# Platform Invoke Tutorial

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**Visual Studio .NET 2003**

Platform Invocation Services (PInvoke) allows managed code to call unmanaged functions that are implemented in a DLL.

This tutorial shows you what you need to do to be able to call unmanaged DLL functions from C#. The attributes discussed in the tutorial allow you to call these functions and have data types be marshaled correctly.

## Sample Files

See [Platform Invoke Sample](http://msdn.microsoft.com/en-us/library/ksk40b62(v=vs.71).aspx) to download and build the sample files discussed in this tutorial.

Platform Invoke

## Further Reading

* [A Closer Look at Platform Invoke](http://msdn.microsoft.com/en-us/library/aa719485(v=vs.71).aspx)
* [Using Attributes](http://msdn.microsoft.com/en-us/library/48zeb25s(v=vs.71).aspx)
* [DllImportAttribute Class](http://msdn.microsoft.com/en-us/library/system.runtime.interopservices.dllimportattribute(v=vs.71).aspx)
* [MarshalAsAttribute Class](http://msdn.microsoft.com/en-us/library/system.runtime.interopservices.marshalasattribute(v=vs.71).aspx)
* [StructLayoutAttribute Class](http://msdn.microsoft.com/en-us/library/system.runtime.interopservices.structlayoutattribute(v=vs.71).aspx)
* [InAttribute Class](http://msdn.microsoft.com/en-us/library/system.runtime.interopservices.inattribute(v=vs.71).aspx)
* [OutAttribute Class](http://msdn.microsoft.com/en-us/library/system.runtime.interopservices.outattribute(v=vs.71).aspx)

## Tutorial

There are two ways that C# code can directly call unmanaged code:

* Directly call a function exported from a DLL.
* Call an interface method on a COM object (for more information, see [COM Interop Part 1: C# Client Tutorial](http://msdn.microsoft.com/en-us/library/aa645736(v=vs.71).aspx)).

For both techniques, you must provide the C# compiler with a declaration of the unmanaged function, and you may also need to provide the C# compiler with a description of how to marshal the parameters and return value to and from the unmanaged code.

The tutorial consists of the following topics:

* [Calling a DLL Export Directly from C#](http://msdn.microsoft.com/en-us/library/aa288468(v=vs.71).aspx#pinvoke_callingdllexport)
* [Default Marshaling and Specifying Custom Marshaling for Parameters to Unmanaged Methods](http://msdn.microsoft.com/en-us/library/aa288468(v=vs.71).aspx#pinvoke_defaultmarshaling)
* [Specifying Custom Marshaling for User-Defined Structs](http://msdn.microsoft.com/en-us/library/aa288468(v=vs.71).aspx#pinvoke_custommarshaling)
* [Registering Callback Methods](http://msdn.microsoft.com/en-us/library/aa288468(v=vs.71).aspx#pinvoke_registeringcallback)

The tutorial includes the following examples:

* [Example 1 Using DllImport](http://msdn.microsoft.com/en-us/library/aa288468(v=vs.71).aspx#pinvoke_example1)
* [Example 2 Overriding Default Marshaling](http://msdn.microsoft.com/en-us/library/aa288468(v=vs.71).aspx#pinvoke_example2)
* [Example 3 Specifying Custom Marshaling](http://msdn.microsoft.com/en-us/library/aa288468(v=vs.71).aspx#pinvoke_example3)

### Calling a DLL Export Directly from C#

To declare a method as having an implementation from a DLL export, do the following:

* Declare the method with the **static** and **extern** C# keywords.
* Attach the **DllImport** attribute to the method. The **DllImport** attribute allows you to specify the name of the DLL that contains the method. The common practice is to name the C# method the same as the exported method, but you can also use a different name for the C# method.
* Optionally, specify custom marshaling information for the method's parameters and return value, which will override the .NET Framework default marshaling.

#### Example 1

This example shows you how to use the **DllImport** attribute to output a message by calling puts from msvcrt.dll.

