

ASP.NET Using C#

Student Guide
Revision 4.7

ASP.NET Using C#

Rev. 4.7

Student Guide

Information in this document is subject to change without notice. Companies, names and data used in examples herein are fictitious unless otherwise noted. No part of this document may be reproduced or transmitted in any form or by any means, electronic or mechanical, for any purpose, without the express written permission of Object Innovations.

Product and company names mentioned herein are the trademarks or registered trademarks of their respective owners.



TM is a trademark of Object Innovations.

Authors: Robert J. Oberg, Arun Ganesh, Srini Manickam

Special Thanks: Mark Bueno, Peter Thorsteinson, Sharman Staples, Ernani Cecon, Dave Solum, Daniel Berglund

Copyright ©2015 Object Innovations Enterprises, LLC All rights reserved.

Object Innovations
877-558-7246
www.objectinnovations.com

Printed in the United States of America.

Table of Contents (Overview)

Chapter 1	Introduction to ASP.NET
Chapter 2	Web Forms Architecture
Chapter 3	ASP.NET and HTTP
Chapter 4	Web Applications Using Visual Studio
Chapter 5	State Management and Web Applications
Chapter 6	Server Controls
Chapter 7	Caching in ASP.NET
Chapter 8	ASP.NET Configuration and Security Fundamentals
Chapter 9	Debugging, Diagnostics and Error Handling
Chapter 10	More Server Controls
Chapter 11	ADO.NET and LINQ
Chapter 12	Data Controls and Data Binding
Chapter 13	ASP.NET AJAX
Chapter 14	ASP.NET MVC
Chapter 15	ASP.NET Web API
Chapter 16	ASP.NET and Azure
Appendix A	Learning Resources
Appendix B	Hosting in IIS 7.5

Directory Structure

- **The course software installs to the root directory C:\OIC\AspCs.**
 - Example programs for each chapter are in named subdirectories of chapter directories **Chap01**, **Chap02**, and so on.
 - The **Labs** directory contains one subdirectory for each lab, named after the lab number. Starter code is frequently supplied, and answers are provided in the chapter directories.
 - The **CaseStudy** directory contains case studies in multiple steps.
 - The **Demos** directory is provided for doing in-class demonstrations led by the instructor.
- **Data files install to the directory C:\OIC\Data.**
- **Log files are written to the directory C:\OIC\Logs.**

Table of Contents (Detailed)

Chapter 1 Introduction to ASP.NET	1
Web Application Fundamentals.....	3
Setting up the Web Examples	4
Benefits of ASP.NET	8
ASP.NET Example Program	9
An Echo Program.....	10
ASP.NET Features	13
Compiled Code	15
Server Controls	16
Browser Independence.....	17
Separation of Code and Content	18
State Management.....	19
Lab 1	20
Summary	21
Chapter 2 Web Forms Architecture	25
Web Forms Architecture.....	27
Code-Behind Version of Echo Example.....	28
HelloCodebehind.aspx	29
HelloCodebehind.aspx.cs.....	30
Page Class	31
Code-Behind Inheritance Model.....	32
Web Forms Page Life Cycle	33
View State.....	36
Enabling View State for Controls	37
Web Forms Event Model.....	38
Page Processing	40
Page Events	41
Page Properties	42
Sample Program.....	43
Page Directive.....	47
Tracing	49
Lab 2	51
Summary	52
Chapter 3 ASP.NET and HTTP	55
Classical Web Programming.....	57
Active Server Pages Object Model.....	58
Request and Response Objects	59
Request/Response in ASP.NET	60
HttpRequest Class	61
Properties of HttpRequest	62
Using HttpRequest Class	63

HTTP Collections	64
HttpServletResponse Class	66
Redirect.....	67
HttpUtility	68
Echo Program Example	69
Echo.aspx	70
EchoBack.aspx.....	71
GET and POST Compared.....	72
QueryString and Form Collections	73
Lab 3	74
Summary	75
Chapter 4 Web Applications Using Visual Studio.....	79
Using Visual Studio	81
Visual Studio Web Demo	82
Starter Web Site	83
ASP.NET Empty Web Site	85
Adding a Web Form.....	86
Default.aspx	87
Adding Controls.....	89
Setting Properties	90
Using Components in ASP.NET	93
Running Under IIS	94
Shadow Copying.....	98
Shadow Copy Demonstration	99
Temporary Copy of the Component	101
ASP.NET Applications	103
Global.asax	104
Web Application Life Cycle	105
Application Life Cycle Example	106
Sample Log File.....	107
Code in Global.asax	108
Log Class	109
Adding Global.asax File	110
ListBox.....	111
Data Binding	112
Data Binding Code Example	113
Items Collection	114
XHTML	115
XHTML in Visual Studio	116
Flow Positioning	117
Lab 4	118
Summary	119
Chapter 5 State Management and Web Applications	127
Session and Application State.....	130

Example Program.....	131
Session Object.....	132
Page_Load.....	133
Session Variable Issues.....	135
Session State and Cookies	136
Session State Timeout.....	137
Session State Store	138
Application State.....	139
Implementing Application State	140
Global.asax	141
Users.aspx.cs.....	142
Multithreading Issues.....	143
Bouncing the Web Server	144
Lab 5A	145
Cookies	146
Cookies and ASP.NET.....	147
HttpCookie Properties.....	148
Example – Exposing Cookies	149
Acme Travel Agency Case Study	155
State Management Techniques	157
Lab 5B.....	158
Summary	159
Chapter 6 Server Controls	173
Server Controls in ASP.NET	175
HTML Server Controls	176
Using HTML Server Controls	177
HTML vs. Web Forms Server Controls.....	178
Server Control Examples	179
HTML Controls Example	180
Code for Login.....	181
HTML Controls in Visual Studio	182
Using HTML Controls	183
Web Controls	184
Validation Controls.....	185
Required Field Validation.....	187
Regular Expression Validation	188
Rich Controls	189
Copying a Web Site	190
Lab 6	191
User Controls	192
Using a User Control	193
Copyright.ascx	194
Copyright.ascx.cs	195
User Control Example.....	196
Summary	197

Chapter 7 Caching in ASP.NET	201
Introduction.....	203
What is Caching?	204
Need for Caching (Why Cache?).....	205
Data to be Cached – Time Frame	206
ASP vs. ASP.NET Response Model.....	207
Caching in ASP.NET	208
Three Types of Caching in ASP.NET.....	209
Output Caching	210
@ OutputCache Directive	211
Simple Output Caching Example.....	212
@ OutputCache – Attributes in Detail.....	215
VaryByParam in Detail.....	216
HttpCachePolicy Class	218
HttpCachePolicy Class – Example	219
Page Fragment Caching	221
Common Mistakes in Using Fragment Caching	222
Fragment Caching Example.....	223
Data Caching or Application Caching	224
Add an Item to the Cache Object.....	225
Insert and Add Methods.....	226
Application Caching – Example	227
Expiration.....	229
Problems in Caching	230
Lab 7	231
Summary	232
Chapter 8 ASP.NET Configuration and Security Fundamentals	237
One-minute Introduction to XML!	239
ASP.NET Configuration - Overview	240
Multi-level Configuration	241
Configuration Hierarchy	242
Example of Configuration Hierarchy.....	243
Web.Config File Structure	244
Web.Config Sections	245
Application Settings.....	246
ASP.NET Security – Overview	247
Role-Based Security and CAS	248
Types and Steps	249
Steps in Enabling Role-Based Security	250
Two Ways to Authenticate.....	251
Forms Authentication Example	252
Forms Authentication – Default.aspx	254
Forms Authentication – Web.Config	257
Features of Forms Authentication.....	258
Authentication Cookie	259

Forms Authentication Classes	260
Customizing Forms Authentication	261
Authentication Source.....	262
Forms Authentication – Analysis	263
Windows Authentication	264
Windows Authentication – Analysis	265
Authorization	266
Lab 8	267
Summary	268
Chapter 9 Debugging, Diagnostics and Error Handling.....	275
ASP.NET Diagnostics.....	277
Debugging Using Visual Studio	278
Calculator Example.....	279
Debugging Calculator	280
Application-Level Tracing.....	282
Tracing Calculator	283
Using the Page Cache	286
Single Page Example	287
Preparing to Debug	288
Trace Messages	289
Tracing the Calculator Page.....	290
Conditional Tracing	291
Trace Category.....	292
Trace Warning	293
Exceptions in Trace	294
Errors in ASP.NET	295
Uncaught Exception.....	296
Custom Error Pages	297
Lab 9	298
Summary	299
Chapter 10 More Server Controls.....	301
ASP.NET Control Improvements	303
Newer Controls in ASP.NET	304
Master Pages	305
Master Page Demonstration.....	306
HTML 5 and Modernizr	312
Creating Content Pages.....	313
TreeView Control	314
Master Page Application.....	316
Lab 10	317
Summary	318
Chapter 11 ADO.NET and LINQ.....	323
ADO.NET	325
ADO.NET Architecture	326

.NET Data Providers	328
ADO.NET Interfaces	329
.NET Namespaces	330
Connected Data Access	331
SQL Express LocalDB	332
SqlLocalDB Utility	333
Visual Studio Server Explorer	334
Queries	336
ADO.NET with ASP.NET	337
Web Client Isolation	338
Web Client Database Code	339
Using Commands	341
Creating a Command Object	342
Using a Data Reader	343
Data Reader: Code Example	344
Use of Session State	345
Generic Collections	346
Executing Commands	347
Parameterized Queries	348
Parameterized Query Example	349
Lab 11A	350
DataSet	351
DataSet Architecture	352
Why DataSet?	353
DataSet Components	354
DataAdapter	355
DataSet Example Program	356
Data Access Class	357
Retrieving the Data	358
Filling a DataSet	359
Accessing a DataSet	360
Using a Standalone DataTable	361
DataTable Update Example	362
Adding a New Row	364
Searching and Updating a Row	365
Deleting a Row	366
Row Versions	367
Row State	368
Iterating Through DataRow	369
Command Builders	370
Updating a Database	371
Language Integrated Query (LINQ)	372
ADO.NET Entity Framework	373
LINQ and EDM Demo	374
IntelliSense	377

Basic LINQ Query Operators	378
Obtaining a Data Source	379
LINQ Query Example.....	380
Filtering.....	381
Ordering	382
Aggregation	383
Obtaining Lists and Arrays	384
Deferred Execution	385
Modifying a Data Source	386
LINQ to Entities Update Example.....	387
Entity Framework in a Class Library.....	388
Data Access Class Library	389
Client Code	390
Lab 11B.....	391
Summary	392
Chapter 12 Data Controls and Data Binding.....	405
Data Access in ASP.NET	407
Data Access Demonstration.....	408
Data Entry Demonstration	413
SQL Generation Options	414
Enable Edit and Delete	415
Editing Records.....	416
GridView Control	417
DetailsView Control	418
Storing the Connection String.....	419
Protecting the Configuration String.....	420
Lab 12A	421
FormView Control	422
Master/Detail Web Pages.....	423
Data Binding	426
Template Editing.....	427
Using XML Data.....	429
Example Program.....	430
XML Data Source Demo	431
Multiple-Tier Data Access.....	434
Object Data Source	436
Lab 12B.....	439
Summary	440
Chapter 13 ASP.NET AJAX.....	449
Desktop Applications.....	451
Web Applications.....	452
Plug-Ins	453
Client-Side Scripting.....	454
JavaScript Example.....	455

Script Code	456
JavaScript in ASP.NET.....	457
Dynamic Pages.....	458
Efficient Page Redraws.....	459
AJAX	460
Google Maps.....	461
ASP.NET AJAX	462
Partial Page Rendering.....	463
Partial Page Rendering Example	464
UpdatePanel Control.....	465
AJAX Extensions Controls	466
UpdatePanel Demo	467
AJAX Client Library	469
Using the Client Library	470
ScriptManager Control	471
Client Library Namespaces.....	472
Sys.Debug Tracing.....	473
Simple Client Library Example	474
Document Object Model.....	475
JavaScript for Simple Calculator.....	476
Using the Client Library	477
AJAX Control Toolkit	478
Installing AJAX Control Toolkit	479
ACT Controls in Visual Studio.....	480
ACT Sample Web Site.....	481
AjaxControlToolkit.dll	482
Registering <i>AjaxControlToolkit.dll</i>	483
Extender Controls	484
NumericUpDownExtender Control	485
Lab 13	486
Summary	487

Chapter 14 ASP.NET MVC	493
Model-View-Controller (MVC)	495
What Is ASP.NET MVC?	496
Advantages of ASP.NET MVC	497
Advantages of Web Forms.....	498
Visual Studio ASP.NET MVC Demo.....	499
Starter Application	501
Simple App with Controller Only	503
Action Methods and Routing	509
Action Method Return Type	510
Rendering a View	511
Creating a View in Visual Studio	512
The View Web Page	513
Dynamic Output.....	514
Razor View Engine	515
Embedded Scripts	516
Embedded Script Example.....	517
Using a Model with ViewBag	518
Controller Using Model and ViewBag	519
View Using Model and ViewBag.....	520
Using Model Directly	521
A View Using Model in Visual Studio.....	522
View Created by Visual Studio	523
Using Forms.....	524
HTML Helper Functions	525
Handling Form Submission	526
Model Binding	527
Greet View	528
Input Validation	529
Nullable Type	530
Checking Model Validity.....	531
Validation Summary	532
Lab 14	533
Summary	534
Chapter 15: ASP.NET Web API	541
ASP.NET Web API	543
REST.....	544
Representation, State and Transfer	545
Collections and Elements.....	546
Web API Demo	547
Specifying a Start Page	551
Implementing PUT Verb.....	552
Using Fiddler	553
Composing a Request	555
ASP.NET MVC and Web API.....	557

