

Chapter 12

Extending Web Applications



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Overview

In this chapter, you will learn how Web services communicate between applications, which standards and protocols are required for Web services, and how to create, consume, and secure Web services using Visual Studio .NET. You will also learn how to extend your Web application to alternative platforms such as PDAs and mobile devices.

Chapter Objectives

In this chapter, students will learn:

- Describe how Web services communicate
- Learn how to apply Web services to business applications
- Identify Web service standards and protocols required to implement Web services
- Create a Web service using Visual Studio .NET
- Describe the SOAP protocol
- Create a web page that consumes a Web service using Visual Studio .NET
- Explore the security methods used to protect a Web service
- Build a web application that can deliver content to a mobile device

Instructor Notes

Overview of Web Services

Web applications consist of a client, which is the browser application, and a web server. The web browser requests a web page from the web server. The web server interacts with other applications, such as a SQL Server database. Then, the web server delivers the web page to the browser. But what if the owner of the web site wants to share the web site's data with another web site? In previous versions of ASP, you would create a custom program on each web server that would allow communication between programs. One program would include a **Remote Procedure Call (RPC)** to call another application on the web server. This is not useful when you need to create applications that work across platforms, however. Integrating systems across multiple platforms is time-consuming, costly, and often ineffective. The .NET Framework introduces Web services as an integral part of the architecture, making it easy for you to create and consume these services with minimal amounts of code written. Web services use open standards and protocols, allowing programs to communicate easily across platforms.

Teaching Tip	It's important at the outset to show students that companies have created applications that work together. But these were often customized and expensive.
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Communicating Between Applications with Web Services

With Visual Studio .NET and ASP.NET, you can quickly build Web services that expose parts of your web application to other businesses and applications. The Web service is part or all of a web application that is publicly exposed so that other applications can interact with it. The program logic that is exposed via the Web service is accessible through standard web protocols such as HTTP, XML, and the Simple Object Access Protocol (SOAP). Therefore, the Web service is platform independent. This means that any client can access the application using standard protocols.

Because Web services are built using open standards, you can use them to develop applications that can be called from a variety of clients on a variety of platforms. As a result, Web services combine the best aspects of component-based development and web development. (*Note:* Web services are like libraries that provide data and services to other applications. That is also why Web services are sometimes referred to as the Application

Programming Interface (API) for the Web application.) Web services make it easier to build distributed Internet applications.

The Web service client can be a web application, a mobile application, or even a Microsoft web application. The browser is a client of the web application. The browser does not know that the web server is communicating with a Web service. Additionally, the Web service client does not know that the Web service is communicating with any back-end applications or data sources.

The Web service client application does not communicate directly with the Web service application. Rather, it creates a WSDL proxy. WSDL stands for **Web Service Description Language (WSDL)**. The **WSDL proxy** is a class that is used to invoke the Web service. The WSDL proxy will communicate with the Web service application through a WSDL stub. The **WSDL stub** is the code that communicates between the proxy class and the Web service application. The purpose of the WSDL stub is to make the communication with the Web service application simpler and transparent. The developer does not have to know about the inner workings of the Web service application in order to invoke the Web service. Rather, the WSDL stub knows what can be sent into and out of the Web service application. The WSDL proxy and stub can be created manually using the WSDL command-line utility (wsdl.exe), or automatically when you use your editor to create and consume your Web service.

Teaching Tip

This section can be confusing for students because of the number of terms. Beginning students will use Visual Studio to create the Web service. However, advanced students may want to learn to create the SOAP envelopes and Web services manually.

Applying Web Services to Business Applications

Businesses want to share information across servers over the Internet. You may have seen web sites that list and compare products that are sold across multiple web sites. A recent trend on the Internet is for a web site, we'll call Traders Point, to display books from an online bookstore, we'll call Barney's Books. The Traders Point web site receives money, credit, or other bonuses for referring the user to Barney's Books to purchase the book. To create the link between Traders Point and Barney's Books, you could hard-code the Barney's Books hyperlinks into your application. If Traders Point is a significant business partner to Barney's Books, you could create a custom distributed application to the Barney's Books web application.

Teaching Tip

Students do not at first understand how Web services impact businesses. You can introduce the importance of using a Web service by demonstrating one, such as how to link to a famous web site.

Microsoft offers documentation on several case studies where their enterprise customers create and consume Web services. This documentation is at <http://msdn.microsoft.com/> and www.microsoft.com/casestudies/.