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// PInvokeTest.cs

using System;

using System.Runtime.InteropServices;

class PlatformInvokeTest

{

[DllImport("msvcrt.dll")]

public static extern int puts(string c);

[DllImport("msvcrt.dll")]

internal static extern int \_flushall();

public static void Main()

{

puts("Test");

\_flushall();

}

}

#### Output

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Test

#### Code Discussion

The preceding example shows the minimum requirements for declaring a C# method that is implemented in an unmanaged DLL. The method PlatformInvokeTest.puts is declared with the **static** and **extern** modifiers and has the **DllImport** attribute which tells the compiler that the implementation comes from msvcrt.dll, using the default name of puts. To use a different name for the C# method such as putstring, you must use the **EntryPoint** option in the **DllImport** attribute, that is:

[Copy](javascript:CodeSnippet_CopyCode('CodeSnippetContainerCode_67662a87-2e37-4364-b2f6-f7ecc8fb4d26');)

[DllImport("msvcrt.dll", EntryPoint="puts")]

For more information on the syntax of the **DllImport** attribute, see [DllImportAttribute Class](http://msdn.microsoft.com/en-us/library/system.runtime.interopservices.dllimportattribute(v=vs.71).aspx).

### Default Marshaling and Specifying Custom Marshaling for Parameters to Unmanaged Methods

When calling an unmanaged function from C# code, the common language runtime must marshal the parameters and return values.

For every .NET Framework type there is a default unmanaged type, which the common language runtime will use to marshal data across a managed to unmanaged function call. For example, the default marshaling for C# string values is to the type LPTSTR (pointer to TCHAR char buffer). You can override the default marshaling using the **MarshalAs** attribute in the C# declaration of the unmanaged function.

#### Example 2

This example uses the **DllImport** attribute to output a string. It also shows you how to override the default marshaling of the function parameters by using the **MarshalAs** attribute.

[Copy](javascript:CodeSnippet_CopyCode('CodeSnippetContainerCode_74c4ff27-da9d-4afa-90ce-dceec5fd40a9');)

// Marshal.cs

using System;

using System.Runtime.InteropServices;

class PlatformInvokeTest

{

[DllImport("msvcrt.dll")]

public static extern int puts(

[MarshalAs(UnmanagedType.LPStr)]

string m);

[DllImport("msvcrt.dll")]

internal static extern int \_flushall();

public static void Main()

{

puts("Hello World!");

\_flushall();

}

}

#### Output

When you run this example, the string,

[Copy](javascript:CodeSnippet_CopyCode('CodeSnippetContainerCode_493fdfc7-1401-481c-86e8-49a6ed7e0f06');)

Hello World!

will display at the console.

#### Code Discussion

In the preceding example, the default marshaling for the parameter to the puts function has been overridden from the default of LPTSTR to LPSTR.

The **MarshalAs** attribute can be placed on method parameters, method return values, and fields of structs and classes. To set the marshaling of a method return value, place the **MarshalAs** attribute in an attribute block on the method with the return attribute location override. For example, to explicitly set the marshaling for the return value of the puts method:

[Copy](javascript:CodeSnippet_CopyCode('CodeSnippetContainerCode_deb987cb-0840-42b7-a2fd-2fb34adb92a8');)

...

[DllImport("msvcrt.dll")]

[return : MarshalAs(UnmanagedType.I4)]

public static extern int puts(

...

For more information on the syntax of the **MarshalAs** attribute, see [MarshalAsAttribute Class](http://msdn.microsoft.com/en-us/library/system.runtime.interopservices.marshalasattribute(v=vs.71).aspx).

**Note** The **In** and **Out** attributes can be used to annotate parameters to unmanaged methods. They behave in a similar manner to the **in** and **out** modifiers in MIDL source files. Note that the **Out** attribute is different from the C# parameter modifier, out. For more information on the **In** and **Out** attributes, see [InAttribute Class](http://msdn.microsoft.com/en-us/library/system.runtime.interopservices.inattribute(v=vs.71).aspx) and [OutAttribute Class](http://msdn.microsoft.com/en-us/library/system.runtime.interopservices.outattribute(v=vs.71).aspx).

### Specifying Custom Marshaling for User-Defined Structs

You can specify custom marshaling attributes for fields of structs and classes passed to or from unmanaged functions. You do this by adding **MarshalAs** attributes to the fields of the struct or class. You must also use the **StructLayout** attribute to set the layout of the struct, optionally to control the default marshaling of string members, and to set the default packing size.

#### Example 3

This example demonstrates how to specify custom marshaling attributes for a struct.