String API Demo.....	558
Route Registration	560
Lab 15A	563
HTTP Response Codes	564
POST Response Code	565
HttpResponseException.....	566
Web API Clients	567
HttpClient.....	568
Initializing HttpClient	569
Issuing a GET Request	570
Issuing a POST Request	571
Lab 15B.....	572
Summary	573
Chapter 16: ASP.NET and Azure	583
What Is Windows Azure?	585
A Windows Azure Testbed.....	586
Windows Azure Demo.....	587
Publish to Azure.....	588
Add an Account	589
Select Existing Web App.....	590
Create a Web App.....	591
Publish Windows Azure Web	592
Web Deployment Completed.....	594
Modifying a Web Application	595
Deploy to Original Site	596
Publish Preview	597
Lab 16	598
Summary	599
Appendix A Learning Resources.....	603
Appendix B: Hosting in IIS 7.5.....	607
Internet Information Services	608
Installing IIS 7.5	609
ASP.NET with IIS 7.5	613
.NET Framework Version.....	614
Registering ASP.NET	615

Chapter 1

Introduction to ASP.NET

EVALUATION COPY
Unauthorized Reproduction or Distribution Prohibited

Introduction to ASP.NET

Objectives

After completing this unit you will be able to:

- Review the fundamentals of Web applications and set up a testbed using Internet Information Services and ASP.NET.
- Explain the benefits of ASP.NET.
- Describe the programming models provided by ASP.NET: Web Forms, Web services and MVC.
- Create a simple Web Forms application using the .NET Framework SDK.
- Outline the principal features of ASP.NET.

Web Application Fundamentals

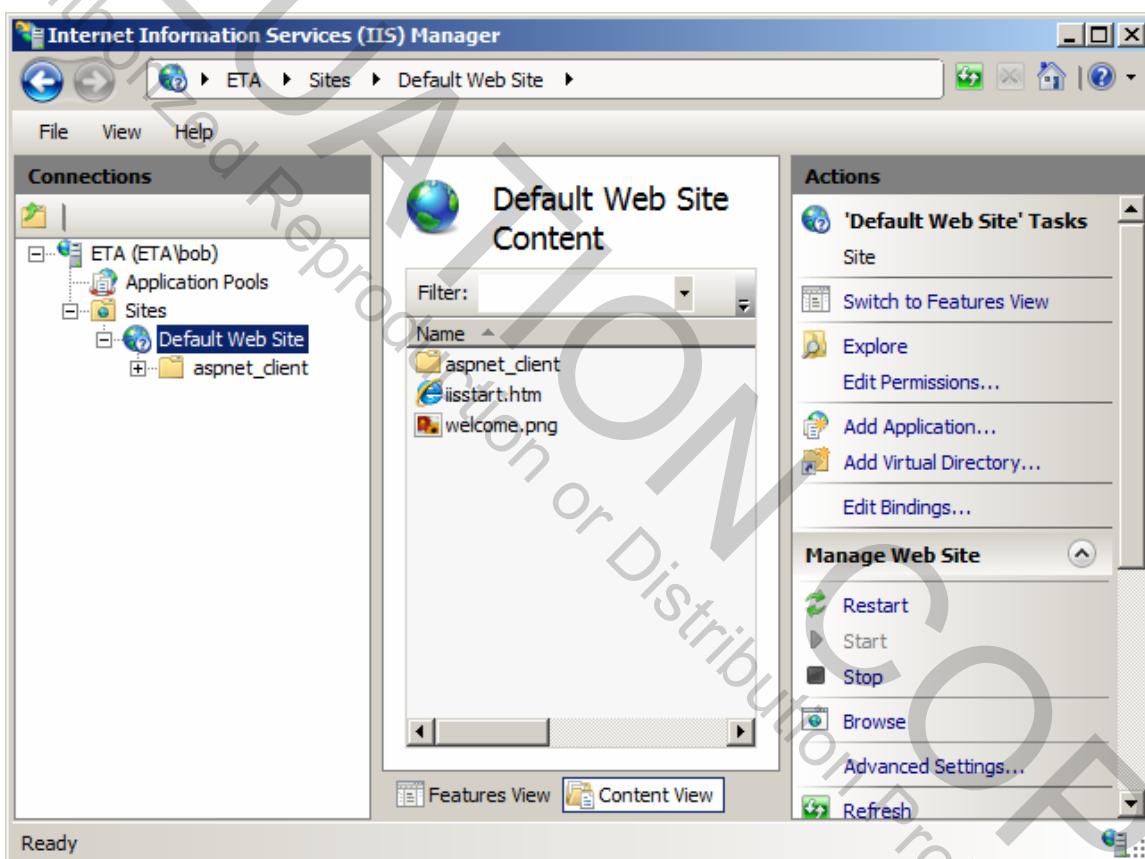
- A Web application consists of document and code pages in various formats.
- The simplest kind of document is a static HTML page, which contains information that will be formatted and displayed by a Web browser.
 - An HTML page may also contain hyperlinks to other HTML pages.
 - A hyperlink (or just “link”) contains an address, or a Uniform Resource Locator (URL), specifying where the target document is located.
- The resulting combination of content and links is sometimes called “hypertext” and provides easy navigation to a vast amount of information on the World Wide Web.

Setting up the Web Examples

- All the example programs for this chapter are in the chapter folder *Chap01* underneath the root folder *|OIC|AspCs*.
- One way to run the examples is to have Internet Information Services (IIS) installed on your system.
 - You will have to explicitly install it with Windows 7.
- Appendix B discusses installing and configuring IIS 7.5 in Windows 7.
- The management tool for IIS is a Microsoft Management Console (MMC) “snap-in,” the Internet Services Manager, which you can find under Administrative Tools in the Control Panel.
- You may run also run the ASP.NET examples using the built-in IIS Express.
 - This built-in Web server is started automatically from within Visual Studio 2015.
 - The use of this development Web server is discussed in Chapter 4

IIS Manager

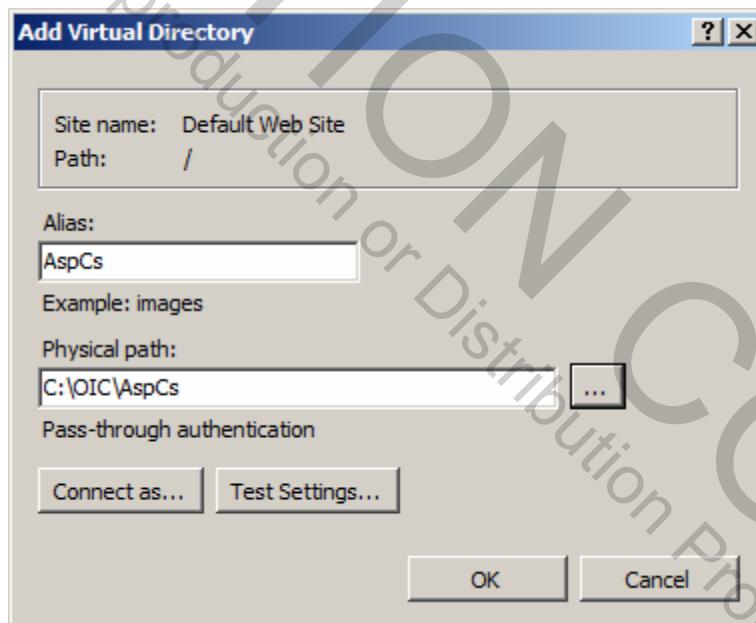
- The figure shows the main window of the Internet Services Manager for IIS 7.5, which comes with Windows 7.
 - We have selected the Content View tab at the bottom of the middle pane.



- You can Start and Stop the Web server and perform other tasks from the Manage Web Site group.
- With Advanced Settings you can change the physical path of the Default Web Site, which by default is located at **\inetpub\wwwroot** on the drive where Windows is installed.

Virtual Directory

- You can access Web pages stored at any location on your hard drive by creating a “virtual directory.”
 - Click Add Virtual Directory¹.
 - You can enter the desired alias, which will be the name of the virtual directory.
 - Browse to the desired physical path and click OK.
- The figure shows creating an alias *AspCs* for the folder *|OIC\AspCs*.

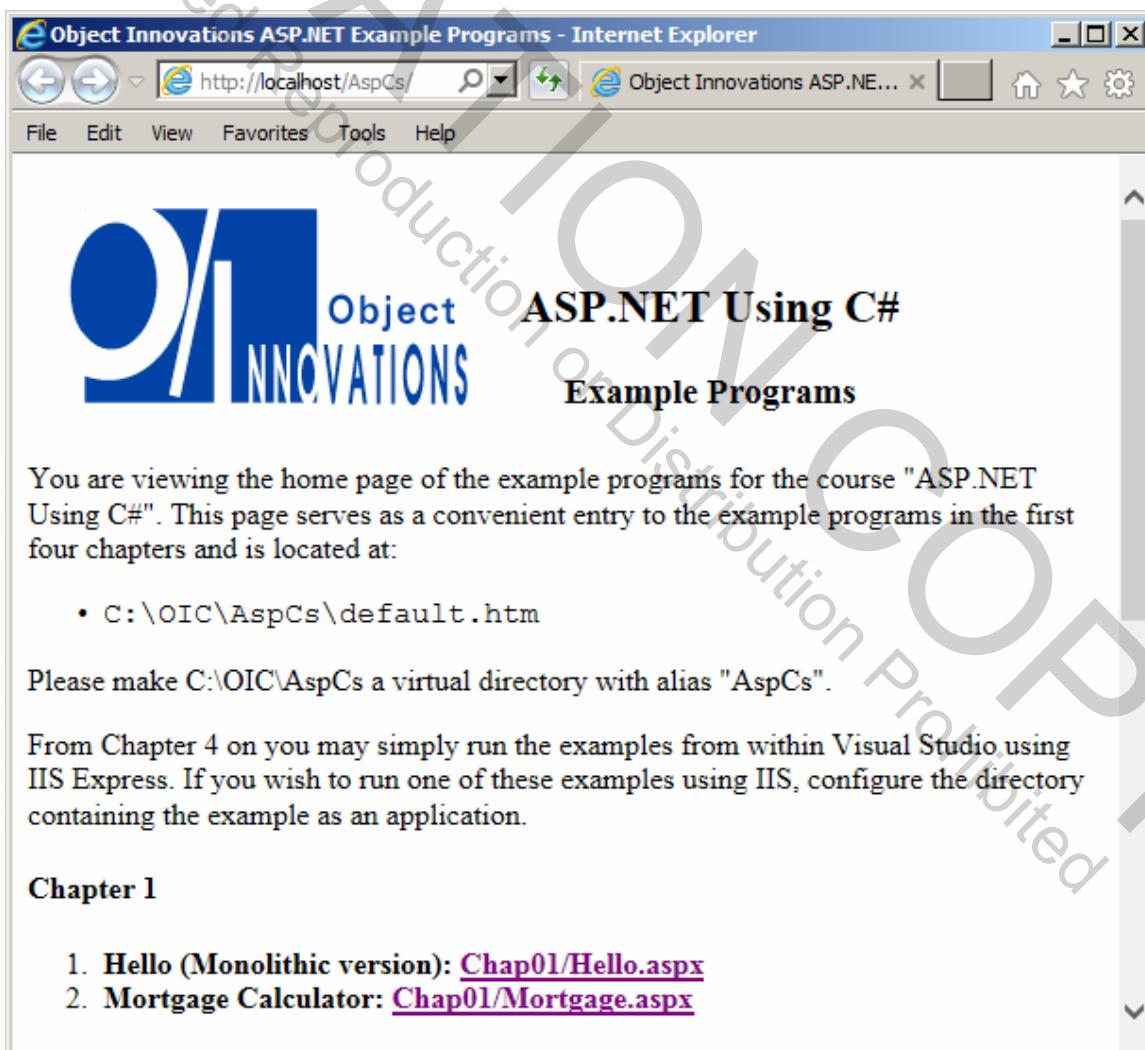


- You should perform this operation now on your own system so that you may follow along as the course examples are discussed.

¹ You can also add a virtual directory from the context menu brought up by a right-click over the Default Web Site.

Home Page for ASP.NET Examples

- Once a virtual directory has been created, you can access files in it by including the virtual directory in the path of the URL.
 - In particular, you can access the file **default.htm** using the URL <http://localhost/AspCs/>.
 - The file **default.htm** contains a home page for all the ASP.NET example programs for the course.