Using Web Editors to Create and Consume Web Services

In order to create a Web service, you must create a class method with standard input and output parameters and then mark those classes and the specific methods as exposable over the Internet by using the **WebMethod** keyword.

Three major components make up a Web service:

- The Web service on the server side
- The client application that calls the Web service via a web reference
- A WSDL Web service description that describes the functionality of the Web service

The first part of the Web service is the server application that is exposed. In ASP.NET, the name of the file for the Web service must have the file extension .asmx. This Web service file compiles into a class. So, a Web service is a class that can be called over a TCP/IP network. As with a traditional web page, you can create the source file of the Web service by using a text editor such as Notepad, or a web development tool. If you are creating your code in a text editor, you need to import the System.Web.Services namespace into the source code for the Web service.

Teaching Tip

You will want to display a simple Web service first. One way to do this is to have the students break into groups. One group creates a Web service and the other two groups create applications to consume the web service in different ways.

Quick Quiz

1. WSDL stands for _____.
Answer: Web Service Description Language (WSDL)
2. The _____ is the code that communicates between the proxy class and the Web service application.
Answer: WSDL stub
3. The directory mechanism is the means to locate a Web service through a Web service _____.
Answer: Discovery Directory
4. The application uses the WSDL document to create a(n) _____.
Answer: proxy class
5. If you are sending the message using SOAP, the proxy class creates the _____, and then passes the envelope to the Web service.
Answer: SOAP envelope

Discussion Questions

Web Services

- Discuss some of the business cases today that could be replaced with Web services.
- What new business models could be implemented with a Web service?

Protocols

- Discuss what parts of Web services are proprietary and non-proprietary open protocols.
- What role did Microsoft play in promoting Web services?

Web Services Standards and Protocols

The HTTP protocol was selected as the primary delivery protocol of Web services because it can be used to deliver documents through proxy servers and firewalls. The three methods used to route the message over HTTP are HTTPGet, HTTPPost, and SOAP. When you create a Web service page such as default.asmx, ASP.NET automatically creates the support for a test page also known as the Service Description page.

Programming Web Services with .NET Development Editors

Web services are fully integrated into the .NET development environment. When you use either Visual Studio .NET or Visual Web Developer Express to create your Web service, the application generates the WSDL document, the DISCO document, and the test web page. You can use the breakpoints within the debugger tool and the tracing features to debug your Web service. When you use a .NET editor to consume a Web service, the application generates a client-side proxy class with both synchronous and asynchronous calls. Then, when you want to access an object, property, or function within the Web service, the local web application treats the Web service as a local object. As a result, all the features of the .NET development environment, such as IntelliSense and debugging, are also supported.

The SOAP Contract

The SOAP protocol is an industry standard that is maintained by the W3C. Simple Object Access Protocol (SOAP) is an XML-based protocol used for messaging delivery. SOAP is language independent and platform independent. The SOAP message is a remote procedure call over HTTP using XML. Because it is an XML-based message format, it can easily be transmitted over HTTP through firewalls and proxy servers. Because SOAP can represent remote procedure calls and responses from another application, it allows the client application to call the Web service over HTTP. The SOAP packet contains a SOAP envelope and the response in an XML document. The response may contain the XML data. And, because it serializes the calls and data in XML, SOAP provides a flexible way to express application defined data types. Once the application receives the XML data, the application can deserialize the data into an object such as the DataSet object. So, if you plan to create a Web service that creates objects, you likely will want to call the Web service by using SOAP.

Teaching Tip

You may want to spend time showing student examples of SOAP contracts and the WSDL and DISCO files that are automatically created. They are XML based. Students do not need to create these in this course, but they should know what they are used for.

The code following this paragraph is a sample of how you can use the WSDL command-line utility to look at the contract and generate the proxy class. The `wsdl` command is the command to call the WSDL utility, and `/language:VB` configures Visual Basic .NET as the language of the class. The URL provides the location of the contract to the Web service.

```
wsdl /language:VB http://localhost/Service1.asmx?wsdl
```

The DISCO (discovery) document is not the SOAP contract. Rather, it is a pointer to the location of the Web services within the web project. The DISCO document is an XML document that examines the SOAP contract to describe the method and data formats within the Web service. The DISCO document describes how the proxy class should make calls to the Web service. Although in Visual Studio .NET you can use the tools to create and consume Web services, you can also use command-line utilities without Visual Studio .NET. The `wsdl.exe` file is used to create the SOAP contract.

