of TDragControlObjectEx class. I called this class TDerivedDragObject. Add a constructor method that accepts a TControl pointer as parameter. Also add a member fDragItem of type AnsiString. We create a member variable of this class in the

form header file. Hence, this definition must appear before the form class definition. I presume that I do not have to explicitly tell a C++ programmer how to organize the class definition and implementation code. For simplicity's sake, I included this code in the same form header file, before the form class definition:

```
class TDerivedDragObject : public TDragControlObjectEx {
public:         // user defined memebers
        __fastcall TDerivedDragObject(TControl*fControl);
        AnsiString fDragItem;
};
```

- In the form class definition, add a public member of type pointer to the class TDerivedDragObject:

```
TDerivedDragObject* fCustomDragObject;
```

- Implement the simple constructor for the class we created. Again, for simplicity's sake, I included this code in the form cpp file itself:

```
__fastcall TDerivedDragObject::TDerivedDragObject(TControl* fControl)
        : TDragControlObjectEx(fControl)
{
}
```

- Here I would like to mention that I implemented a very simple descendent class just to demonstrate how it can be implemented. You are free to extend this to include more complex data members to pass through this object.
- For each of the three components that we placed on the form, we implement the OnMouseDown and OnStartDrag event handlers. In the OnMouseDown event handler we call the BeginDrag event handler of the component itself. In the OnStartDrag event handler make sure that the data item you are passing is not null, and then set this data item to the fDragItem member of the drag object. Finally, set the custom drag object that we created to the DragObject parameter.
- Now implement the OnDragOver event handler for the drop target list box. In this event handler the important parameter is the Boolean value Accept. Set this value to true if the Source parameter is a drag object type; otherwise, set it to false. In this event handler we are deciding whether the drop target is going to accept the dragged object or not.

```
if (IsDragObject(Source))
    Accept = true;
```

```
    else
        Accept = false;
```

- Finally we implement the OnDragDrop event handler for the drop target list box. Notice that the Source parameter is the custom drag object (that we created earlier) and not the control that is being dragged. From the Source object, we extract the fDragItem data member and display the value in the target list box. This program clearly demonstrates that by implementing custom drag objects, we are able to package data items from different sources and send it to the drop target.
- The complete source code for the program is given in Listing 6-5 (CustDrag.cpp file) and Listing 6-6 (corresponding header CustDrag.h file).

Listing 6-5 (CustDrag.cpp)

```
//---------------------------------------------------------------------------

#include <vcl.h>
#pragma hdrstop

#include "CustDrag.h"
//---------------------------------------------------------------------------
#pragma package(smart_init)
#pragma resource "*.dfm"
TCustDragAndDrop *CustDragAndDrop;
//---------------------------------------------------------------------------
__fastcall TDerivedDragObject::TDerivedDragObject(TControl* fControl)
        : TDragControlObjectEx(fControl)
{
}
//---------------------------------------------------------------------------
__fastcall TCustDragAndDrop::TCustDragAndDrop(TComponent* Owner)
        : TForm(Owner)
{
}
//---------------------------------------------------------------------------

void __fastcall TCustDragAndDrop::ListBox1MouseDown(TObject *Sender,
      TMouseButton Button, TShiftState Shift, int X, int Y)
{
        TListBox* lb = (TListBox*)Sender;
        lb->BeginDrag(true,5);
}
//---------------------------------------------------------------------------
```

```
void __fastcall TCustDragAndDrop::ListBox1StartDrag(TObject *Sender,
      TDragObject *&DragObject)
{
        // Create an instance of TDerivedDragObject object and
        // pass it as the DragObject
        TListBox* flb1 = (TListBox*)Sender;
        // Create the custom drag object instance for list box object
        fCustomDragObject = new TDerivedDragObject(flb1);

        // If the list box is empty or no item is selected do nothing
        if (flb1->Items->Count <=0)
                return;
        if (flb1->ItemIndex <0)
                return;
        // Set the data to be passed to the drop target
        fCustomDragObject->fDragItem = flb1->Items->Strings[flb1->ItemIndex];
        // Set the drag object to the custom drag object
        DragObject = fCustomDragObject;
}
//---------------------------------------------------------------------------

void __fastcall TCustDragAndDrop::Edit1MouseDown(TObject *Sender,
      TMouseButton Button, TShiftState Shift, int X, int Y)
{
        TEdit* edit1 = (TEdit*)Sender;
        edit1->BeginDrag(false,5);
}
//---------------------------------------------------------------------------

void __fastcall TCustDragAndDrop::Edit1StartDrag(TObject *Sender,
      TDragObject *&DragObject)
{
        // Create an instance of TDerivedDragObject object and
        // pass it as the DragObject
        TEdit* edit1 = (TEdit*)Sender;
        // Create the custom drag object instance for the edit box object
        fCustomDragObject = new TDerivedDragObject(edit1);

        // If the edit box is empty, do nothing
        if (edit1->Text == "")
                return;
        // Set the data to be passed to the drop target
        fCustomDragObject->fDragItem = edit1->Text;
        // Set the drag object to the custom drag object
        DragObject = fCustomDragObject;
}
//---------------------------------------------------------------------------

void __fastcall TCustDragAndDrop::BitBtn1MouseDown(TObject *Sender,
```

```
      TMouseButton Button, TShiftState Shift, int X, int Y)
{
        TBitBtn* bbtn1 = (TBitBtn*)Sender;
        bbtn1->BeginDrag(true,5);
}
//---------------------------------------------------------------------------

void __fastcall TCustDragAndDrop::BitBtn1StartDrag(TObject *Sender,
      TDragObject *&DragObject)
{
        // Create an instance of TDerivedDragObject object and
        // pass it as the DragObject
        TBitBtn* bbtn1 = (TBitBtn*)Sender;
        // Create the custom drag object instance for the bitbtn object
        fCustomDragObject = new TDerivedDragObject(bbtn1);

        // If the button caption is empty, do nothing
        if (bbtn1->Caption == "")
                return;
        // Set the data to be passed to the drop target
        fCustomDragObject->fDragItem = bbtn1->Caption;
        // Set the drag object to the custom drag object
        DragObject = fCustomDragObject;
}
//---------------------------------------------------------------------------

void __fastcall TCustDragAndDrop::ListBox2DragOver(TObject *Sender,
      TObject *Source, int X, int Y, TDragState State, bool &Accept)
{
        // If the source is an instance of TDragObjet or its descendent
        // then accept the dragged item
        if (IsDragObject(Source))
                Accept = true;
        else
                Accept = false;
}
//---------------------------------------------------------------------------

void __fastcall TCustDragAndDrop::ListBox2DragDrop(TObject *Sender,
      TObject *Source, int X, int Y)
{
        TDerivedDragObject* fdo = (TDerivedDragObject*)Source;
        AnsiString fDraggedItem = fdo->fDragItem;
        TListBox* flb2 = (TListBox*)Sender;
        if (flb2->Items->Count > 0)
                flb2->Items->Clear();
        flb2->Items->Add(fDraggedItem);
}
//---------------------------------------------------------------------------
```