Benefits of ASP.NET

- You can use compiled, object-oriented languages with ASP.NET, including C# and Visual Basic.
 - All the power of the .NET Framework is available to you, including the extensive class library.
- Code and presentation elements can be cleanly separated.
 - Code can be provided in a separate section of a Web page from user interface elements.
 - The separation can be carried a step further by use of separate “code behind” files.
- ASP.NET comes with an extensive set of server controls that provide significant functionality out of the box.
- Server controls transparently handle browser compatibility issues.
- Configuration is handled by XML files without need of any registry settings, and deployment can be done simply by copying files.
- Visual Studio provides a very powerful and easy-to-use environment for developing and debugging Web applications.

ASP.NET Example Program

- We examine an example, *Hello.aspx*, in detail.
 - The example is complete in one file and contains embedded server code. ASP.NET pages have an **.aspx** extension.
- The source code consists of HTML along with some C# script code. There are also some special tags for “server controls,” recognized by ASP.NET.

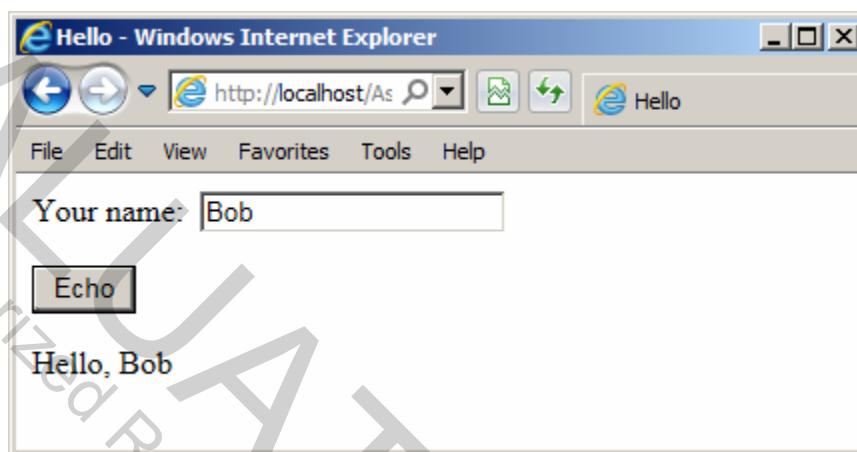
```
<!-- Hello.aspx -->
<%@ Page Language="C#" %>
<html>
<head>
    <title>Hello</title>
    <script runat="server">
        void cmdEcho_Click(object source,
                           EventArgs e)
        {
            lblGreeting.Text = "Hello, " + txtName.Text;
        }
    </script>
</head>
<body>
<form runat="server">Your name:&nbsp;
<asp:textbox ID="txtName" runat="server">
</asp:textbox>
<p><asp:button ID="cmdEcho" OnClick="cmdEcho_Click"
    Text="Echo" runat="server"
    tooltip="Click to echo your name">
</asp:button></p>
<asp:label ID="lblGreeting"
    runat="server"></asp:label>
</form>
</body>
</html>
```

An Echo Program

- You can run the program using the URL
<http://localhost/AspCs/Chap01>Hello.aspx> or by clicking on the link *Chap01/Hello.aspx* in the home page of the examples programs.
 - The page shows a text box where you can type in your name, and there is an “Echo” button.
 - Clicking the button will echo your name back, with a “Hello” greeting.
 - The simple form is again displayed, so you could try out other names.
 - If you slide the browser’s mouse cursor over the button, you will see the tool tip “Click to echo your name” displayed in a yellow box.

An Echo Program (Cont'd)

- The figure illustrates a run of this example.



- This little program would not be completely trivial to implement with other Web application tools, including ASP.
- The key user interface feature of such an application is its thoroughly forms-based nature.
 - The user is presented with a form and interacts with the form.
 - The server does some processing, and the user continues to see the same form.
 - This UI model is second nature in desktop applications but is not so common in Web applications.
 - Typically, the Web server will send back a different page.

An Echo Program (Cont'd)

- This kind of application could certainly be implemented using a technology like ASP, but the code would be a little ugly.
- The server would need to synthesize a new page that looked like the old page, creating the HTML tags for the original page, plus extra information sent back (such as the greeting shown at the bottom in our echo example).
 - A mechanism is needed to remember the current data that is displayed in the controls in the form.
- Another feature of this Web application is that it does some client-side processing too—the Echo button's tooltip displayed in a yellow box is performed by the browser.
 - Such rich client-side processing can be performed by modern browsers, such as Internet Explorer and Firefox.
- As can be seen by the example code, with ASP.NET it is very easy to implement this kind of Web application.
- We will study the code in detail later.
 - For now, just observe how easy it is!

ASP.NET Features

- ASP.NET provides a programming model and infrastructure that facilitates developing new classes of Web applications.
- Part of this infrastructure is the .NET runtime and framework.
- Server-side code is written in .NET compiled languages.
- Three main Web programming models are supported by ASP.NET.
- Web Forms helps you build form-based Web pages. A WYSIWYG development environment enables you to drag controls onto Web pages.
 - Special “server-side” controls present the programmer with an event model similar to what is provided by controls in ordinary Windows programming.
- ASP.NET MVC is a newer framework that provides an alternative to Web Forms for creating Web applications.
 - It is based on the Model-View-Controller design pattern.
- ASP.NET Web API supports the creation of HTTP services.
- ASP.NET MVC and ASP.NET Web API are introduced in the last two chapter of this course.

ASP.NET Features (Cont'd)

- **ASP.NET also supports Web Services, which make it possible for a Web site to expose functionality via an API that can be called remotely by other applications.**
 - Data is exchanged using standard Web protocols and formats such as HTTP and XML, which will cross firewalls.
 - A newer technology, Windows Communication Foundation, is now preferred for implementing Web services, along with Web API for HTTP services.
- **Web Forms, ASP.NET MVC, ASP.NET Web API and ASP.NET Web services can all take advantage of the facilities provided by .NET, such as the compiled code and .NET runtime.**
- **In addition, ASP.NET itself provides a number of infrastructure services, including:**
 - state management
 - security
 - configuration
 - caching
 - tracing

Compiled Code

- **Web Forms can be written in any .NET language that is compatible with the common language runtime, including C# and Visual Basic.**
 - This code is compiled, and thus offers better performance than ASP pages with code written in an interpreted scripting language such as VBScript.
- **Compilation normally occurs at HTTP request time, and subsequent accesses to the page do not require compilation.**
 - The ASP.NET compilation model is described in the next chapter.
- **All of the benefits, such as a managed execution environment, are available to this code, and of course the entire .NET Framework Class Library is available.**
 - Legacy unmanaged code can be called through the .NET interoperability services.

Server Controls

- ASP.NET provides a significant innovation known as “server controls.” These controls have special tags such as `<asp:textbox>`.
- Server-side code interacts with these controls, and the ASP.NET runtime generates straight HTML that is sent to the Web browser.
 - The result is a programming model that is easy to use and yet produces standard HTML that can run in any browser.

Browser Independence

- **Although the World Wide Web is built on standards, the unfortunate fact of life is that browsers are not compatible and have special features.**
 - A Web page designer then has the unattractive options of either writing to a lowest common denominator of browser, or else writing special code for different browsers.
 - Server controls help remove some of this pain.
- **ASP.NET takes care of browser compatibility issues when it generates code for a server control.**
 - If the requesting browser is upscale, the generated HTML can take advantage of these features, otherwise the generated code will be vanilla HTML.
 - ASP.NET takes care of detecting the type of browser.

Separation of Code and Content

- Typical ASP pages have a mixture of scripting code interspersed with HTML elements.
- In ASP.NET there can be a clean separation between code and presentation content.
 - The server code can be isolated within a single `<script runat="server"> ... / script>` block or, even better, placed within a “code behind” page.
- We will discuss "code-behind" pages in the next chapter.

State Management

- **HTTP is a stateless protocol.**
- **Thus, if a user enters information in various controls on a form, and sends this filled-out form to the server, the information will be lost if the form is displayed again, unless the Web application provides special code to preserve this state.**
 - ASP.NET makes this kind of state preservation totally transparent.
 - There are also convenient facilities for managing other types of session and application state.

Lab 1

A Mortgage Calculator Web Page

You have received a consulting contract to add useful functionality to a realtor's Web site. In this lab you will implement the first feature, which is a Web page that can be used to calculate a mortgage payment.

The screenshot shows a Microsoft Internet Explorer window titled "Mortgage Calculator - Windows Internet Explorer". The URL in the address bar is "http://localhost/As". The window contains a form with three input fields and one output field:

- Amount:**
- Rate (pct):**
- Years:**

Below the form is a "Calculate" button and the resulting output: **\$1,055.67**.

Detailed instructions are contained in the Lab 1 write-up at the end of the chapter.

Suggested time: 30 minutes

Summary

- **ASP.NET is a unified Web development platform that greatly simplifies the implementation of sophisticated Web applications.**
- **ASP.NET supports three Web programming models, Web Forms, ASP.NET MVC and ASP.NET Web API.**
- **Server controls present the programmer with an event model similar to what is provided by controls in ordinary Windows programming.**
- **Other features of ASP.NET include:**
 - Compiled code
 - Browser independence
 - Separation of code and content
 - State management
 - Security
 - Configuration
 - Tracing
 - Caching

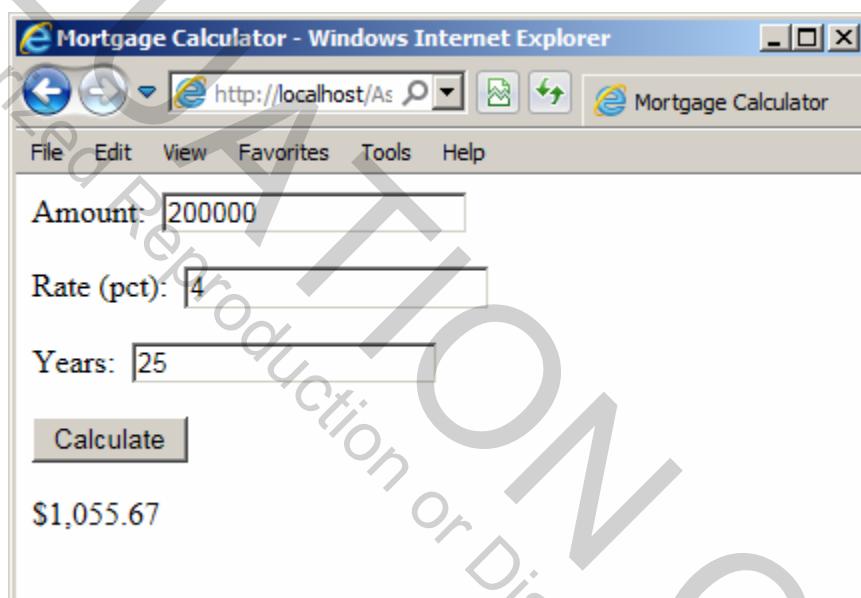
Lab 1

A Mortgage Calculator Web Page

Introduction

You have received a consulting contract to add useful functionality to a realtor's web site. In this lab you will implement the first feature, which is a Web page that can be used to calculate a mortgage payment.

The screen capture shows the completed Web page with a sample calculation.



Suggested Time: 30 minutes

Root Directory: OIC\AspCs

Directories: Labs\Lab1
Chap01\Hello.aspx
Chap01\MortgageCalculator

(do your work here)
(starter file)
(console mortgage calculator)

Files: Chap01\Mortgage.aspx

(answer)

1. As a starter file, copy the file **Hello.aspx** into **Labs\Lab1** and rename as **Mortgage.aspx**. You should now be able to access the “echo” page through the URL <http://localhost/AspCs/Labs/Lab1/Mortgage.aspx>.
2. Change the title to “Mortgage Calculator”.

3. Create the user interface for your Web mortgage calculator by making two copies of the textbox for the name in Hello. Rename the three textboxes, one button and one label appropriately. Rename the button handler to match the new name of the button.
4. Examine the code for the C# console program in the **MortgageCalculator** folder. Run this program a couple of times to generate some test data for use in testing your Web mortgage calculator.
5. Implement the event handler for the Calculate button by copying in code from the **MortgageCalculator** project. For the Web version you will obtain a numerical value by using the **Convert** class. For example,

```
decimal amount;      // amount of mortgage  
...  
amount = Convert.ToDecimal(txtAmount.Text);
```

6. After you have calculated **calcPymt**, display it formatted as currency in the label **lblPayment**. You can do the formatting by the **String.Format** method.

```
lblPayment.Text = String.Format("{0, 8:C}", calcPymt);
```

7. Save your file and test it in the browser. Try out the test data obtained from running the console version of the program.

EVALUATION COPY
Unauthorized Reproduction or Distribution Prohibited

Chapter 2

Web Forms Architecture

EVALUATION COPY
Unauthorized Reproduction or Distribution Prohibited

Web Forms Architecture

Objectives

After completing this unit you will be able to:

- Implement an ASP.NET Web application using a code-behind file that separates the visual content from user interface code.
- Describe the role of the Page class in Web Forms architecture.
- Explain the use of view state to preserve state information in round trips between client and server.
- Describe the Web Forms event model and compare it with the Windows Forms event model.
- Describe the page directive and outline the common attributes.
- Explain how to perform tracing in your ASP.NET applications.