Quick Quiz

1. You use _____ compiler to create the proxy class for a Visual Basic .NET class.
Answer: Visual Basic .NET compiler (VBC.exe)
2. _____ is an XML-based protocol used for messaging delivery.
Answer: Simple Object Access Protocol (SOAP)
3. The _____ document is not the SOAP contract. Rather, it is a pointer to the location of the Web services within the web project.
Answer: DISCO (discovery)
4. The three methods used to route the message over HTTP are HTTPGet, HTTPPost, and _____.
Answer: SOAP
5. The SOAP protocol is an industry standard maintained by the _____.
Answer: W3C

Discussion Questions

Locating Web Services

- Locate a Web service directory on the web. Describe the location, URL, accessibility, cost, purpose of the UDDI, and types of

Web services they link to.

- Discuss the benefit of using a UDDI to locate Web services.

Creating a Web Service in an Editor

- Discuss the benefits of using the editor to create the Web service and WSDL contracts versus creating the contracts and files manually.

Creating a Web Service

Web services are fully integrated into the .NET development environment. When you use .NET tools to create your Web service, the application generates the WSDL document, the DISCO document, and the test web page. You can use the breakpoints within the debugger tool and the tracing features to debug your Web service. When you create the Web service project, web editor automatically includes references to the System.Data, System.Drawing, System.Web, System.WebServices, and System.XML namespaces. Therefore, you do not have to import these namespaces into your projects.

When you create a Web service, there are two parts. When you create a Web service in the .NET development environment, the file automatically will import the Web Service namespace at the top of the file. Then, the page class is converted into a Web service by the insertion of the WebServiceAttribute, which means that the WebService keyword is inserted before the class declaration.

The **Namespace property** identifies a unique URL that can distinguish your Web service from other Web services on the Internet. The default uses the domain tempuri.org. If you use tempuri.org as the namespace, your Web service home page will display a message reminding you to change the namespace value. It is highly recommended to replace the tempuri.org namespace with your company's domain name. The default namespace was changed to tarastore.org. The **Description property** can be used to provide information about your Web service. The Description attribute will appear on the Web service home page. Therefore, you can use HTML commands to format the Description attribute. The **Name property** allows you to provide a name for the Web service that will be displayed in the Web service home page.

The CacheDuration property is used to identify in seconds how long to cache results from the Web service. This method often is set when you are sending data from the Web service. The WebMethod will automatically cache the results for each unique parameter sent to the WebMethod. The **MessageName property** allows you to assign a name for the method that will be displayed within the Web service home page. The **Description property** allows you to provide a description for the method that will be displayed within the Web service home page. Because this is a string, you can format the description with HTML.

Teaching Tip

Create Web services with different types of information being passed such as strings, numbers, objects, and datasets.

Quick Quiz

1. The _____ identifies a unique URL that can distinguish your Web service from other Web services on the Internet.
Answer: Namespace property
2. The _____ can be used to provide information about your Web service.
Answer: Description property
3. The _____ allows you to store the response on the server until the entire function is processed.
Answer: BufferResponse property
4. The _____ allows you to assign a name for the method that will be displayed within the Web service home page.
Answer: MessageName property
5. The _____ allows you to provide a description for the method that will be displayed within the Web service home page.
Answer: Description property

Discussion Questions

Creating a Web Service

- Discuss the procedure to create the Web service in the code behind the page.
- Discuss how to send data across a Web service.

Using a Web Service

You can call Web services via the HTTPGet and HTTPPost methods, or via SOAP. Although the HTTPGet and HTTPPost methods are limited to sending only primitive data types such as integers and strings, they can also send arrays of these primitive data types. The SOAP protocol allows you to send any structure, class, or enumerator over the Internet. For example, you can send an ADO object, such as a DataSet object, or an array of Data objects.

The application that calls the Web service is a Web service client. You create a Web service client from an ASP.NET page. The Web service may be called by the HTTPGet and HTTPPost methods, or SOAP. The Server Explorer window allows you to see Web services installed within your local web server.