Listing 6-6 (CustDrag.h)

```
//---------------------------------------------------------------------------

#ifndef CustDragH
#define CustDragH
//---------------------------------------------------------------------------
#include <Classes.hpp>
#include <Controls.hpp>
#include <StdCtrls.hpp>
#include <Forms.hpp>
#include <Buttons.hpp>
//---------------------------------------------------------------------------
class TDerivedDragObject : public TDragControlObjectEx {
public:         // user defined members
        __fastcall TDerivedDragObject(TControl*fControl);
        AnsiString fDragItem;
};
//---------------------------------------------------------------------------
class TCustDragAndDrop : public TForm
{
__published:     // IDE-managed Components
        TListBox *ListBox1;
        TListBox *ListBox2;
        TEdit *Edit1;
        TBitBtn *BitBtn1;
        void __fastcall ListBox1MouseDown(TObject *Sender,
          TMouseButton Button, TShiftState Shift, int X, int Y);
        void __fastcall ListBox1StartDrag(TObject *Sender,
          TDragObject *&DragObject);
        void __fastcall Edit1MouseDown(TObject *Sender,
          TMouseButton Button, TShiftState Shift, int X, int Y);
        void __fastcall Edit1StartDrag(TObject *Sender,
          TDragObject *&DragObject);
        void __fastcall BitBtn1MouseDown(TObject *Sender,
          TMouseButton Button, TShiftState Shift, int X, int Y);
        void __fastcall BitBtn1StartDrag(TObject *Sender,
          TDragObject *&DragObject);
        void __fastcall ListBox2DragOver(TObject *Sender, TObject *Source,
          int X, int Y, TDragState State, bool &Accept);
        void __fastcall ListBox2DragDrop(TObject *Sender, TObject *Source,
          int X, int Y);

private:      // User declarations
public:       // User declarations
        __fastcall TCustDragAndDrop(TComponent* Owner);
        TDerivedDragObject* fCustomDragObject;
};
//---------------------------------------------------------------------------
```

```
extern PACKAGE TCustDragAndDrop *CustDragAndDrop;
//---------------------------------------------------------------------------
#endif
```

Drag and Drop Across Modules in an Application

Another interesting aspect of custom drag and drop is the ability to implement dragging from one module and dropping onto another module of the same application. The following steps pertain to an application that has a main EXE program and a DLL. The concept can be extended easily to applications containing more than one DLL. The complete source code for both projects is presented at the end of the discussion.

- Create a class file (a simple unit file with a corresponding header file) containing the definition and implementation of the TDerivedDragObject class. For simplicity I am reusing the same class definition as in the previous example. The only difference is that this time I am implementing it in separate unit and header files. The reason is that I have to include this class definition in two projects, one for the main EXE and the other for the DLL. Name the unit file CustomDragObject.cpp. The corresponding header file is automatically named CustomDragObject.h by the IDE. Listings 6-7 and 6-8, respectively, display these files.
- Create a main application that generates an EXE program when built. Save the files in a directory of your choice with names of your choice. I named the project InterModuleDragExeProject.bpr and the main form source file InterModuleExeForm.cpp. Listings 6-9 and 6-10 display the cpp and header files, respectively. Add the CustomDragObject.cpp unit to this project and include the corresponding header file in the header file of the form. You need to also include the DLL source header file (as explained in the next step) in the form header file. Also add a public member of type pointer to the class TDerivedDragObject in the form class definition:

  ```
  TDerivedDragObject* fCustomDragObject;
  ```

- Drop a TListBox component on the form to act as the drag source object, and add a few items using the Object Inspector. Since we are implementing custom drag, this component is used to initiate the drag operation. Implement the OnStartDrag event handler for this component. Also drop a TButton component on the form and

implement its OnClick event handler with code to display the DLL form.

- Create a DLL application and save the files with appropriate names, in a directory of your choice. I named the project InterModuleDragDllProject.bp, and the source unit containing the DLLEntryPoint function InterModuleDragDllSource.cpp. As discussed in the chapter "VCL Explored," I manually created a header file for the latter program so that I can include it in the main form header file in the EXE application. This header file contains the definition of a function that invokes the form embedded in the DLL. Listings 6-11 and 6-12 display the DLL source and header files, respectively.
- Create a form to be added to the DLL project. I named this form InterModuleDragDllForm.cpp. Listings 6-13 and 6-14 display the cpp and header files, respectively. On this form, add a TListBox component to act as the drag target. Implement the OnDragOver and OnDragDrop event handlers for the list box.
- Build the two projects and execute the main EXE program. When you click the button on the main form, the DLL form is displayed. Now you can test dragging the individual items from the main form list box to the DLL form list box.

Listing 6-7 (CustomDragObject.cpp)

```
//---------------------------------------------------------------------------
#pragma hdrstop
#include "CustomDragObject.h"
//---------------------------------------------------------------------------

#pragma package(smart_init)
__fastcall TDerivedDragObject::TDerivedDragObject(TControl* fControl)
        : TDragControlObjectEx(fControl)
{
}
//---------------------------------------------------------------------------
```

Listing 6-8 (CustomDragObject.h)

```
//---------------------------------------------------------------------------
#ifndef CustomDragObjectH
#define CustomDragObjectH
#include <vcl.h>
#include <windows.h>
```

```
//---------------------------------------------------------------------------
class TDerivedDragObject : public TDragControlObjectEx {
public:         // user defined memebers
        __fastcall TDerivedDragObject(TControl*fControl);
        AnsiString fDragItem;
};
//---------------------------------------------------------------------------
#endif
```

Listing 6-9 (InterModuleExeForm.cpp)

```
//---------------------------------------------------------------------------
#include <vcl.h>
#pragma hdrstop

#include "InterModuleDragExeForm.h"
//---------------------------------------------------------------------------
#pragma package(smart_init)
#pragma resource "*.dfm"
TForm1 *Form1;
//---------------------------------------------------------------------------
__fastcall TForm1::TForm1(TComponent* Owner)
        : TForm(Owner)
{
}
//---------------------------------------------------------------------------
void __fastcall TForm1::Button1Click(TObject *Sender)
{
    CreateForm(this);
}
//---------------------------------------------------------------------------

void __fastcall TForm1::ListBox1StartDrag(TObject *Sender,
      TDragObject *&DragObject)
{
        // Create an instance of TDerivedDragObject object and
        // pass it as the DragObject
        TListBox* flb1 = (TListBox*)Sender;
        // Create the custom drag object instance for list box object
        fCustomDragObject = new TDerivedDragObject(flb1);

        // If the list box is empty or no item is selected do nothing
        if (flb1->Items->Count <=0)
                return;
        if (flb1->ItemIndex <0)
                return;
        // Set the data to be passed to the drop target
        fCustomDragObject->fDragItem = flb1->Items->Strings[flb1->ItemIndex];
```

```
        // Set the drag object to the custom drag object
        DragObject = fCustomDragObject;
}
//---------------------------------------------------------------------------
```

Listing 6-10 (InterModuleExeForm.h)

```
//---------------------------------------------------------------------------

#ifndef InterModuleDragExeFormH
#define InterModuleDragExeFormH
//---------------------------------------------------------------------------
#include <Classes.hpp>
#include <Controls.hpp>
#include <StdCtrls.hpp>
#include <Forms.hpp>
#include "CustomDragObject.h"
#include "InterModuleDragDllSource.h"
//---------------------------------------------------------------------------
class TForm1 : public TForm
{
__published:     // IDE-managed Components
        TListBox *ListBox1;
        TButton *Button1;
        void __fastcall Button1Click(TObject *Sender);
        void __fastcall ListBox1StartDrag(TObject *Sender,
          TDragObject *&DragObject);
private:     // User declarations
public:       // User declarations
        __fastcall TForm1(TComponent* Owner);
        TDerivedDragObject* fCustomDragObject;
};
//---------------------------------------------------------------------------
extern PACKAGE TForm1 *Form1;
//---------------------------------------------------------------------------
#endif
```