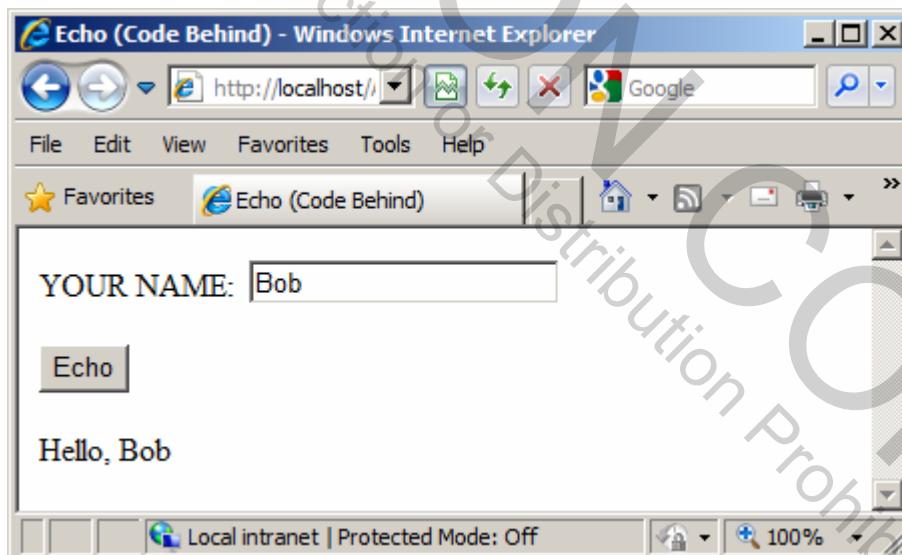
Web Forms Architecture¹

- **A Web Form consists of two parts:**
 - The visual content or presentation, typically specified by HTML elements.
 - Code that contains the logic for interacting with the visual elements.
- **A Web Form is physically expressed by a file with the extension .aspx.**
- **Any HTML page could be renamed to have this extension and could be accessed using the new extension with identical results to the original.**
 - Thus Web Forms are upwardly compatible with HTML pages.
- **The way code can be separated from the form is what makes a Web Form special.**
 - This code can be either in a separate file (having an extension corresponding to a .NET language, such as .cs for C#) or in the .aspx file, within a `<script runat="server"> ... </script>` block.
 - When your page is run in the Web server, the user interface code runs and dynamically generates the output for the page.

¹ Under the hood ASP.NET 5 (previously called ASP.NET vNext), has been significantly redesigned to provide an optimized development framework for applications that can be deployed either to the cloud or to local servers. This redesign does not affect the contents of this chapter. For an introduction to ASP.NET 5 see <http://docs.asp.net/en/latest/conceptual-overview/aspnet.html>. The last chapter of this course introduces ASP.NET on the Azure cloud.

Code-Behind Version of Echo Example

- We can understand the architecture of a Web Form most clearly by looking at the code-behind version of our “echo” example.
 - The visual content is specified by the **.aspx** file **HelloCodebehind.aspx**.
 - The user interface code is in the file **HelloCodebehind.aspx.cs**.
 - Use the link on the home page, or else the URL <http://localhost/AspCs/Chap02/Hello/HelloCodebehind.aspx>



HelloCodebehind.aspx

```
<!-- HelloCodeBehind.aspx -->
<%@ Page Language="C#"
   CodeFile="HelloCodeBehind.aspx.cs"
   Inherits="MyWebPage" %>
<html>
<head>
    <title>Echo (Code Behind)</title>
</head>
<body>
<form runat="server">
    YOUR NAME:  <asp:textbox id="txtName"
        runat="server"></asp:textbox>
    <p><asp:button id="cmdEcho"
        OnClick="cmdEcho_Click" Text="Echo"
        runat="server"></asp:button></p>
    <asp:label id="lblGreeting"
        runat="server"></asp:label>
</form>
</body>
</html>
```

- This .aspx file specifies the presentation or visual content.
- It is HTML with enhancements:
 - A page directive `<%@ Page Language="C#" ... %>`
 - Special server-side controls such as `<asp:button>`
 - The `runat="server"` attribute
- This code uses the *CodeFile* attribute to specify the code-behind file.

HelloCodebehind.aspx.cs

```
using System;
using System.Web;
using System.Web.UI;
using System.Web.UI.WebControls;

public partial class MyWebPage : System.Web.UI.Page
{
    //protected TextBox txtName;
    //protected Button cmdEcho;
    //protected Label lblGreeting;

    protected void cmdEcho_Click(object sender,
        EventArgs e)
    {
        lblGreeting.Text = "Hello, " + txtName.Text;
    }
}
```

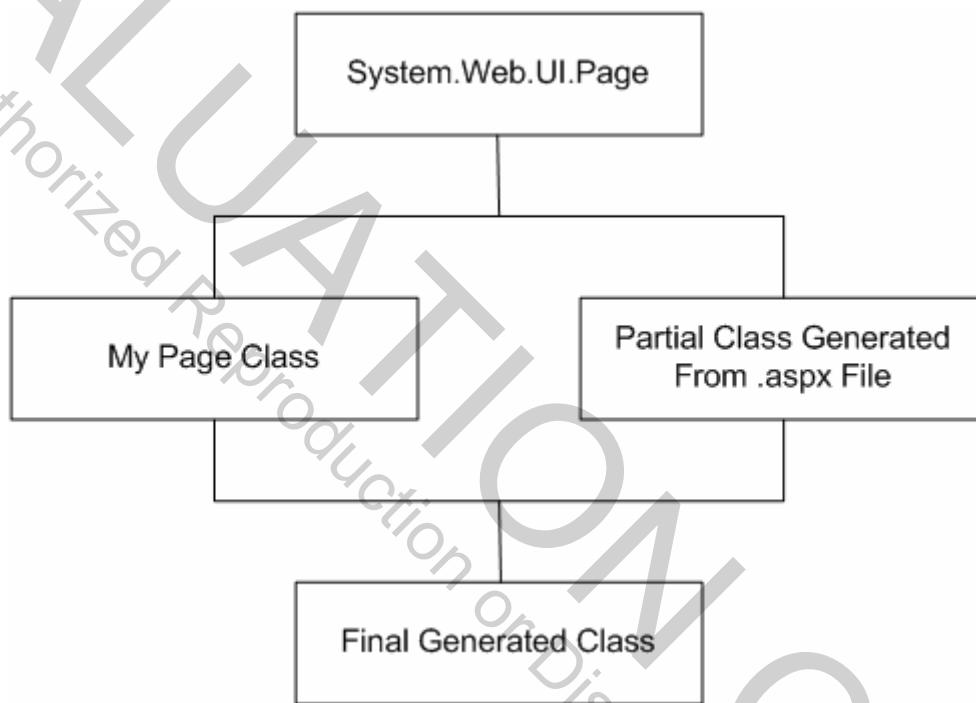
- **The .aspx.cs file provides the user interface code.**
 - It is straight C# code.
 - Later we will see examples of other code files that provide additional code processing beyond user interface.
- **Note the use of the *partial* keyword, which enables splitting the definition of a class over two or more source files.**
 - The comments show protected data members representing the controls on the page.
 - These fields are generated automatically at request time.

Page Class

- **The key namespace for Web Forms and Web Services is *System.Web*.**
 - Support for Web Forms is in the namespace **System.Web.UI**.
 - Support for server controls such as text boxes and buttons is in the namespace **System.Web.UI.WebControls**.
 - The class that is used to dynamically generate the output for a Web Form is the **Page** class in the **System.Web.UI** namespace.
- **The next page shows the inheritance model for Page classes used by ASP.NET beginning with .NET 2.0 and employing partial classes.**

Code-Behind Inheritance Model

- You do not need to define variables for controls.
 - These variables are defined for you automatically in a *partial class* that is generated from the .aspx file.

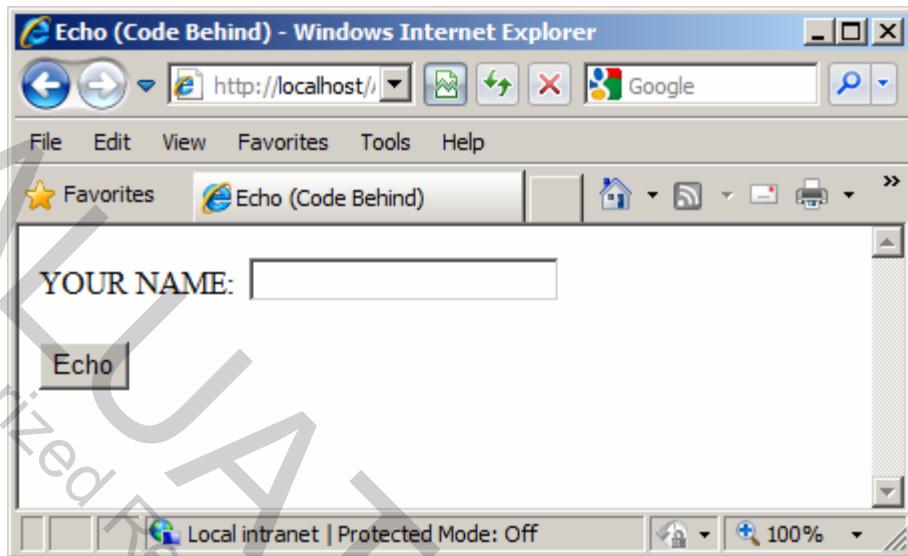


- Beginning in .NET 2.0 you can split the definition of a class over two or more source files by using the **partial** keyword.
- At compile time the two partial classes are merged into a single class that inherits from the **Page** class.
- This class is compiled into an executable, which is run when the page is requested by the browser.
- The executable code creates the HTML that is sent to the browser.

Web Forms Page Life Cycle

- We can get a good high-level understanding of the Web Forms architecture by following the life cycle of our simple Echo application.
 - We will use the code-behind version, *HelloCodebehind.aspx*.
1. User requests the **HelloCodebehind.aspx** Web page in the browser.
 2. Web server compiles the page class from the **.aspx** file and its associated code-behind page. The Web server executes the code, creating HTML, which is sent to the browser. (In Internet Explorer you can see the HTML code from the menu View | Source.) Note that the server controls are replaced by straight HTML. The code you see is what arrives at the browser, *not the original code on the server*. This compilation occurs on the first reference to the page. Subsequent references use the compiled code.
 3. The browser renders the HTML, displaying the simple form shown in the figure. To distinguish this example from the first one, we show “YOUR NAME” in all capitals. Since this is the first time the form is displayed, the text box is empty, and no greeting message is displayed.

Web Forms Page Life Cycle (Cont'd)

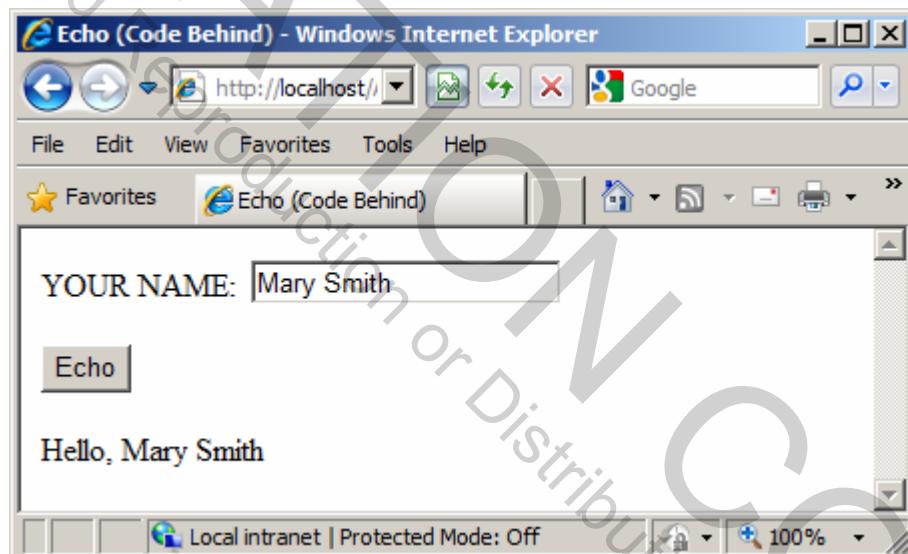


4. The user types in a name (e.g., "Mary Smith") and clicks the "Echo" button. The browser recognizes that a Submit button has been clicked. The method for the form is "post" and the action is "HelloCodebehind.aspx". We thus have what is called a "post back" to the original .aspx file.
5. The server now performs processing for this page. An event was raised when the user clicked the "Echo" button, and an event handler in the **MyWebPage** class is invoked.

```
protected void cmdEcho_Click(object Source,
                           EventArgs e)
{
    lblGreeting.Text = "Hello, " + txtName.Text;
}
```

Web Forms Page Life Cycle (Cont'd)

6. The **Text** property of the **TextBox** server control **txtName** is used to read the name submitted by the user. A greeting string is composed and assigned to the **Label** control **lblGreeting**, again using property notation.
7. The server again generates straight HTML for the server controls and sends the whole response to the browser.
8. The browser renders the page, as shown in the figure. Now a greeting message is displayed.