Locating Third-Party Web Services

Many third-party Web services are available. The UDDI is a directory service that was initially created by Microsoft and IBM to provide businesses a method for registering and searching for Web services. The UDDI allows you to search for third-party Web services. The home page for UDDI is located at www.uddi.org. Additional information about UDDI can also be located on Microsoft's web site at www.microsoft.com/windowsserver2003/technologies/idm/uddi/default.msp. (Note: Windows Server 2003 now includes Enterprise UDDI Services, which you can use to run your own UDDI service on your own computers.) When you add a web reference to your project, instead of typing the URL in the location text box, you can click on the UDDI hyperlink to locate Web services.

In addition to the UDDI, you can find several third-party Web services at www.xmethods.net, www.asp.net, and www.gotdotnet.com. You can easily integrate non-Windows Web services into your application in the same way you would integrate Microsoft Windows Web services.

When you add a Web service, you can locate additional Web services on your local network or server. To locate local Web services, add a web reference to your project. Instead of typing in the URL of the Web service in the location text box, click the hyperlink Web References on Local Machine. The discovery document points you to where the Web services are located. Notice in the image that the Web service you created earlier will be listed.

The following is a list of web sites that discuss Web services or provide Web services:

- directory.google.com/Top/Computers/Programming/Internet/Service-Oriented_Architecture/Web_Services/www.hitmill.com/webservices/direct.asp
- www.prairietruckandtractor.com/webserdir.html
- www.programming-x.com/programming/uddi.html
- www.remotemethods.com
- www.soaprpc.com/webservice
- www.soapwebservices.com
- www.webservicelist.com

Microsoft provides additional Web services for developers. You can locate the Microsoft Web services at <http://msdn2.microsoft.com/en-us/webservices/aa740657.aspx>. Microsoft.com Web service is an XML Web service that will enable you to integrate information and services from MSDN, TechNet, other Microsoft.com sites, and Microsoft Support. The Web service provides information about top downloads from Microsoft. Microsoft MapPoint allows you to integrate high-quality maps and other location intelligence into your applications. Three additional Web services that are useful for developers are as follows:

- Amazon.Com Web services — www.amazon.com/gp/browse.html/?node=3435361
- GoogleWeb APIs Service — www.google.com/apis/
- TerraServer Web service — terraserver-usa.com/webservices.aspx

Teaching Tip

Students really enjoy learning to use popular Web services. You may want to include an assignment to read and create an example consuming a Web service.

Third-party Web services may change often, so it is important to create the activity generically so you can reuse it each term.

Quick Quiz

1. _____ is the process of changing an object into a form that can be readily transported over the network.

Answer: Serialization

2. You then change the string back into the original structure, which is known as _____.

Answer: deserialization

Discussion Questions

Third-Party Web Services

- Have students locate, read, and build a web page to connect to a third-party Web service. Have them share the information learned with the class. Discuss the problems that the students may have had locating and connecting to the Web service. Discuss the WSDL and documentation provided. Was the information adequate?

Securing Web Services

In addition to configuring state management, you will want to make sure your Web services are secure. Securing and maintaining security for a web site are important, ongoing responsibilities. Data-driven web sites and Web services often require additional security measures to protect data integrity and prevent malicious acts from hackers. You will want to limit access to your Web services by using an authentication scheme. Although the Web service architecture doesn't provide security for the developer, you can take advantage of the traditional security methods such as HTTP authentication services and SSL.

Teaching Tip

Security is included throughout the book. However, you may want to spend time here and emphasize the issues with collecting information and sending information out from your applications. Issues of confidentiality and security should be addressed.

Discussion Questions

Securing Web Services

- Discuss three methods that could be used to secure a Web service.

Working with Alternative Platforms: PDAs and Mobile Devices

Today, a web application is thought of as a series of web pages viewed with a browser. Each year, more consumers are viewing web content via alternative devices such as mobile phones. Several major issues affect the development of a web application for mobile devices. Because there is a wide range of hardware and software for these devices, not all of them have the same screen size, resolution, color, graphics, and multimedia capabilities. Some devices support a scaled-down version of a browser, and others only support text. Although some users connect directly via a network or wireless LAN, other users connect via modems or cellular phones. This means that web developers have less control over the end-user interface than ever before. Therefore, you should focus on what you can control, which is the content you are providing to the end user.

Creating a WML Document

The standard used to program on a mobile device is the **Wireless Application Protocol (WAP)**. WAP is an open standard that is available from the Open Mobile Alliance at www.wapforum.com. Within the WAP is the **Wireless S Protocol (WSP)**, which is a transport protocol that performs the same functions as HTTP for mobile devices. To work with web content, the WAP standards use an application standard known as **Wireless Markup Language (WML)**. Files that use the WML end with the file extension .wml. These files can contain small programs written in a scripting language such as VBScript. If the file contains programming scripts, the file extension ends in .wmls. Wireless bitmap images end in .wbmp.