Listing 6-11 (InterModuleDragDllSource.cpp)

```
//---------------------------------------------------------------------------
#include <vcl.h>
#include <windows.h>
#pragma hdrstop
//---------------------------------------------------------------------------
//   Important note about DLL memory management when your DLL uses the
//   static version of the RunTime Library:
//
//   If your DLL exports any functions that pass String objects (or structs/
```

```
//   classes containing nested Strings) as parameter or function results,
//   you will need to add the library MEMMGR.LIB to both the DLL project and
//   any other projects that use the DLL.  You will also need to use MEMMGR.LIB
//   if any other projects which use the DLL will be performing new or delete
//   operations on any non-TObject-derived classes which are exported from the
//   DLL. Adding MEMMGR.LIB to your project will change the DLL and its calling
//   EXE's to use the BORLNDMM.DLL as their memory manager.  In these cases,
//   the file BORLNDMM.DLL should be deployed along with your DLL.
//
//   To avoid using BORLNDMM.DLL, pass string information using "char *" or
//   ShortString parameters.
//
//   If your DLL uses the dynamic version of the RTL, you do not need to
//   explicitly add MEMMGR.LIB as this will be done implicitly for you
//---------------------------------------------------------------------------
#include "InterModuleDragDllSource.h"
#pragma argsused
int WINAPI DllEntryPoint(HINSTANCE hinst, unsigned long reason, void*
lpReserved)
{
    return 1;
}
//---------------------------------------------------------------------------
void __stdcall CreateForm(TComponent* Owner)
{
    dllForm = new TDllForm (Owner);
    dllForm->Show();
}
//---------------------------------------------------------------------------
```

Listing 6-12 (InterModuleDragDllSource.h)

```
#ifndef DllH
#define DllH

#include "InterModuleDragDllForm.h"
TDllForm* dllForm;
extern "C" __declspec(dllexport) __stdcall void CreateForm(TComponent* Owner);
//---------------------------------------------------------------------------

#endif
```

Listing 6-13 (InterModuleDragDllForm.cpp)

```
//---------------------------------------------------------------------------

#include <vcl.h>
#pragma hdrstop

#include "InterModuleDragDllForm.h"
//---------------------------------------------------------------------------
#pragma package(smart_init)
#pragma resource "*.dfm"
TDllForm *DllForm;
//---------------------------------------------------------------------------
__fastcall TDllForm::TDllForm(TComponent* Owner)
        : TForm(Owner)
{
}
//---------------------------------------------------------------------------
void __fastcall TDllForm::ListBox1DragDrop(TObject *Sender,
      TObject *Source, int X, int Y)
{
        TDerivedDragObject* fdo = (TDerivedDragObject*)Source;
        AnsiString fDraggedItem = fdo->fDragItem;
        TListBox* flb2 = (TListBox*)Sender;
        if (flb2->Items->Count > 0)
                flb2->Items->Clear();
        flb2->Items->Add(fDraggedItem);
}
//---------------------------------------------------------------------------
void __fastcall TDllForm::ListBox1DragOver(TObject *Sender,
      TObject *Source, int X, int Y, TDragState State, bool &Accept)
{
        // If the source is an instance of TDragObject or its descendent
        // then accept the dragged item
        if (IsDragObject(Source))
                Accept = true;
        else
                Accept = false;
}
//---------------------------------------------------------------------------
void __fastcall TDllForm::FormClose(TObject *Sender, TCloseAction &Action)
{
        Action = caFree;
}
//---------------------------------------------------------------------------
```

Listing 6-14 (InterModuleDragDllForm.h)

```
//---------------------------------------------------------------------------
#ifndef InterModuleDragDllFormH
#define InterModuleDragDllFormH
//---------------------------------------------------------------------------
#include <Classes.hpp>
#include <Controls.hpp>
#include <StdCtrls.hpp>
#include <Forms.hpp>
#include "CustomDragObject.h"
//---------------------------------------------------------------------------
class TDllForm : public TForm
{
__published:    // IDE-managed Components
        TListBox *ListBox1;
        void __fastcall ListBox1DragDrop(TObject *Sender, TObject *Source,
          int X, int Y);
        void __fastcall ListBox1DragOver(TObject *Sender, TObject *Source,
          int X, int Y, TDragState State, bool &Accept);
        void __fastcall FormClose(TObject *Sender, TCloseAction &Action);
private:    // User declarations
public:     // User declarations
        __fastcall TDllForm(TComponent* Owner);
};
//---------------------------------------------------------------------------
extern PACKAGE TDllForm *DllForm;
//---------------------------------------------------------------------------
#endif
```

Date/Time Management

Another useful feature that almost all the programmers are required to work with is date and time management and timestamp management. VCL has a powerful set of functions and the TDateTime class to handle these features, which I discuss in this section. The date and time related functions are defined in the SYSUTILS unit of VCL, and I am going to use them along with the TDateTime class in my discussion. Since the SYSUTILS unit is automatically included when we include vcl.h in our project, there is no need to explicitly include this unit.

TDateTime Class

The TDateTime class is provided in C++Builder to function like the TDateTime data type in the Object Pascal language that is used in Delphi. Similar to the AnsiString class discussed in the previous chapter, there is no need to use the new operator to create objects of this class. Thus, you can instantiate this object in the following two ways:

```
TDateTime dateTime1;
TDateTime dateTime2 = new TDateTime();
```

The data member that stores the date-time value is a double data type. The reference timestamp that represents a TDateTime value of 0 is 12/30/1899 12:00 AM. When instantiated without any initial value, the date-time value is set to this reference value. The object can be instantiated with another date-time object, a double value, system date, system time, or system timestamp. The following examples illustrate the different ways to instantiate the TDateTime object:

```
TDateTime dateTime1 = Date();     // instantiates to the current date value
TDateTime dateTime2 = Time();     // instantiates to the current time value
TDateTime dateTime3 = Now();  // instantiates to the current date and time value
TDateTime dateTime4 = 2.25;       // instantiates to 01/01/1899 06:00 AM
TDateTime dateTime5 = dateTime2;  // instantiates to another date-time object
TDateTime dateTime6 = TDateTime(2001, 10, 23);  // specific year, month, and day
```

The functions Date(), Time(), and Now() are VCL functions defined in the SYSUTILS unit, which return the current system date, current system time, and current timestamp as TDateTime objects. These values can also be obtained from the methods CurrentDate(), CurrentTime(), and CurrentDateTime(), respectively, of the TDateTime object.

TDateTime objects participate in arithmetic operations to give us flexibility in date-based or timestamp-based computations. The operands that participate with a TDateTime object are other date-time objects or double values or integer values. When we add fractional values to a TDateTime object, the integer portion of the data member indicates the number of days past the reference date and the decimal portion indicates the proportion of time that has passed (out of 24 hours) since midnight of the previous day.

```
TDateTime dateTime1;
DateTime1 += 0.25     // indicates 6:00 AM on 12/30/1899
```

If the result of arithmetic operations is a negative value (such as –2.25) the interpretation is slightly different. The negative sign applies only to the integer portion and hence to the number of days, indicating that the

date is behind the reference date by the negative integer value (in this case, –2). The decimal fraction always represents the proportion of time that has passed since midnight of the previous day. In this example, a value of –2.25 represents 12/28/1899 6:00 AM. Table 6-2 describes the methods and some frequently needed operators supported by the TDateTime object.

Table 6-2

Methods	Description
CurrentDate()	Returns the current system date as a TDateTime object.
CurrentDateTime()	Returns the current system date and time as a TDateTime object.
CurrentTime()	Returns the current system time as a TDateTime object.
DateString()	Returns the date portion of the object as an AnsiString object.
DateTimeString()	Returns the date and time value of the object as an AnsiString object.
DayOfWeek()	Returns the day of the week for the date portion of the object as an integer. Sunday is treated as the first day of the week and Saturday as the seventh.
DecodeDate(unsigned short* year, unsigned short* month, unsigned short* day)	This is a very useful method to separate the day, month, and year of the object into individual items. Notice that the parameters to the method are pointers to unsigned short variables.
DecodeTime(unsigned short* hour, unsigned short* min, unsigned short* sec, unsigned short* msec)	This is very similar to the DecodeDate() method; it is used to decode the time portion of the object into individual items.
FileDate()	Files stored on the disk have a timestamp associated with them. This method is used to convert the date-time value of the object to an integer value representing the file timestamp.
FileDateToDateTime()	Converts the file timestamp to a TDateTime object and stores it in the current object.
FormatString(AnsiString& format)	Returns the date and time value of the object as a formatted AnsiString object. The required format is provided as an input parameter to the method.
TimeString()	Returns the time portion of the object as an AnsiString object.