View State

- An important characteristic of Web Forms is that all information on forms is “remembered” by the Web server.
 - Since HTTP is a stateless protocol, this preservation of state does not happen automatically but must be programmed.
- A key feature of ASP.NET Web Forms² is that this state information, referred to as “view state,” is preserved automatically by the Framework, using a “hidden” control.
 - This view state is Base 64 encoded and not encrypted.

```
...
<input type="hidden" name="__VIEWSTATE"
value="dDwxMzc4MDMwNTk1O3Q8O2w8aTwyPjs+O2w8dDw7bDxp
PDU+Oz47bDx0PHA8cDxsPFRleHQ7PjtsPEh1bGxvLCBNYXJ5IFN
taXR0Oz4+Oz47Oz47Pj47Pj47Pg==" />
...
...
```

- Later in the course we will examine other facilities provided by ASP.NET for managing session state and application state.

² View state is not employed in ASP.NET MVC.

Enabling View State for Controls

- By default, view state is enabled for all controls.
- But view state increases the amount of time it takes to send a page to the client and post it back.
 - Storing more view state than is necessary can decrease performance.
- Beginning with .NET 4.0 you can disable view state for an entire page.
 - Set the `ViewStateMode` property of the page to **Disabled**.
 - You can then enable view state for just those controls that need it by setting the `EnableViewState` property to true.
- You could also leave `ViewStateMode` enabled for the page and set `EnableViewState` to false for those controls that do not need it.

Web Forms Event Model

- **From the standpoint of the programmer, the event model for Web Forms is very similar to the event model for Windows Forms.**
 - Indeed, this similarity is what makes programming with Web Forms so easy.
 - What is actually happening in the case of Web Forms, though, is rather different.
- **The big difference is that events get raised on the client and processed on the server.**
- **Our simple form with one text box and one button is not rich enough to illustrate event processing very thoroughly.**

Web Forms Event Model (Cont'd)

- Let's imagine a more elaborate form with several text boxes, list boxes, check boxes, buttons, and the like.
 - Because round trips to the server are expensive, events do not automatically cause a postback to the server.
- Server controls have what is known as an *intrinsic event set* of events that automatically cause a postback to the server.
 - The most common such intrinsic event is a button click.
 - Other events, such as selecting an item in a list box, do not cause an immediate postback to the server unless the **AutoPostBack** property of the control is set to true.
 - Otherwise, these events are cached, until a button click causes a post to the server.
 - Then, on the server the various change events are processed, in no particular order, and the event that caused the post is processed.

Page Processing

- Processing a page is a cooperative endeavor between the Web server, the ASP.NET run-time, and your own code.
- The *Page* class provides a number of events, which you can handle to hook into page processing.
- The *Page* class also has properties and methods that you can use.
 - We cover some of the major ones here.
 - For a complete description, consult the .NET Framework documentation.
- The example programs in this chapter will illustrate features of the *Page* class.

Page Events

- A number of events are raised on the server as part of the normal processing of a page.
- These events are actually defined in the *Control* base class and so are available to server controls also.
- The most important ones are listed below.
 - **PreInit** is the very first step in the page's life cycle and occurs when the page is initialized. There is no view-state information for any of the controls at this point. This event is used for loading personalization data and initializing themes. Personalization and themes are discussed later in the course.
 - **Init** is the next step in the page's life. There is still no view-state information for any of the controls at this point.
 - **Load** occurs when the controls are loaded into the page. View-state information for the controls is now available.
 - **PreRender** occurs just before the controls are rendered to the output stream. Normally this event is not handled by a page but is important for implementing your own server controls.
 - **Unload** occurs when the controls are unloaded from the page. At this point it is too late to write your own data to the output stream.

Page Properties

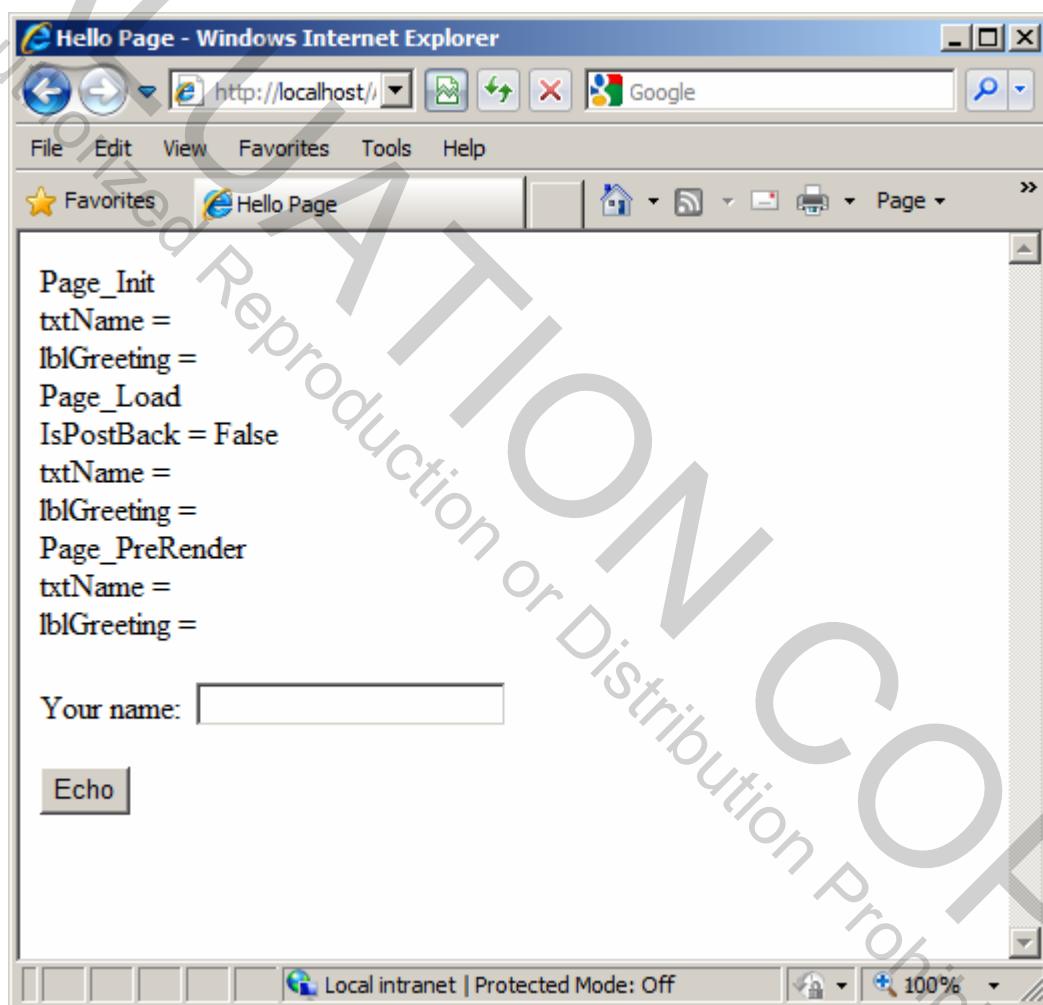
- The **Page** class has a number of important properties. Some of the most useful are listed below.
 - **EnableViewState** indicates whether the page maintains view state for itself and its controls. You can get or set this property. The default is **true**, view state is maintained.
 - **ErrorPage** specifies the error page to which the browser should be redirected in case an unhandled exception occurs.
 - **IsPostBack** indicates whether the page is being loaded in response to a postback from the client or is being loaded for the first time.
 - **IsValid** indicates whether page validation succeeded.
 - **Request** gets the HTTP Request object, which allows you to access data from incoming HTTP requests.
 - **Response** gets the HTTP Response object, which allows you to send response data to a browser.
 - **Session** gets the current Session object, which is provided by ASP.NET for storing session state.
 - **Trace** gets a **TraceContext** object for the page, which you can use to write out trace information.

Sample Program

- We can illustrate some of these features of page processing with a simple extension to our Echo program.
 - See **HelloPage.aspx**.
- This page provides handlers for a number of page events, and we write simple text to the output stream, using the *Response* property.
 - For each event the current text is in the **txtName** and **lblGreeting** server controls. In the handler for **Load** we display the current value of **IsPostBack**, which should be **false** the first time the page is accessed, and subsequently **true**.

Sample Program (Cont'd)

- When we display the page the first time the output reflects the fact that both the text box and the label are empty, since we have entered no information.
IsPostBack is false.



Sample Program (Cont'd)

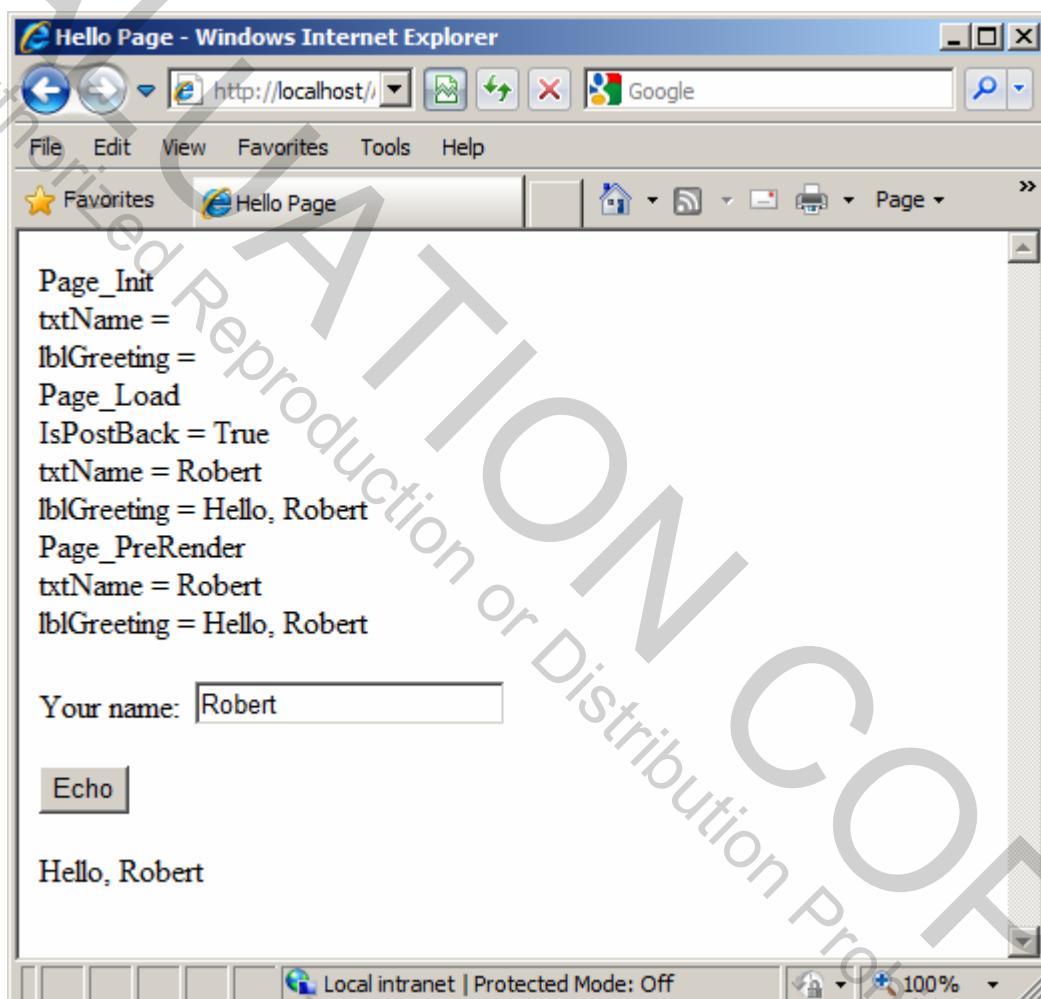
- Now enter a name and click the “Echo” button. We obtain the following output from our handlers for the page events:

```
Page_Init  
txtName =  
lblGreeting =  
Page_Load  
IsPostBack = True  
txtName = Robert  
lblGreeting =  
Page_PreRender  
txtName = Robert  
lblGreeting = Hello, Robert
```

- In **Page_Init** there is no information for either control, since view state is not available at page initialization.
 - In **Page_Load** the text box has data, but the label does not, since the click-event handler has not yet been invoked.
IsPostBack is now **true**.
 - In **Page_PreRender** both controls now have data.
- **Click “Echo” a second time.**
 - Again, the controls have no data in **Page_Init**.

Sample Program (Cont'd)

- This time, however, in **Page_Load** the view state provides data for both controls. The figure shows the browser output after “Echo” has been clicked a second time. Note that the second **lblGreeting** now has data.



Page Directive

- An *.aspx* file may contain a page directive defining various attributes that can control how ASP.NET processes the page. A page directive contains one or more attribute/value pairs of the form

```
attribute="value"
```

within the page directive syntax

```
<%@ Page ... @>
```

- Our example program *HelloCodebehind.aspx* illustrates an *.aspx* page that does not have any code within it.
- The “code-behind” file *HelloCodebehind.aspx.cs* that has the code is specified using the *CodeFile* attribute.

```
<!-- HelloCodeBehind.aspx -->
<%@ Page Language="C#"
  CodeFile="HelloCodeBehind.aspx.cs"
  Inherits="MyWebPage" %>
<html>
  ...