WML is compliant with the XML protocols, and therefore is case sensitive. You must also close each tag with a closing tag or by adding a forward slash to the end of the opening tag. All WML files contain the MIME type declared in the document type declaration.

Teaching Tip

Some mobile devices use HTML or a mini-version of HTML. Some devices use Windows CE as the operating system. You should try to provide examples that are commonly used today. The iPhone recently was introduced. Virtual simulators of most of these devices are readily available to developers. You can either have students pick their own simulator, or select a few for the class to use as a group.

Stress that WML is just one option available.

Building PDA and Mobile Applications in .NET Development Tools

You can create ASP.NET pages that can be displayed on mobile devices. The ASP.NET web pages that contain Mobile controls are known as **Mobile Forms**. The tool within .NET development editors that allows you to create Mobile Forms using a GUI is called the **Mobile Internet Designer**. You do not have to create the WML code. ASP.NET will generate the code that is appropriate for the mobile device. So, if you use ASP.NET, the ASP.NET **Mobile controls** will generate the WML output for your web application. Just as with Web Forms, you can also create Mobile Forms by using an editor or in a simple editor such as Notepad.

Teaching Tip

The Mobile controls inherit from the System.Web.Mobile namespace. You can add Mobile Forms to an ASP.NET web application, or create a mobile web project and create the Mobile Forms within it.

You may want to take your students to the documentation for the System.Web.Mobile namespace so they can see what controls are available to them.

Using Mobile Controls in an ASP.NET Application

Mobile controls inherit a code behind the page named `System.Web.UI.MobileControls.MobilePage`. Each web page contains a register directive that is used to register the mobile tag controls with the Mobile control namespace. This code is automatically placed on the Mobile Form by your editor when you create the Mobile Form.

Teaching Tip

Creating a mobile form is a fun activity for students. If you have students with Internet access, it is fun to have them try this out in class on a portable device.

The paging, navigation, controls, text, and display are different on each device. The editors allow you to set global properties for your form. However, that does not mean that the device has the features.

There are many other Mobile Form controls that you can insert into a Mobile Form. You can add `AdRotator` controls and `Calendar` controls to the Mobile Forms. You can also create a form with text boxes.

Quick Quiz

1. Because mobile phones have become more sophisticated and are offering capabilities similar to PDAs, they often are referred to as _____ or smart devices.
Answer: SmartPhones
2. To work with web content, the WAP standards use an application standard known as _____.
Answer: Wireless Markup Language (WML)
3. The tool within .NET development editors that allows you to create Mobile Forms using a GUI is called the _____.
Answer: Mobile Internet Designer
4. For each item within the List control, the _____ assigns the value and the displayed text.
Answer: Text attribute
5. You can set the _____ of the form to `NoWrap` to stop the control from wrapping.
Answer: Wrapping property

Discussion Questions

Mobile Applications

- Compare the variety of browsers and platforms to the variety of mobile devices and applications. Is programming a web application today different than it was for a web browser? How has Visual Studio simplified this programming process?
- Provide an example of a mobile device and the programming capabilities, requirements, features and company, and developer information. Discuss the tools and techniques you would use to create a web application on that mobile device.

Key Terms

- **BufferResponse property:** Allows you to store the response on the server until the entire function is processed
- **Decoration property:** Identifies the type of list
- **Description property:** Used to provide information about your Web service
- **Deserialization:** Changing a string back into its original structure
- **MessageName property:** Allows you to assign a name for the method that will be displayed within the Web service home page
- **Namespace property:** Identifies a unique URL that can distinguish your Web service from other Web services on the Internet
- **NavigateURL:** Used to identify links
- **OpenWave Simulator:** Allows you to simulate phones from Ericsson, Mitsubishi, and Samsung
- **Remote Procedure Call (RPC):** Calls another application on the web server
- **Serialization:** The process of changing an object into a form that can be readily transported over the network
- **Wireless Application Protocol (WAP):** The standard used to program on a mobile device
- **WSDL contract:** Provides information about how to connect to the Tara Store Web service

- **WSDL proxy:** A class that is used to invoke the Web service
- **WSDL stub:** The code that communicates between the proxy class and the Web service application