Operators	Description

AnsiString()	Returns the date-time value as an AnsiString.
	Usage:
	`TDateTime dtime = Now();`
	`AnsiString str = AnsiString(dtime);`

double()	Returns the date time value as a double.
	Usage:
	`TDateTime dtime = Now();`
	`double dbl = double(dtime);`

Apart from the TDateTime object, VCL has a wealth of functions defined in the SYSUTILS unit that provide date and time management functionality. Most of them are conversion utilities to convert date-time value to and from other formats. Table 6-3 lists these functions.

Table 6-3

SysUtils Function	Description
Date()	Returns the current system date as a TDateTime object.
DateTimeToFileDate (System::TDateTime DateTime)	Converts the TDateTime object that is passed as a parameter to this function to an integer value representing the DOS file timestamp. This integer can be used in the function FileSetDate(int Handle, int Age) to set the timestamp of a file. Handle represents the file and Age represents the integer value of the DOS date-timestamp. The FileSetDate() function is part of file management routines in the VCL. The DOS file timestamp is discussed later in this section.
DateTimeToStr (System::TDateTime DateTime)	Returns the TDateTime object that is passed as a parameter to this function as an AnsiString object.
DateTimeToString (AnsiString &Result, const AnsiString Format, System::TDateTime DateTime)	Converts the TDateTime object that is passed as a parameter to this function to a formatted AnsiString object and stores it in the Result parameter. The Format parameter provides the required format. Formatting features are discussed later in this section.
DateTimeToSystemTime (System::TDateTime DateTime, _SYSTEMTIME &SystemTime)	Converts the TDateTime object that is passed as a parameter to this function to an instance of Win32 SYSTEMTIME structure type. The SYSTEMTIME structure and its use are discussed later in this section.

SysUtils Function	Description
DateTimeToTimeStamp (System::TDateTime DateTime)	Returns the TDateTime object that is passed as a parameter to this function as an instance of the VCL TTimeStamp structure type. TTimeStamp stores individual date and time values as integers. The date value represents the number of days that have passed since the date 01/01/0001, and the time value represents the number of seconds elapsed since midnight. This structure is intended to give another form of representation to the current timestamp value.
DateToStr (System::TDateTime Date)	Returns the date portion of the TDateTime object that is passed as a parameter to this function as a formatted AnsiString object. The format is specified by the ShortDateFormat global variable, which is obtained from the operating system Control Panel → Regional Settings → Date tab page.
DayOfWeek (System::TDateTime Date)	Returns the day of the week for the TDateTime object that is passed as a parameter to this function as an integer value; 1 represents Sunday and 7 represents Saturday.
DecodeDate (System::TDateTime Date, Word &Year, Word &Month, Word &Day)	Converts the date portion of the TDateTime object that is passed as a parameter to this function to individual day, month, and year components.
DecodeTime(System::TDateTime Time, Word &Hour, Word &Min, Word &Sec, Word &MSec)	Converts the time portion of the TDateTime object that is passed as a parameter to this function to individual hour, minute, second, and millisecond components.
EncodeDate (Word Year, Word Month, Word Day)	Returns a TDateTime object containing a date value that is constructed from the individual components of day, month, and year. The year must be between 1 and 9999. The month must be between 1 and 12. The day must be between 1 and 31 based on the month specified. If the specified values do not yield a valid date, an EConvertError exception is thrown.
EncodeTime (Word Hour, Word Min, Word Sec, Word MSec)	Returns a TDateTime object containing a time value that is constructed from the individual components of hour, minute, second, and millisecond. Valid Hour values are 0 through 23. Valid Min and Sec values are 0 through 59. Valid MSec values are 0 through 999. The resulting object contains the decimal fraction value that conforms to the TDateTime object's time value rules. If the specified values are not within range, an EConvertError exception is thrown.

SysUtils Function	Description
FormatDateTime (const AnsiString Format, System::TDateTime DateTime)	Returns a formatted AnsiString object representing the TDateTime object that is passed as a parameter. The format is specified by the Format parameter.
IncMonth (const TDateTime Date, int Months)	Returns a new TDateTime object that contains the month value incremented by Months. If the input day of month is greater than the last day of the resulting month, the day is set to the last day of the resulting month. If the incremented month value exceeds the current year (any following years), the year value is also set to the appropriate value.
IsLeapYear (Word Year)	Returns true if the specified year is a leap year.
MSecsToTimeStamp (System::Comp MSecs)	Returns an instance of the TTimeStamp object that is constructed from the number of milliseconds (since 01/01/0001). The number of milliseconds is specified as a Comp data type. Comp is a C++ struct that implements the Object Pascal 64-bit integer data type. Comp can represent a value in the range $-2^{63}+1$ to $2^{63}-1$ (about $-9.2 * 10^{18}$ to $9.2 * 10^{18}$). Comp values can represent 19 significant digits.
Now ()	Returns current timestamp as a TDateTime object.
ReplaceDate (TDateTime &DateTime, const TDateTime NewDate)	Replaces the date portion of the first TDateTime object with the date portion of the second TDateTime object without changing the time.
ReplaceTime (TDateTime &DateTime, const TDateTime NewTime)	Replaces the time portion of the first TDateTime object with the time portion of the second TDateTime object without changing the date.
0StrToDate (const AnsiString S)	Returns a TDateTime object after converting the input string value that represents a date-time value containing the date. The string value S must consist of two or three numbers separated by the character defined by the DateSeparator global variable. The order for month, day, and year is determined by the ShortDateFormat global variable; possible combinations are m/d/y, d/m/y, and y/m/d. If the date contains only two numbers separated by the DateSeparator, it is interpreted as a date in the current year. If the specified string does not represent a valid date, an EConvertError exception is thrown. The global variables are obtained from the operating system Control Panel → Regional Settings → Date tab page.

SysUtils Function	Description
StrToDateTime (const AnsiString S)	Returns a TDateTime object after converting the input string value that represents a date-time value containing the date and time. The date portion of the string must follow formatting rules specified by the DateSeparator and ShortDateFormat global variables, and the time portion of the string must follow formatting rules obtained from the Control Panel → Regional Settings → Date tab page. It is not necessary to indicate the time portion with AM or PM, in which case the time must be specified in 24-hour format. If the specified string does not represent a valid date, an EConvertError exception is thrown.
StrToTime (const AnsiString S)	Returns a TDateTime object after converting the input string value that represents a date-time value containing the time. The rules for specifying the time string are the same as discussed for the previous function.
SystemTimeToDateTime (const _SYSTEMTIME &SystemTime)	Returns a TDateTime object after converting the input Win32 SYSTEMTIME struct data type.
Time()	Returns current time value as a TDateTime object.
TimeStampToDateTime (const TTimeStamp &TimeStamp)	Returns a TDateTime object after converting the input TTimeStamp object.
TimeStampToMSecs ()	Returns the absolute number of milliseconds after converting both the date and time portions of the input TTimeStamp object. The returned value is an instance of the Comp structure and the reference date for this value is 01/01/0001.
TimeToStr (System::TDateTime Time)	Returns an AnsiString object after converting the input TDateTime object containing a time value. The conversion uses the LongTimeFormat global value.
Constants	**Description**
DateDelta	The TDateTime object uses the reference date of 12/30/1899 and the TTimeStamp object uses the reference date of 01/01/0001. The DateDelta constant is provided to make date value corrections. It is defined in the SysUtils.pas file as the number of days between 01/01/0001 and 12/31/1899. Its value is 693594.
MSecsPerDay	This constant represents the number of milliseconds per day. Its value is 86400000.
SecsPerDay	This constant represents the number of seconds per day. Its value is 86400.