```

- An attribute implicitly used in *HelloPage.aspx* is *AutoEventWireup*, whose default value is true.
 - *AutoEventWireup* causes the **Page_Init**, **Page_Load**, **Page_PreRender**, and **Page_Unload** methods to be associated with the **Init**, **Load**, **PreRender**, and **Unload** events.

Page Directive (Cont'd)

- The **CodeFile** attribute identifies the code-behind. (Prior to .NET 2.0 a **Src** attribute was used for this purpose and is still recognized for the sake of compatibility.)
- The **Language** attribute specifies the language used for the page. The code in this language may be in either a code-behind file or a **script** block within the same file. Values can be any ASP.NET-supported language, including C# and Visual Basic.
- The **Inherits** directive specifies the page class from which the page will inherit.
- The **Debug** attribute indicates whether the page should be compiled with debug information. If true, debug information is enabled, and the browser can provide detailed information about compile errors. The default is false.
- The **ErrorPage** attribute specifies a target URL to which the browser will be redirected in the event that an unhandled exception occurs on the page.
- The **Trace** attribute indicates whether tracing is enabled. A value of true turns tracing on. The default is false.

Tracing

- ASP.NET provides extensive tracing capabilities.
- Merely setting the *Trace* attribute for a page to true will cause trace output generated by ASP.NET to be sent to the browser.
 - In addition, you can output your own trace information using the **Write** method of the **TraceContext** object, which is obtained from the **Trace** property of the **Page**.
- The page *HelloTrace.aspx* illustrates using tracing in place of writing to the *Response* object.

Tracing (Cont'd)

- The figure shows the browser output after entering a name and clicking the Echo button.
 - Notice that the trace output is shown *after* the form, along with trace information that is generated by ASP.NET itself.

The screenshot shows a Windows Internet Explorer window titled "Hello Trace - Windows Internet Explorer". The URL is "http://localhost/AspCs/Chap". The page content includes a text input field with "Your name: Robert" and a button labeled "Echo". Below the form, the text "Hello, Robert" is displayed. A large black bar covers the top portion of the page content. Below this bar, the "Request Details" section is visible, containing session information and request parameters. The "Trace Information" section is also visible, listing numerous trace events with their categories, messages, and timing details.

Category	Message	From First(s)	From Last(s)
aspx.page	Begin PreInit		
aspx.page	End PreInit	0.000046	0.000046
aspx.page	Begin Init	0.000091	0.000045
	Page_Init 	0.000193	0.000101
	txtName = 	0.000226	0.000033
	lblGreeting = 	0.000254	0.000028
aspx.page	End Init	0.000280	0.000026
aspx.page	Begin InitComplete	0.000306	0.000026
aspx.page	End InitComplete	0.000341	0.000035
aspx.page	Begin LoadState	0.000369	0.000027
aspx.page	End LoadState	0.000569	0.000200
aspx.page	Begin ProcessPostData	0.000598	0.000028
aspx.page	End ProcessPostData	0.001173	0.000575
aspx.page	Begin PreLoad	0.001204	0.000031
aspx.page	End PreLoad	0.001231	0.000027
aspx.page	Begin Load	0.001257	0.000026
	Page_Load 	0.001287	0.000030
	IsPostBack = True 	0.001319	0.000032
	txtName = Robert 	0.001347	0.000028
	lblGreeting = 	0.001374	0.000027

Lab 2

Code-Behind Version of Mortgage Calculator

In this lab you will create a code-behind version of the Mortgage Calculator Web page you implemented in Lab 1. You will study the behavior of this application by tracing methods of the **Page** class.

Detailed instructions are contained in the Lab 2 write-up at the end of the chapter.

Suggested time: 30 minutes

Summary

- **Code-behind files separate the visual content from user interface code.**
- **The *Page* class dynamically generates output for an .aspx page, and your code-behind file contains a class deriving from *Page*.**
- **View state is state information automatically maintained by ASP.NET through a hidden control.**
- **The Web Forms event model is similar to the Windows Form event model, but events typically get raised on the client and processed on the server.**
- **An .aspx file may contain a page directive defining various attributes that can control how ASP.NET processes the page.**
- **You can perform tracing in your ASP.NET applications by turning tracing on in the page directive and writing to the *Trace* object.**
- **The code-behind model uses the attribute *CodeFile* to specify the code-behind file.**
 - Partial classes enable you to write less code in this model.

Lab 2

Code-Behind Version of Mortgage Calculator

Introduction

In this lab you will create a code-behind version of the Mortgage Calculator Web page you implemented in Lab 1. You will study the behavior of this application by tracing methods of the **Page** class.

Suggested Time: 30 minutes

Root Directory: OIC\AspCs

Directories: Labs\Lab2
Chap02\Mortgage

(do your work here)
(answer)

Part 1. Create Code-Behind Version

1. Copy the file **Mortgage.aspx** from **Labs\Lab1** to use as your starter file. Alternatively, if you did not complete Lab 1 or would like a fresh file, you may copy the answer code for Lab 1 from **Chap01\Mortgage.aspx**.
2. Copy the file **HelloCodebehind.aspx.cs** from **Chap02** and rename to **Mortgage.aspx.cs** to use as your code behind file.
3. Edit the page directive in **Mortgage.aspx** to have the proper **CodeFile** and **Inherits** attributes. You may use **HelloCodebind.aspx** as a template.
4. Move the C# code from the script block to **Mortgage.aspx.cs** and delete the **script** tags in **Mortgage.aspx**.
5. You should now be able to test via the URL
<http://localhost/AspCs/Labs/Lab2/Mortgage.aspx>.

Part 2. Override Methods of the Page class

1. Using **HelloPage.aspx** as a template, add methods to handle the **Init**, **Load** and **PreRender** methods.
2. Add code to these methods to display the values of your textboxes and label by writing to the **Response** object.
3. Test your program, and make sure you understand the life cycle of a simple ASP.NET web page.

Part 3. Tracing Methods of the Page class

1. In the file **Mortgage.aspx** add the attribute **Trace = true** to the page directive.
2. In the file **Mortgage.aspx.cs** replace the calls to **Response.Write** by calls to **Trace.Write**.
3. Test your program and make sure you understand the basic output of the trace. Don't worry about all the details.

EVALUATION COPY
Unauthorized Reproduction or Distribution Prohibited

Chapter 9

Debugging, Diagnostics and Error Handling

Debugging, Diagnostics and Error Handling

Objectives

After completing this unit you will be able to:

- Debug ASP.NET applications created using Visual Studio.
- Perform tracing at both the application and page level.
- Handle errors in your ASP.NET applications.

ASP.NET Diagnostics

- Debugging ASP applications has been notoriously difficult.
 - A primary debugging tool is **Response.Write()**.
- ASP.NET applications can be debugged the same way as other .NET applications and components.
 - ASP.NET applications are compiled into executable assemblies, so the same techniques apply.
- Debugging ASP.NET applications using Visual Studio is easy, because any ASP.NET web site can be opened in Visual Studio.
- ASP.NET also provides convenient tracing facilities at both the page and application level.
- Later in the chapter we will also look at error handling in ASP.NET.

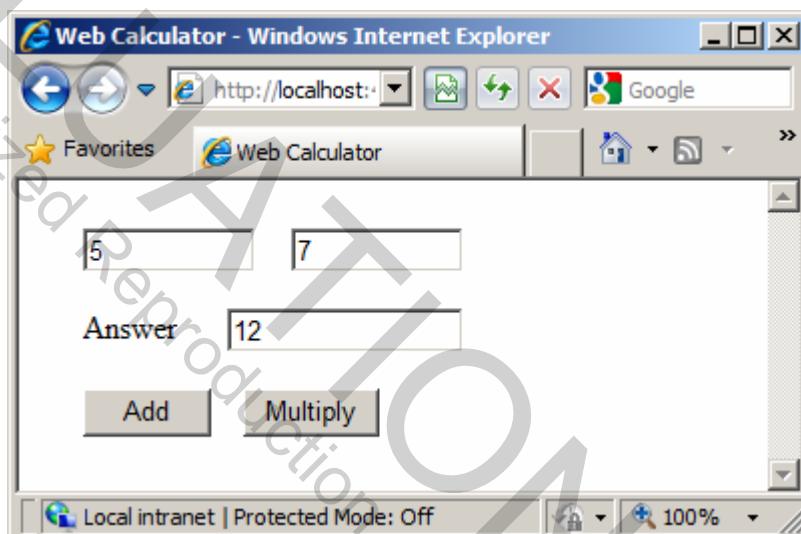
Debugging Using Visual Studio

- Applications created using Visual Studio are very easy to debug.
 - Build in Debug mode (the default).
 - You can then set breakpoints, single-step, use watch windows, and all the other features of the Visual Studio debugger.

EVANJELIATION COPY
Unauthorized Reproduction or Distribution Prohibited

Calculator Example

- We will illustrate diagnostics in this chapter with a simple Web calculator program *VsCalculator*.
 - Work with the copy in the **Demos** folder. The original program is in **VsCalculator\Step0** in the chapter folder.



- An initial Add works fine, but if you try Multiply or adding different numbers, the application behaves strangely.
- In the demo on the following page, your results may vary depending on how long it takes you to perform the various steps.

Debugging Calculator

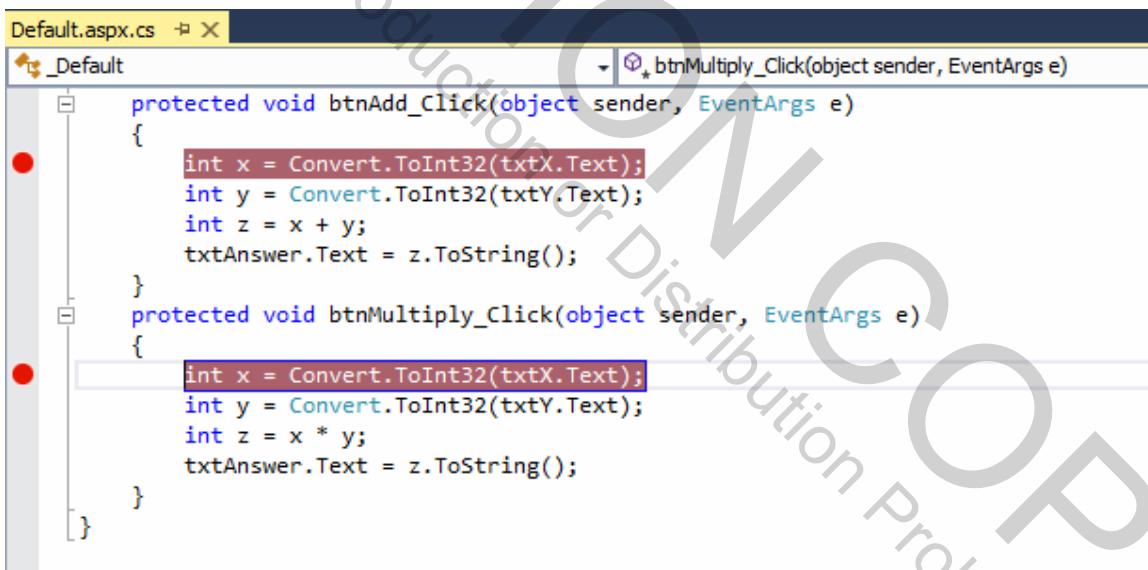
1. Examine the **Web.Config** file.

```
<configuration>

    <system.web>
        <compilation debug="true"
            targetFramework="4.5" />
        <httpRuntime targetFramework="4.5" />
    </system.web>

</configuration>
```

2. Set breakpoints at the first instructions of the handlers for the Add and Multiply buttons.



3. Run under the debugger (Debug | Start or F5 or the toolbar button ¹). If see a dialog box asking if you want to enable debugging, click OK.

¹ Whatever is your default browser will be shown as the text in the button, unless you choose a different browser from the dropdown.

Debugging Calculator (Cont'd)

4. Enter some numbers to add, and click the Add button. You should hit a breakpoint.

```
Web.Config Default.aspx.cs > X  
_Default  
protected void btnAdd_Click(object sender, EventArgs e)  
{  
    int x = Convert.ToInt32(txtX.Text);  
    int y = Convert.ToInt32(txtY.Text);  
    int z = x + y;  
    txtAnswer.Text = z.ToString();  
}  
protected void btnMultiply_Click(object sender, EventArgs e)  
{  
    int x = Convert.ToInt32(txtX.Text);  
    int y = Convert.ToInt32(txtY.Text);  
    int z = x * y;  
    txtAnswer.Text = z.ToString();  
}
```

5. Continue (F5 or toolbar button).
6. Click the Multiply button. You don't hit the breakpoint!
7. Try adding different numbers. You may see the original numbers brought back! And no breakpoint!