Consider the following C structure:

[Copy](javascript:CodeSnippet_CopyCode('CodeSnippetContainerCode_23e7bc11-9e04-41b9-8765-685d08d34410');)

typedef struct tagLOGFONT

{

LONG lfHeight;

LONG lfWidth;

LONG lfEscapement;

LONG lfOrientation;

LONG lfWeight;

BYTE lfItalic;

BYTE lfUnderline;

BYTE lfStrikeOut;

BYTE lfCharSet;

BYTE lfOutPrecision;

BYTE lfClipPrecision;

BYTE lfQuality;

BYTE lfPitchAndFamily;

TCHAR lfFaceName[LF\_FACESIZE];

} LOGFONT;

In C#, you can describe the preceding struct by using the **StructLayout** and **MarshalAs** attributes as follows:

[Copy](javascript:CodeSnippet_CopyCode('CodeSnippetContainerCode_840f5456-0863-4a64-8bd6-80f8cf4c9287');)

// logfont.cs

// compile with: /target:module

using System;

using System.Runtime.InteropServices;

[StructLayout(LayoutKind.Sequential)]

public class LOGFONT

{

public const int LF\_FACESIZE = 32;

public int lfHeight;

public int lfWidth;

public int lfEscapement;

public int lfOrientation;

public int lfWeight;

public byte lfItalic;

public byte lfUnderline;

public byte lfStrikeOut;

public byte lfCharSet;

public byte lfOutPrecision;

public byte lfClipPrecision;

public byte lfQuality;

public byte lfPitchAndFamily;

[MarshalAs(UnmanagedType.ByValTStr, SizeConst=LF\_FACESIZE)]

public string lfFaceName;

}

For more information on the syntax of the **StructLayout** attribute, see [StructLayoutAttribute Class](http://msdn.microsoft.com/en-us/library/system.runtime.interopservices.structlayoutattribute(v=vs.71).aspx).

The structure can then be used in C# code as shown below:

[Copy](javascript:CodeSnippet_CopyCode('CodeSnippetContainerCode_98b64cb8-7039-410a-ade7-44de143ae99c');)

// pinvoke.cs

// compile with: /addmodule:logfont.netmodule

using System;

using System.Runtime.InteropServices;

class PlatformInvokeTest

{

[DllImport("gdi32.dll", CharSet=CharSet.Auto)]

public static extern IntPtr CreateFontIndirect(

[In, MarshalAs(UnmanagedType.LPStruct)]

LOGFONT lplf // characteristics

);

[DllImport("gdi32.dll")]

public static extern bool DeleteObject(

IntPtr handle

);

public static void Main()

{

LOGFONT lf = new LOGFONT();

lf.lfHeight = 9;

lf.lfFaceName = "Arial";

IntPtr handle = CreateFontIndirect(lf);

if (IntPtr.Zero == handle)

{

Console.WriteLine("Can't creates a logical font.");

}

else

{

if (IntPtr.Size == 4)

Console.WriteLine("{0:X}", handle.ToInt32());

else

Console.WriteLine("{0:X}", handle.ToInt64());

// Delete the logical font created.

if (!DeleteObject(handle))

Console.WriteLine("Can't delete the logical font");

}

}

}

#### Sample Run

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C30A0AE5

#### Code Discussion

In the preceding example, the CreateFontIndirect method is using a parameter of the type LOGFONT. The **MarshalAs** and **In** attributes are used to qualify the parameter. The program displays the numeric value returned by the method as a hexadecimal uppercase string.

### Registering Callback Methods

To register a managed callback that calls an unmanaged function, declare a delegate with the same argument list and pass an instance of it via PInvoke. On the unmanaged side it will appear as a function pointer. For more information about PInvoke and callback, see [A Closer Look at Platform Invoke](http://msdn.microsoft.com/en-us/library/aa719485(v=vs.71).aspx).

For example, consider the following unmanaged function, MyFunction, which requires callback as one of the arguments:

[Copy](javascript:CodeSnippet_CopyCode('CodeSnippetContainerCode_26634751-ae65-4b87-b6cb-ee272240a19d');)

typedef void (\_\_stdcall \*PFN\_MYCALLBACK)();

int \_\_stdcall MyFunction(PFN\_ MYCALLBACK callback);

To call MyFunction from managed code, declare the delegate, attach DllImport to the function declaration, and optionally marshal any parameters or the return value:

[Copy](javascript:CodeSnippet_CopyCode('CodeSnippetContainerCode_aa2824bc-7c39-4b55-a352-e62517e31c4b');)

public delegate void MyCallback();

[DllImport("MYDLL.DLL")]

public static extern void MyFunction(MyCallback callback);

Also, make sure the lifetime of the delegate instance covers the lifetime of the unmanaged code; otherwise, the delegate will not be available after it is garbage-collected.