DOS File Timestamp

DOS File Timestamp is also known as DOS File DateTime value. It is the combination of two packed 16-bit values, one to store DOS File date and the other to store DOS File time. The individual bit values that comprise these structures are shown here, as defined in the Microsoft documentation (MSDN).

Table 6-4 (DOS File Date)

Bits	Contents
0-4	Day of the month (1-31)
5-8	Month (1 = January, 2 = February, etc.)
9-15	Year offset from 1980 (add 1980 to get actual year value)

Table 6-5 (DOS File Time)

Bits	Contents
0-4	Second, divided by 2
5-10	Minute (0-59)
11-15	Hour (0-23 on a 24-hour clock)

Win32 Core Date-Time Management

Now it is time to discuss some of the Win32-based date and time management functions which can be used in conjunction with the VCL functions to deliver easy-to-interface systems. SYSTEMTIME is a structure data type and is comprised of individual data members to represent day, month, and year, etc. This structure is used by Win32 functions to store the timestamp values. The structure definition is shown here followed by the functions that use this structure:

```
typedef struct _SYSTEMTIME {  // st
WORD wYear;
  WORD wMonth;
  WORD wDayOfWeek;
  WORD wDay;
  WORD wHour;
  WORD wMinute;
  WORD wSecond;
  WORD wMilliseconds;
} SYSTEMTIME;
```

```
VOID GetLocalTime(
    LPSYSTEMTIME lpSystemTime       // address of output system time structure
);

VOID GetSystemTime(
    LPSYSTEMTIME lpSystemTime       // address of output system time structure
);

BOOL SetLocalTime(
    CONST SYSTEMTIME *              // sets system time, using local time
);

BOOL SetSystemTime(
    CONST SYSTEMTIME *lpSystemTime  // sets system time, using UTC time
);
```

The GetLocalTime() function retrieves the current local date and time from the clock in the computer where the operating system is loaded. The input parameter is a pointer to the structure SYSTEMTIME, and contains the value returned by the function call. Most of the time, applications need to display (and use) the local time. However, there may be time-sensitive global (or internationalized) applications that require using universal time. The GetSystemTime() function retrieves the current system date and time in terms of coordinated universal time (UTC). Microsoft documentation (MSDN) defines the UTC as follows: "System time is the current date and time of day. The system keeps time so that your applications have ready access to accurate time. The system bases system time on coordinated universal time (UTC). UTC-based time is loosely defined as the current date and time of day in Greenwich, England." The SetSystemTime() function sets the system date and time, using the universal time value as input. The SetLocalTime() function sets the system date and time, using the local time as input.

Both the GetLocalTime and GetSystemTime functions do not return any value. Both the SetSystemTime and SetLocalTime functions return a non-zero value if the function succeeds, and a zero value if the function fails. If the function fails, check the last error code using the Win32 GetLastError() function. Executing Win32 functions from a VCL application is discussed in an earlier chapter.

Since VCL provides functions to convert date and time values between VCL formats and Win32 formats, it becomes easy on the part of programmers to provide systems (and components) that can interact with the applications developed using Win32 SDK directly, or with applications

developed by other vendors. This type of data (object or structure) conversion is visible in other units of VCL as well, not just SYSUTILS.

Formatting Date-Time Strings

We have seen that date-time values can be retrieved as AnsiString objects. This is very useful for embedding date-time values in message strings or as timestamps to display to the user. While converting the date-time value to a string, the format of the string can be specified using the FormatString() method. There are a number of format specifiers that VCL supports, a few of which are shown here. C++Builder 6 online documentation provides the complete list.

- The specifier "c" indicates that the date-time value be displayed in the format given by the ShortDateFormat global variable:

```
TDateTime dt = Now();
AnsiString dts = dt.FormatString("c");
```

  In this example, the string dts contains a value similar to "12-23-2001 4:35:33 PM". However, the actual format depends on how Regional Settings are set up in the Control Panel on your computer.

- The specifier "d" indicates that the day value be displayed without a leading zero if it is a single-digit value (such as "1-31"), as opposed to the specifier "dd," which indicates that the single-digit day value be displayed with a leading zero (such as "01-31").
- The specifier "am/pm" indicates that the 12-hour clock be used and the word "am" appended to the string for time values before noon and "pm" appended to the string for time values after noon.
- The specifier "ampm" indicates that the 12-hour clock be used and the string be appended with the global variable TimeAMString for time values before noon and the global variable TimePMString for time values after noon.
- Embedded constant string literals can be used to provide meaningful formats, as shown in the example here:

```
TDateTime dt = Now();
AnsiString dts = dt.FormatString("'on' dd-mm-yyyy 'at' hh:nn:ss", dt);
AnsiString msg = "The process started "+dts;
```

  In this example, the string msg contains a value similar to "The process started on 23-01-2001 at 15:20:25".

Constants Defined in SYSUTILS

Here is a list of date and time related constants defined in the SYSUTILS unit, which may be used in conjunction with the functions discussed in this section.

- ShortMonthNames is an array[1..12] of the short form of month names. The mmm format specifier in the format string uses the value obtained from this array. The default values are retrieved from the LOCALE_SABBREVMONTHNAME s0ystem locale entries.
- LongMonthNames is an array[1...12] of the long form of month names. The default values are retrieved from the LOCALE_SMONTHNAME system locale entries.
- ShortDayNames is an array[1..7] of the short form of day names. The ddd format specifier in the format string uses the value obtained from this array. The default values are retrieved from the LOCALE_SABBREVDAYNAME system locale entries.
- LongDayNames is an array[1..7] of the long form of day names. The default values are retrieved from the LOCALE_SDAYNAME system locale entries.
- TimeAMString is the suffix string used for time values between 00:00 and 11:59 in 12-hour clock format. The initial value is retrieved from the LOCALE_S1159 system locale entry.
- TimePMString is the suffix string used for time values between 12:00 and 23:59 in 12-hour clock format. The initial value is retrieved from the LOCALE_S2359 system locale entry.
- ShortDateFormat is the format string used to convert a date value to a short string suitable for editing. The initial value is retrieved from the LOCALE_SSHORTDATE system locale entry.
- LongDateFormat is the format string used to convert a date value to an AnsiString suitable for display but not for editing. The initial value is retrieved from the LOCALE_SLONGDATE system locale entry.

Directory and File Management

Another set of features provided by the SYSUTILS unit is the functions and objects that enable access to the files and directories stored on the disk. We explain these functions before starting our discussion. Apart from the SYSUTILS unit, FILECTRL unit also provides some of these functions. I will highlight these differences wherever they exist. Unlike the SYSUTILS unit, including the vcl.h file does not automatically include the FILECTRL unit. We have to explicitly include the filectrl.hpp file.

Working with Directories

The CreateDir() function enables us to create a directory with the given name on the current drive. The definition of the function is given here:

```
bool __fastcall CreateDir(const AnsiString DirName);
```

The function returns true if it succeeds in creating the directory; otherwise, it returns false. The input parameter may specify the simple name of the directory or the directory name preceded by the full or relative path name. If we specify just the directory name, the directory will be created in the current directory. If we include the full or relative path name, then each and every subdirectory in the path must exist prior to execution of this function. If not, an exception is thrown. To avoid this situation, use the ForceDirectories() function if we need the subdirectories to be created, or check for existence of subdirectories using the DirectoryExists() function before trying to create the directory (or subdirectory).