Application-Level Tracing

- In this case, debugging has not revealed the problem.
 - We did not hit breakpoints, so we could not do things like inspect the value of the parameters that came in to the server from the client.
- Another diagnostic tool is tracing, which can be enabled at both the application level and page level.
- You enable tracing at the application level by setting *trace enabled* to *true* in the *Web.config* file.
 - To avoid clutter in the trace output, also set **debug** to **false**.

```
<compilation debug="false"  
           targetFramework="4.5">  
</compilation>  
<trace enabled="true"/>  
...
```

- With the **pageOutput** setting you can have the output shown directly on the page.

```
<trace enabled="true" pageOutput="true" />
```

Tracing Calculator

1. In the **CalculatorVs** application enable tracing in the **Web.config** file as shown on the preceding page.

```
<trace enabled="true" />
```

2. To ensure that **Default.aspx** is the first page seen in the application, make that it is your start page. (Right-click over **Default.aspx** and choose Set As Start Page from the context menu.)
3. Run the application, not in the debugger.
4. Enter the numbers 5 and 77 and click the Add button. This will bring up the browser at a URL like **http://localhost:49490/Default.aspx**.



5. Make the second number 777 and click Add again. You should see the results displayed of the first addition and not the second, and the second number has reverted to 77.

Tracing Calculator (Cont'd)

6. To see the trace, navigate in the browser to the **Trace.axd** URL at the root of the application directory. (The URL should look like **http://localhost:49490/Trace.axd**.)
 - If you see other requests in the trace, clear the current trace and try again.

The screenshot shows a Mozilla Firefox browser window with the title bar "Mozilla Firefox". The address bar contains "http://localhost:49490/Trace.axd". The main content area displays the "Application Trace" page. At the top, there is a link "[clear current trace]" and a physical directory path "Physical Directory:C:\OIC\AspCs\Demos\VsCalculator\". Below this, a table titled "Requests to this Application" lists three requests:

No.	Time of Request	File	Status Code	Verb	Remaining:
1	12/3/2013 4:41:24 PM	Default.aspx	200	GET	View Details
2	12/3/2013 4:41:29 PM	Default.aspx	200	POST	View Details
3	12/3/2013 4:41:34 PM	Default.aspx	200	POST	View Details

At the bottom of the page, it says "Microsoft .NET Framework Version:4.0.30319; ASP.NET Version:4.0.30319.18408".

7. There is one GET, from the first view of the page, and two POST, one for each time you clicked the Add button.

Tracing Calculator (Cont'd)

8. View the details of the first POST. Look in the Form collection.

Form Collection	
Name	Value
__VIEWSTATE	/wEPDwULLTExMTI5OTk1ODVkJarEkD8nTKfpYjDF3rUTSCk
__EVENTVALIDATION	/wEWBgKmi9OKCgKShpCYCAKShvy8DwLdsKuIBAKMk4HYDwLsn
txtX	5
txtY	77
txtAnswer	
btnAdd	Add

9. View the details of the second POST.

Form Collection	
Name	Value
__VIEWSTATE	/wEPDwULLTExMTI5OTk1ODVkJarEkD8nTKfpYjDF3rUTSCk
__EVENTVALIDATION	/wEWBgKmi9OKCgKShpCYCAKShvy8DwLdsKuIBAKMk4HYDwLsn
txtX	5
txtY	777
txtAnswer	82
btnAdd	Add

10. It is clear that the second number, 777, *did* reach the server.

Using the Page Cache

- By this time you may have realized what the problem likely is: we have cached this page!

```
<%@ Page Language="C#" AutoEventWireup="true"
CodeFile="Default.aspx.cs" Inherits="_Default" %>
<%@OutputCache Duration="15" VaryByParam="none"%>

<!DOCTYPE html>

<html xmlns="http://www.w3.org/1999/xhtml" >
<head runat="server">
    <title>Web Calculator</title>
</head>
<body>
    <form id="form1" runat="server">
        <div>
            <asp:TextBox ID="txtX" runat="server"
Style="z-index: 100; left: 32px; position:
absolute; top: 24px" Width="80px">
            </asp:TextBox>
            <asp:TextBox ID="txtY" runat="server"
Style="z-index: 101; left: 136px; position:
absolute; top: 24px" Width="80px">
            </asp:TextBox>
            ...
        </div>
        </form>
    </body>
</html>
```

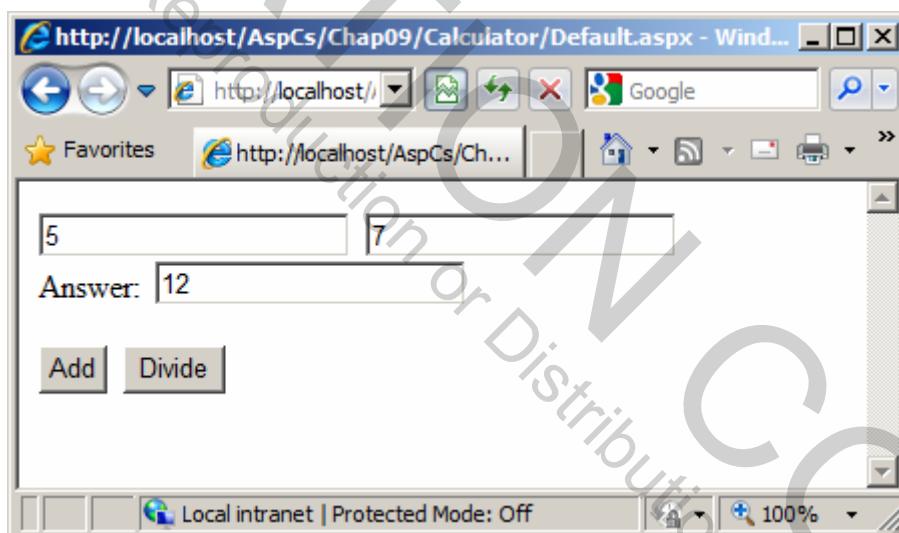
- The version of the program that does tracing is saved in **VsCalculator\Step1** in the chapter folder.

Single Page Example

- Let's look some more at debugging and tracing.
- As an illustration, consider the *Default.aspx* page in the *Calculator* folder in this chapter, at the URL:

<http://localhost/AspCs/Chap09/Calculator/Default.aspx>

- The core logic is complete in one page, with no code-behind.
- This version of the program use flow layout instead of absolute positioning, and there is a Divide button.



Preparing to Debug

- You can enable debugging on a particular page by setting the *Debug* attribute of the *Page* directive to *true*.

```
<%@ Page Language="C#" Trace="false" Debug="true"%>
<html>
<head>
    <title>Calculator</title>
    <script runat="server">
        void cmdAdd_Click(object source,
                           EventArgs e)
    {
        Trace.WriteLine("Add called");
        int x = Convert.ToInt32(txtX.Text);
        int y = Convert.ToInt32(txtY.Text);
        int z = x + y;
        txtAnswer.Text = z.ToString();
    }
    ...
}
```

- You can enable debugging for an entire application by setting *debug* to *true* in the compilation element of the *Web.config* file.

```
<?xml version="1.0" encoding="utf-8" ?>
<configuration>
    <system.web>
        ...
        <compilation defaultLanguage="c#"
                      debug="true"
                      targetFramework="4.5" />
        ...
    </system.web>
</configuration>
```

Trace Messages

- Besides the standard trace output, you may write custom trace messages using the *Trace* property of the *Page* class.
- As an example, see the Add handler in our *Calculator/Default.aspx* page.

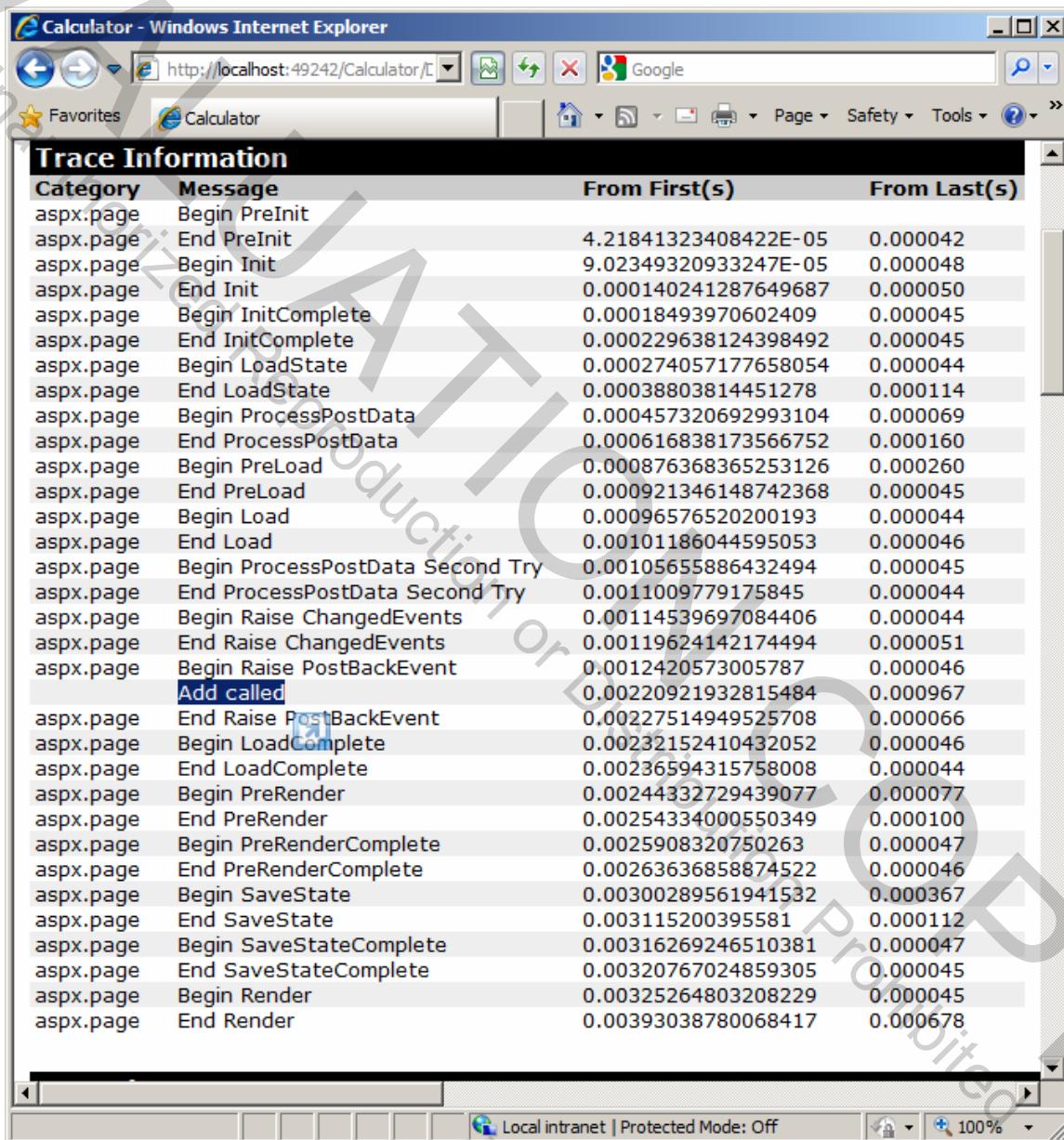
```
...
<script runat="server">
void cmdAdd_Click(object source,
                  EventArgs e)
{
    Trace.Write("Add called");
    int x = Convert.ToInt32(txtX.Text);
    int y = Convert.ToInt32(txtY.Text);
    int z = x + y;
    txtAnswer.Text = z.ToString();
}
...
...
```

- To enable tracing on a page, set the *Trace* attribute of the *Page* directive to *true*.

```
<%@ Page Language="C#" Trace="true" Debug="true" %>
...
```

Tracing the Calculator Page

- We can then see our custom trace message displayed when we click the Add button.



The screenshot shows a Windows Internet Explorer window titled "Calculator - Windows Internet Explorer". The address bar displays the URL "http://localhost:49242/Calculator/Calculator.aspx". The main content area is titled "Trace Information" and contains a table with four columns: Category, Message, From First(s), and From Last(s). The table lists numerous trace events for an ASPX page, including various Init, Load, ProcessPostData, Raise ChangedEvents, and SaveState events. A specific entry for the "Add called" event is highlighted in blue, indicating it was triggered by a user action. The bottom status bar of the browser shows "Local intranet | Protected Mode: Off" and a zoom level of "100%".