The ForceDirectories() function forces the system to create any subdirectories specified in the directory path if they do not already exist, thus avoiding an exception condition. The definition of the function is given here. The path specified may be the full path or a relative path.

```
bool __fastcall ForceDirectories(const AnsiString DirName);
```

The DirectoryExists() function returns true if the specified directory exists on the drive; otherwise, it returns false. This function is provided in the FILECTRL unit.

```
bool __fastcall DirectoryExists(const AnsiString DirName);
```

The GetCurrentDir() function returns the (fully qualified) current directory name.

```
AnsiString __fastcall GetCurrentDir();
```

The ChDir() function changes the current directory to the directory specified in the input parameter. The definition of the function is as follows:

```
void __fastcall ChDir(const AnsiString DirName);
```

The SetCurrentDir() function sets the current working directory to the name specified as the parameter. If the current directory is set successfully, the function returns true; otherwise, it returns false. The definition of the function is described here:

```
bool __fastcall SetCurrentDir(const AnsiString DirName);
```

The RemoveDir() function deletes the directory specified in the input parameter. The directory must be empty before this function is called. The definition of the function is as follows:

```
bool __fastcall RemoveDir(const AnsiString DirName);
```

The SelectDirectory() function displays a directory selection dialog box to the user. There are two variations of this function. The first is shown below:

```
bool __fastcall SelectDirectory(AnsiString &Directory, TSelectDirOpts Options,
      int HelpCtx);
```

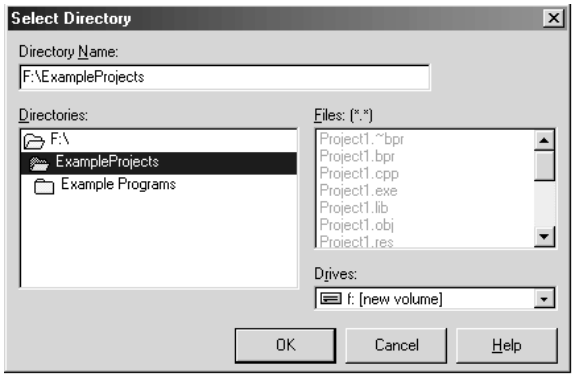
This variation of the function has three parameters: a directory name string, a set of directory selection options, and a help context id. The directory name string parameter contains the initial directory that the user sets. When the user clicks the OK button, the dialog sets this string parameter with the newly selected directory name, including the full path. A sample code snippet is shown in Listing 6-15. When executed in a program, the dialog appears as shown in Figure 6-12.

Listing 6-15

```
//---------------------------------------------------------------------------

const SELDIRHELP = 10;
AnsiString Dir = "F:\\ExampleProjects";
if (SelectDirectory(Dir, TSelectDirOpts() << sdAllowCreate << sdPerformCreate
    << sdPrompt,SELDIRHELP)) {
    Label1->Caption = Dir;
}
//---------------------------------------------------------------------------
```

Figure 6-12



The second form of the function is:

```
bool __fastcall SelectDirectory(const AnsiString Caption, const WideString Root,
AnsiString &Directory);
```

In this form of the function, we provide a caption to the dialog box, a root directory from where to display the subdirectory tree, and an AnsiString variable that stores the user-selected (fully qualified) directory name. The sample code is shown in Listing 6-16 and the corresponding dialog box is displayed as in Figure 6-13.

Listing 6-16

```
//---------------------------------------------------------------------------

WideString Root = " F:\\ExampleProjects";
AnsiString Dir;
AnsiString capt = "Select Directory dialog";
if (SelectDirectory(Caption, Root, Dir)) {
    Label1->Caption = Dir;
}
//---------------------------------------------------------------------------
```

In the first form of the function, the current directory is set to the directory selected by the user. This is not the case with the second form. Also, the second form is limited in functionality and does not show the drive selection combo box, nor the files in the selected directory. We have to choose the appropriate form of the function as needed. This function is provided in the FILECTRL unit.

In all these functions, the directory (or subdirectory) names in the path name must be separated by "\\" instead of "\" in order to provide for the escape sequence.

Figure 6-13

Working with Files

Now we discuss the functions that support file management. A number of routines are provided for file management, and we categorize them based on the subfunctions.

File Existence and Search

The FileCreate() function creates a file with the given name. If it succeeds in creating the file, the file handle is returned; otherwise, –1 is returned. If the filename includes the full (or relative) path, the file is created in the directory (or subdirectory) specified. Otherwise, the file is created in the current directory. The definition of the function is given here:

```
int __fastcall FileCreate(const AnsiString FileName);
```

The FileExists() function returns true if the specified file exists on the disk; otherwise, it returns false. If the filename includes the full (or relative) path, then the file search is performed in the appropriate directory (or subdirectory). Otherwise, the search is performed in the current directory. This function is defined as:

```
bool __fastcall FileExists(const AnsiString FileName);
```

The FileSearch() function searches the specified directory list for the specified filename. If the file is found in the list specified, the fully qualified path name is returned. Otherwise, it returns an empty string. The input directory list is a single AnsiString object, with individual directory names separated by semicolons. The definition of the function is shown below:

```
AnsiString __fastcall FileSearch(const AnsiString Name, const AnsiString
DirList);
```

WIN32_FIND_DATA Structure

The WIN32_FIND_DATA structure describes a file found by one of the Win32 functions FindFirstFile, FindFirstFileEx, and FindNextFile. The structure is defined as given here:

```
typedef struct _WIN32_FIND_DATA {
  DWORD    dwFileAttributes;
  FILETIME ftCreationTime;
FILETIME ftLastAccessTime;
FILETIME ftLastWriteTime;
DWORD    nFileSizeHigh;
DWORD    nFileSizeLow;
DWORD    dwReserved0;
DWORD    dwReserved1;
TCHAR    cFileName[MAX_PATH];
TCHAR    cAlternateFileName[14];
} WIN32_FIND_DATA, *PWIN32_FIND_DATA;
```

The dwFileAttributes member contains the file attributes. The next three structure members determine the file creation time, last access time, and the last write time respectively, as the names suggest. These times are reported in Coordinated Universal Time (UTC), which was discussed earlier. Windows stores file size in two members, nFileSizeHigh and nFileSizeLow. The full filename is stored as a null-terminated string in the cFileName member and the DOS8.3 format file-name is stored as a null-terminated string in the cAlternateFileName member.

The VCL defines a structure of type TSearchRec that includes the WIN32_FIND_DATA structure as one of its members. It also contains the filename as an AnsiString object and the file size as a single integer (32-bit) variable indicating number of bytes. If the size of a file is expected to exceed the 32-bit int value, then compute the file size using the formula (nFileSizeHigh * (MAXDWORD+1)) + nFileSizeLow), as defined in the MSDN documentation.

The VCL provides three functions to search for files that match a set of specific attributes. They are FindFirst(), FindNext(), and FindClose(). The definitions of these functions are:

```
int __fastcall FindFirst(const AnsiString Path, int Attr, TSearchRec &F);
int __fastcall FindNext(TSearchRec &F);
void __fastcall FindClose(TSearchRec &F);
```

FindFirst() searches the given path for files matching the required attributes. If a file is found, its information is returned in the TSearchRec structure. The TSearchRec structure contains the returned file information. FindNext() returns the next entry matching the path and attributes specified. Hence, it must be used in conjunction with the FirstFirst() method. Both methods return 0 if successful, and a Windows error code if they fail. FindClose() terminates the FindFirst/FindNext sequence and releases the memory allocated.

File Attributes

A set of file attributes characterizes a given file. For example, one attribute may indicate if the file is hidden, and another attribute may indicate if the file is read-only, etc. In Win32 SDK, there are 13 file attributes (and a reserved attribute) provided to characterize files and directories. However, VCL supports a subset of the most frequently used attributes through its functions. This subset of attributes is represented as an int data type in VCL, each of them identified by a bit value. To combine more than one attribute, we must use the bitwise OR operator (|). The list of Win32 attributes is displayed in Table 6-6, indicating which of them are supported by VCL functions.

Table 6-6 (Win32 file attributes)

Win32 File Attribute	Description	VCL Attribute
FILE_ATTRIBUTE_ARCHIVE	The file or directory is an archive file or directory. Applications use this attribute to mark files for backup or removal.	faArchive
FILE_ATTRIBUTE_COMPRESSED	The file or directory is compressed. For a file, this means that all of the data in the file is compressed. For a directory, this means that compression is the default for newly created files and subdirectories.	
FILE_ATTRIBUTE_DEVICE	Reserved; do not use.	
FILE_ATTRIBUTE_DIRECTORY	The handle identifies a directory.	faDirectory
FILE_ATTRIBUTE_ENCRYPTED	The file or directory is encrypted. For a file, this means that all data streams in the file are encrypted. For a directory, this means that encryption is the default for newly created files and subdirectories.	

Win32 File Attribute	Description	VCL Attribute
FILE_ATTRIBUTE_HIDDEN	The file or directory is hidden. It is not included in an ordinary directory listing.	faHidden
FILE_ATTRIBUTE_NORMAL	The file or directory has no other attributes set. This attribute is valid only if used alone.	
FILE_ATTRIBUTE_NOT_ CONTENT_INDEXED		
FILE_ATTRIBUTE_OFFLINE	The data of the file is not immediately available. This attribute indicates that the file data has been physically moved to offline storage. This attribute is used by Remote Storage, the hierarchical storage management software in Windows 2000. Applications should not arbitrarily change this attribute.	
FILE_ATTRIBUTE_READONLY	The file or directory is read-only. Applications can read the file but cannot write to it or delete it. In the case of a directory, applications cannot delete it.	faReadOnly
FILE_ATTRIBUTE_REPARSE_POI NT	The file has an associated reparse point.	
FILE_ATTRIBUTE_SPARSE_FILE	The file is a sparse file.	
FILE_ATTRIBUTE_SYSTEM	The file or directory is part of, or is used exclusively by, the operating system.	faSysFile
FILE_ATTRIBUTE_TEMPORARY	The file is being used for temporary storage. File systems attempt to keep all of the data in memory for quicker access rather than flushing the data back to mass storage. A temporary file should be deleted by the application as soon as it is no longer needed.	

Apart from the attributes identified in the table, VCL has two additional attributes. The attribute faVolumeID indicates the file is a volume id and the attribute faAnyFile indicates any file on the disk. These attributes are used in the FileGetAttr() function to find out the attributes of the file or directory. VCL's FileSetAttr() function internally calls the Win32 SetFileAttributes() function. The SetFileAttributes() function sets only eight of the above 13 file attributes; the remaining five attributes must be set using other Win32 SDK functions, as described in the following discussion. The corresponding Win32 GetFileAttributes() function, however, retrieves all the attributes that are set on the device (file or directory).

Setting Advanced Attributes

As mentioned earlier, these advanced attributes must be set using the Win32 function calls, since the VCL does not directly support them.

FILE_ATTRIBUTE_COMPRESSED Attribute

Use the DeviceIoControl() function with the FSCTL_SET_COMPRESSION operation as the dwIoControlCode parameter. This function sends a control code directly to a specified device driver, causing the corresponding device to perform the corresponding operation.

```
BOOL DeviceIoControl(
  HANDLE hDevice,              // handle to device
  DWORD dwIoControlCode,       // operation
  LPVOID lpInBuffer,           // input data buffer
  DWORD nInBufferSize,         // size of input data buffer
  LPVOID lpOutBuffer,          // output data buffer
  DWORD nOutBufferSize,        // size of output data buffer
  LPDWORD lpBytesReturned,     // byte count actually returned
  LPOVERLAPPED lpOverlapped    // overlapped information
);
```

hDevice is a handle to the directory or file whose attribute must be set as compressed. lpInBuffer is a pointer to input data buffer. In this case it should be NULL. nlpInBufferSize is the size of input buffer. In this case it is 0. lpOutBufferSize is a pointer to output data buffer. In this case it should be NULL. nlpOutBufferSize is the size of output buffer. In this case it is 0. lpBytesReturned is a variable that receives the size, in bytes, of the data stored into the buffer pointed to by lpOutBuffer. lpOverlapped is a pointer to the OVERLAPPED structure, if hDevice was opened with the FILE_FLAG_OVERLAPPED flag. In this case it must be NULL.

FILE_ATTRIBUTE_ REPARSE_POINT Attribute

Use the DeviceIoControl() function with the FSCTL_SET_REPARSE_ POINT operation. On a Windows 2000 NTFS volume, a file or directory can contain a reparse point, which is a collection of user-defined data. The format of this data is understood by the application, which stores the data, and a file system filter, which you install to interpret the data and process the file. When an application sets a reparse point, it stores this data, plus a reparse tag, which uniquely identifies the data it is storing. When the file system opens a file with a reparse point, it attempts to find the file system filter associated with the data format identified by the reparse tag. If such a file system filter is found, the filter processes the file as directed by the reparse data. If no such file system filter is found, the

file open operation fails. If we wish to make use of the reparse points on a file or directory, this flag must be set on the file. If we set the reparse point on a directory, that directory must be empty. More details about reparse points can be obtained from the Microsoft documentation (MSDN), and the reader is encouraged to understand the concepts of reparse points before trying to implement them.

FILE_ATTRIBUTE_ SPARSE_FILE Attribute

Use the DeviceIoControl() function with the FSCTL_SET_SPARSE operation. A file (typically very large) in which a lot of data is all zeros is said to contain a sparse data set. An example is a matrix in which some or much of the data is zeros. Applications that use sparse data sets include image processors and high-speed databases. Windows 2000 NTFS introduces another solution, called a sparse file. When the sparse file facilities are used, the system does not allocate hard drive space to a file except in regions where it contains something other than zeros. The default data value of a sparse file is zero.

FILE_ATTRIBUTE_DIRECTORY Attribute

By setting this attribute, files cannot be converted to directories. By just using the functions to create a directory as we discussed earlier in this section, the attribute is set.

FILE_ATTRIBUTE_ ENCRYPTED Attribute

To create an encrypted file, the file should be created with the FILE_ATTRIBUTE_ENCRYPTED attribute in the Win32 function call CreateFile(). When we create a file using VCL's FileCreate() function, this attribute is not supported, and hence after creating the file we can convert it to an encrypted file, using the EncryptFile() Win32 function.

File Name Manipulation Functions

In this section we focus our attention on how to manipulate the parts of a filename using the functions listed in Table 6-7.

Table 6-7

Function	Description
ChangeFileExt (const AnsiString FileName, const AnsiString Extension)	Changes the file extension of the input FileName string to the new value as specified in the Extension parameter. The function does not change the existing filename. The new filename is returned as an AnsiString value.

Function	Description
DosPathToUnixPath (const AnsiString Path)	Converts a DOS-compatible path specification from the input parameter to a UNIX-compatible path specification. All the backslash characters (\) are converted to forward slash characters (/). The return value is the UNIX path specification. It is recommended that you not include the drive letter in the input DOS path, as the function does not discard the drive letter and in UNIX the drive letter has no meaning.
ExcludeTrailingBackslash (const AnsiString S)	Returns the modified path string without the trailing backslash. Borland discourages the use of this function in new applications, which should use the ExcludeTrailingPathDelimiter() function.
ExcludeTrailingPathDelimiter (const AnsiString S)	Returns the modified path string without the trailing path delimiter, which is the "\" character. This function gives the same result as ExcludeTrailingBackslash(). Borland recommends that new applications should start using this function instead of the previous one. This function is introduced in C++Builder 6.
ExpandFileName (const AnsiString FileName)	Returns the fully qualified path name of the input filename, which contains the relative path name.
ExpandUNCFileName (const AnsiString FileName)	Returns the fully qualified path name using the Universal Naming Convention for the network filenames. The network server name and share name replace the drive name. For local disk files this function produces the same result as ExpandFileName().
ExtractFileDir (const AnsiString FileName)	Returns the drive and fully qualified path names as a string for the input filename.
ExtractFileDrive (const AnsiString FileName)	Returns the drive name portion of the input filename string. For local disk files, the drive letter is retrieved and for network files, the result is in the form "\\<server name>\<share name>".
ExtractFileExt (constAnsiString FileName)	Returns the file extension portion of the input filename. The resulting string includes the period that separates the filename from the extension. If the file has no extension, the result string is empty.
ExtractFileName (const AnsiString FileName)	Extracts the name and extension parts of the filename and returns it as a string. The resulting string does not contain the drive or directory path information.
ExtractFilePath (const AnsiString FileName)	Extracts the drive and directory parts of the filename and returns it as a string. The returned string includes the backslash or colon that separates the path from the filename and extension.

Function	Description
ExtractRelativePath (const AnsiString BaseName, const AnsiString DestName)	Converts a fully qualified path name identified by the DestName parameter to a relative path name with respect to the path name identified by the BaseName parameter. The BaseName may or may not contain the filename, but must include the final path delimiter. The converted value is returned as an AnsiString object.
ExtractShortPathName (const AnsiString FileName)	Converts the path containing long filename (and directory names) to the path containing short filename (and directory names) in DOS 8.3 format. The converted value is returned as an AnsiString object.
IncludeTrailingBackslash (const AnsiString S)	This function ensures that the path name ends with the trailing backslash character "\". Borland discourages the use of this function in new applications. Instead, use the IncludeTrailingPathDelimiter() function.
IncludeTrailingPathDelimiter (const AnsiString S)	This function ensures that the path name ends with the trailing path delimiter, which is the backslash character "\". Borland recommends using this function instead of IncludeTrailingBackslash(). This function is introduced in C++Builder 6.
IsPathDelimiter (const AnsiString S, int Index)	Checks whether the character at Index position is a path delimiter character "\". The index is 0-based. i.e., we should specify the index between 0 and (string length –1). Since we use two backslash characters in the string for the delimiter in order to provide for the escape sequence, the function reports the second backslash as the delimiter character and not the first one. It is important to use this function properly.
MatchesMask (const AnsiString StringToMatch, const AnsiString Mask)	This is a very useful function that checks if a given string StringToMatch matches the pattern specified by the Mask parameter. The pattern specifies how each individual character in the string must match the corresponding matching element in the mask. The mask elements may be individual character literals, sets of character literals, sets of character ranges, or the wildcard characters * and ?. Each of the sets must enclose itself with square bracket, e.g., [a-e]. Individual elements of a set must not be separated by a space or comma. A single mask may contain any combination of these types. Here is an example of a mask: "b[a-f]*[hu]??[o-r]". This mask indicates that the string must start with the character "b" followed by any character between "a" and "f" followed by any number (and combination) of characters (because of the wildcard character *) followed by the character "h" or "u" followed by any two characters (because of the wildcard characters ??) followed by a any single character between "o" and "r."

Function	Description
MinimizeName (const AnsiString Filename, Graphics:: TCanvas* Canvas, int MaxLen)	This is another very useful function that shortens a (long) filename so that it can be drawn on a surface to fit the size specified in the number of (length-wise) pixels. Replacing directories in the path portion of the filename with dots until the resulting name fits the specified number of pixels in length shortens the length of the filename.
ProcessPath (const AnsiString FileName, char &Drive, AnsiString &DirPart, AnsiString &FilePart)	This function parses the input filename and separates the three portions of the string: the drive portion as a character and the directory and file portions as AnsiString objects.
UnixPathToDosPath (const AnsiString Path)	Converts a UNIX-compatible path specification from the input parameter to a DOS-compatible path specification. All the forward slash characters are converted to backslash characters. The return value is the DOS path specification.

File Content Management

In this subsection we are going to discuss the functions that operate on the file contents. These include opening a file, file open modes, positioning the file pointer within a file, reading from and writing to the file, and closing the file.

The FileOpen() function opens the specified file in the specified mode. The access mode can be read-only or write-only, or read-write, deny-read, deny-write, deny-none (meaning give full access to all), share-exclusive (meaning deny read and write), etc. Internally, the VCL calls the Win32 CreateFile() method and converts the VCL access mode to the Win32 access mode value. If successful, the method returns the file handle; otherwise, it returns a value of –1. The definition of this function is as follows:

```
int __fastcall FileOpen(const AnsiString FileName, int Mode);
```

The FileSeek() function positions the current file pointer at a requested position in the file that is already open. Upon successful completion, it returns the new file pointer position; otherwise, it returns –1. The definition of the function is given here:

```
int __fastcall FileSeek(int Handle, int Offset, int Origin);
```

The file pointer usually indicates the position in the file from where the next read or write operation can be performed. When the file is opened initially, the pointer is at the beginning of the file. If the file is not empty

when opened, then it is very important to position the pointer appropriately in order to have the next read operation be successful or to write new contents without damaging existing contents of the file. The Handle parameter represents the file handle, the Offset parameter is the number of bytes the file pointer should be moved, and the Origin parameter indicates from where the Offset bytes should be counted. If Origin is 0, Offset must be counted from the beginning of the file; if Origin is 1, Offset must be counted from the current file pointer position; and if Origin is 2, Offset must be counted from the end of the file towards the beginning (i.e., backward counting).

The FileRead() function reads a specified number of bytes from the specified file and places them in a buffer. The function is defined as:

```
int __fastcall FileRead(int Handle, void *Buffer, int Count);
```

The Handle parameter represents the file handle. The Buffer of Count size must have been created before trying to read the file. Otherwise, an access violation error occurs. The function returns the number of bytes actually read (which may be less than the requested number of bytes) if the read was successful; otherwise, it returns –1.

The FileWrite() function writes the specified number of bytes from the buffer to the specified file at the current file pointer position, and the file pointer is advanced by the number of bytes written to the file. The definition of the function is:

```
int __fastcall FileWrite(int Handle, const void *Buffer, int Count);
```

The function returns the number of bytes actually written to the file if the write was successful; otherwise, it returns –1.

The FileClose() function closes the file specified by the handle. The function is defined as:

```
void __fastcall FileClose(int Handle);
```

Summary

We started the chapter with an introduction to Action objects, followed by ActionList and how the ActionList object simplifies system responses to user input actions. We also discussed the standard action objects provided by VCL and saw how to implement custom action objects. Then the new feature introduced in C++Builder 6, ActionManager, was discussed and an example showed us how to implement most of the standard features required for a Win32-based application.

We then discussed how VCL implements the Windows common dialogs. Afterwards, we spent considerable time discussing the VCL support for implementing Windows drag and drop, and saw how to develop custom drag-and-drop features in our applications. We demonstrated custom drag and drop with a couple of very useful example applications.

Following this, we discussed how two major aspects of SYSUTILS and FILECTRL units make our programming easier with respect to working with date and time functions and directory and file management routines. Though we focused our attention on VCL features, we also discussed how some of the direct Win32 functions could be intermixed in our applications to develop applications that can be easily interfaced with applications developed on other platforms.