Category	Message	From First(s)	From Last(s)
aspx.page	Begin PreInit		
aspx.page	End PreInit	4.21841323408422E-05	0.000042
aspx.page	Begin Init	9.02349320933247E-05	0.000048
aspx.page	End Init	0.000140241287649687	0.000050
aspx.page	Begin InitComplete	0.00018493970602409	0.000045
aspx.page	End InitComplete	0.000229638124398492	0.000045
aspx.page	Begin LoadState	0.000274057177658054	0.000044
aspx.page	End LoadState	0.00038803814451278	0.000114
aspx.page	Begin ProcessPostData	0.000457320692993104	0.000069
aspx.page	End ProcessPostData	0.000616838173566752	0.000160
aspx.page	Begin PreLoad	0.000876368365253126	0.000260
aspx.page	End PreLoad	0.000921346148742368	0.000045
aspx.page	Begin Load	0.00096576520200193	0.000044
aspx.page	End Load	0.00101186044595053	0.000046
aspx.page	Begin ProcessPostData Second Try	0.00105655886432494	0.000045
aspx.page	End ProcessPostData Second Try	0.0011009779175845	0.000044
aspx.page	Begin Raise ChangedEvents	0.00114539697084406	0.000044
aspx.page	End Raise ChangedEvents	0.00119624142174494	0.000051
aspx.page	Begin Raise PostBackEvent	0.0012420573005787	0.000046
aspx.page	Add called	0.00220921932815484	0.000967
aspx.page	End Raise PostBackEvent	0.00227514949525708	0.000066
aspx.page	Begin LoadComplete	0.00232152410432052	0.000046
aspx.page	End LoadComplete	0.00236594315758008	0.000044
aspx.page	Begin PreRender	0.00244332729439077	0.000077
aspx.page	End PreRender	0.00254334000550349	0.000100
aspx.page	Begin PreRenderComplete	0.0025908320750263	0.000047
aspx.page	End PreRenderComplete	0.00263636858874522	0.000046
aspx.page	Begin SaveState	0.00300289561941532	0.000367
aspx.page	End SaveState	0.003115200395581	0.000112
aspx.page	Begin SaveStateComplete	0.00316269246510381	0.000047
aspx.page	End SaveStateComplete	0.00320767024859305	0.000045
aspx.page	Begin Render	0.00325264803208229	0.000045
aspx.page	End Render	0.00393038780068417	0.000678

Conditional Tracing

- You can make the execution of your trace statements conditional on tracing being enabled by testing the *Enabled* property of *Trace*.

```
void cmdDivide_Click(object source,
                      EventArgs e)
{
    if (Trace.IsEnabled)
        Trace.Write("Custom", "Divide called");
    ...
}
```

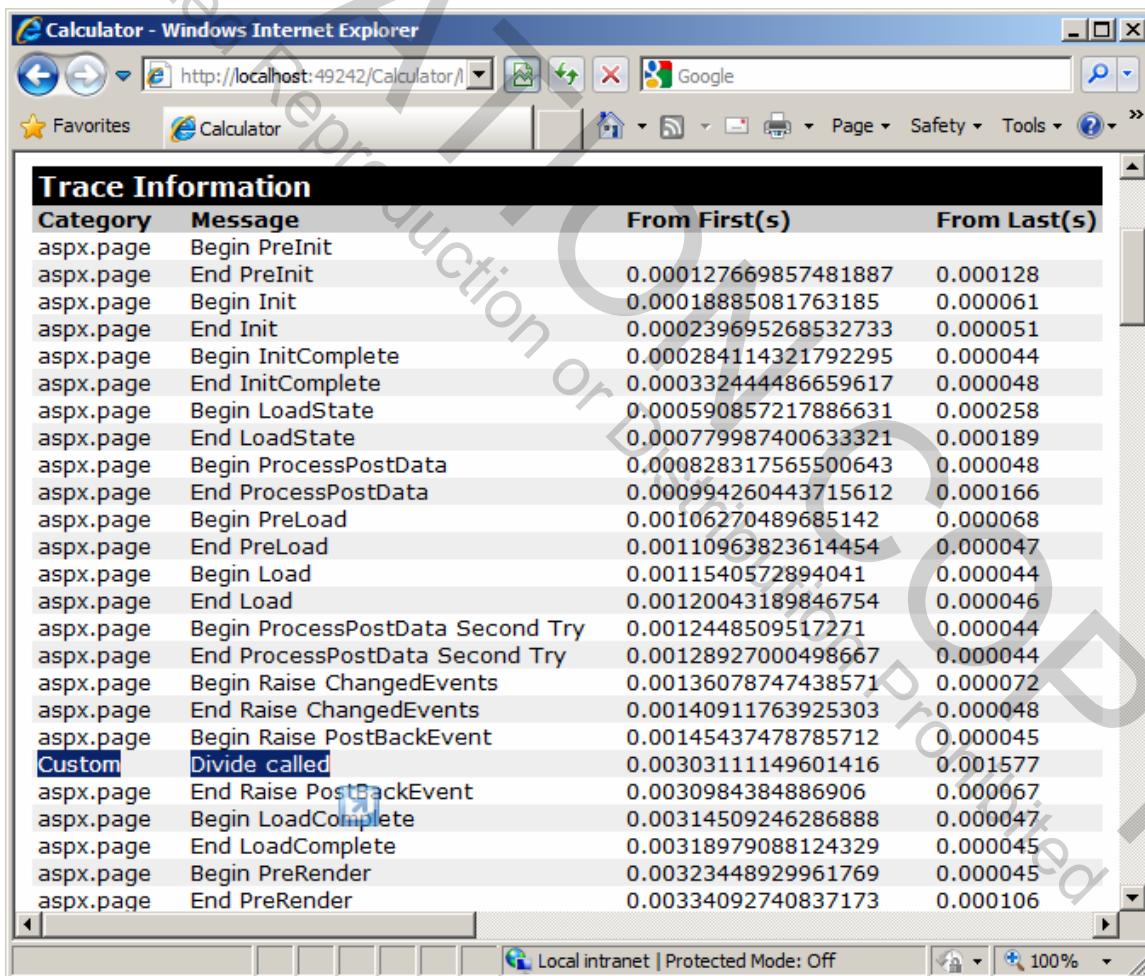
- You can verify by placing a breakpoint on the **Trace.Write()** statement, with debugging enabled and tracing disabled.
- What this means is that you can embed useful trace statements in a production application without concern about output or computation time in the normal case when tracing is disabled.
 - When a problem arises, you can then enable tracing to obtain useful diagnostic information.

Trace Category

- An overloaded version of the `Trace.Write()` method allows you to specify an optional category for the trace message.

```
if (Trace.IsEnabled)
    Trace.WriteLine("Custom", "Divide called");
...
```

- This category will be displayed in the trace output.



A screenshot of a Windows Internet Explorer window titled "Calculator - Windows Internet Explorer". The address bar shows "http://localhost:49242/Calculator/". The main content area displays a "Trace Information" table. The table has four columns: "Category", "Message", "From First(s)", and "From Last(s)". The table lists various ASP.NET page events and a custom trace message. The "Custom" row, which contains the "Divide called" message, is highlighted with a blue selection bar.

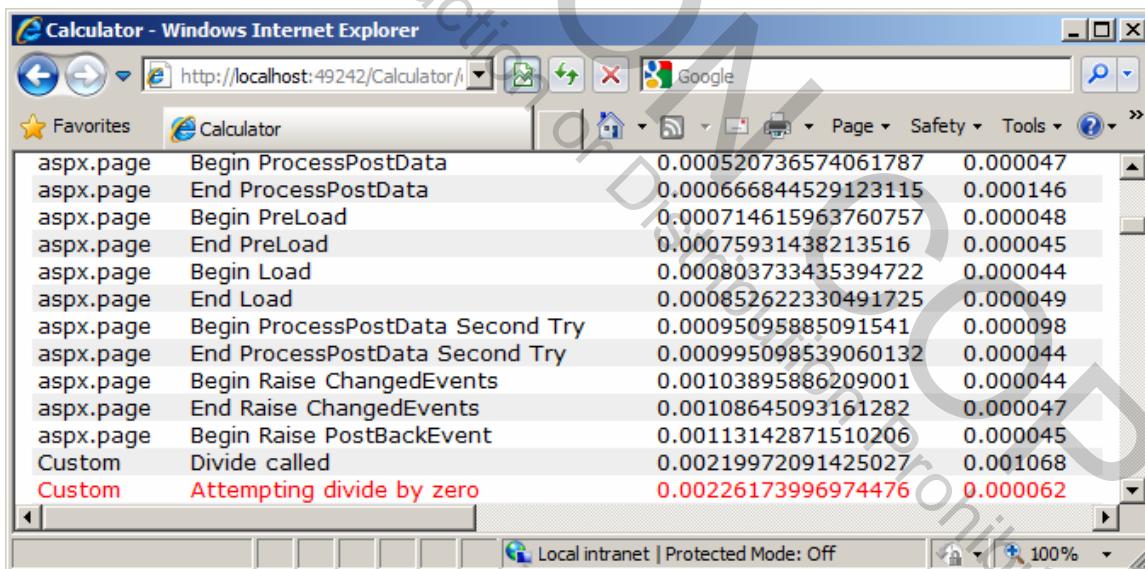
Category	Message	From First(s)	From Last(s)
aspx.page	Begin PreInit	0.000127669857481887	0.000128
aspx.page	End PreInit	0.00018885081763185	0.000061
aspx.page	Begin Init	0.000239695268532733	0.000051
aspx.page	End Init	0.000284114321792295	0.000044
aspx.page	Begin InitComplete	0.000332444486659617	0.000048
aspx.page	End InitComplete	0.000590857217886631	0.000258
aspx.page	Begin LoadState	0.000779987400633321	0.000189
aspx.page	End LoadState	0.000828317565500643	0.000048
aspx.page	Begin ProcessPostData	0.000994260443715612	0.000166
aspx.page	End ProcessPostData	0.00106270489685142	0.000068
aspx.page	Begin PreLoad	0.00110963823614454	0.000047
aspx.page	End PreLoad	0.0011540572894041	0.000044
aspx.page	Begin Load	0.00120043189846754	0.000046
aspx.page	End Load	0.0012448509517271	0.000044
aspx.page	Begin ProcessPostData Second Try	0.00128927000498667	0.000044
aspx.page	End ProcessPostData Second Try	0.00136078747438571	0.000072
aspx.page	Begin Raise ChangedEvents	0.00140911763925303	0.000048
aspx.page	End Raise ChangedEvents	0.00145437478785712	0.000045
aspx.page	Begin Raise PostBackEvent	0.00303111149601416	0.001577
Custom	Divide called	0.0030984384886906	0.000067
aspx.page	End Raise PostBackEvent	0.00314509246286888	0.000047
aspx.page	Begin LoadComplete	0.00318979088124329	0.000045
aspx.page	End LoadComplete	0.00323448929961769	0.000045
aspx.page	Begin PreRender	0.00334092740837173	0.000106
aspx.page	End PreRender		

Trace Warning

- The **Warn** method of *Trace* will cause the trace output to be displayed in red.

- In our example, we display a warning on an attempt to divide by zero.

```
try
{
    int x = Convert.ToInt32(txtX.Text);
    int y = Convert.ToInt32(txtY.Text);
    if (y == 0)
        Trace.Warn("Custom",
                   "Attempting divide by zero");
    ...
}
```



A screenshot of a Windows Internet Explorer window titled "Calculator - Windows Internet Explorer". The address bar shows "http://localhost:49242/Calculator/". The main content area displays a table of trace output. The table has two columns: "Event" and "Message". The "Event" column contains entries like "aspx.page Begin ProcessPostData", "aspx.page End ProcessPostData", etc., and the "Message" column contains corresponding timestamp values. Two specific rows are highlighted in red: "Custom Divide called" and "Custom Attempting divide by zero".

aspx.page	Begin ProcessPostData	0.000520736574061787	0.000047
aspx.page	End ProcessPostData	0.000666844529123115	0.000146
aspx.page	Begin PreLoad	0.000714615963760757	0.000048
aspx.page	End PreLoad	0.00075931438213516	0.000045
aspx.page	Begin Load	0.000803733435394722	0.000044
aspx.page	End Load	0.000852622330491725	0.000049
aspx.page	Begin ProcessPostData Second Try	0.00095095885091541	0.000098
aspx.page	End ProcessPostData Second Try	0.000995098539060132	0.000044
aspx.page	Begin Raise ChangedEvents	0.00103895886209001	0.000044
aspx.page	End Raise ChangedEvents	0.00108645093161282	0.000047
aspx.page	Begin Raise PostBackEvent	0.00113142871510206	0.000045
Custom	Divide called	0.00219972091425027	0.001068
Custom	Attempting divide by zero	0.00226173996974476	0.000062

Exceptions in Trace

- You may pass an Exception object as a third parameter in a call to *Trace.Write()*.

```
catch (Exception ex)
{
    Trace.Write("Custom", "Exception", ex);
}
```

The screenshot shows a Windows Internet Explorer window titled "Calculator - Windows Internet Explorer" displaying a trace log. The log entries are as follows:

aspx.page	Begin ProcessPostData	0.000520736574061787	0.000047
aspx.page	End ProcessPostData	0.000666844529123115	0.000146
aspx.page	Begin PreLoad	0.000714615963760757	0.000048
aspx.page	End PreLoad	0.00075931438213516	0.000045
aspx.page	Begin Load	0.000803733435394722	0.000044
aspx.page	End Load	0.000852622330491725	0.000049
aspx.page	Begin ProcessPostData Second Try	0.00095095885091541	0.000098
aspx.page	End ProcessPostData Second Try	0.000995098539060132	0.000044
aspx.page	Begin Raise ChangedEvents	0.00103895886209001	0.000044
aspx.page	End Raise ChangedEvents	0.00108645093161282	0.000047
aspx.page	Begin Raise PostBackEvent	0.00113142871510206	0.000045
Custom	Divide called	0.00219972091425027	0.001068
Custom	Attempting divide by zero	0.00226173996974476	0.000062
Exception			
Attempted to divide by zero.			
at			
Custom	ASP.default_aspx.cmdDivide_Click (Object source, EventArgs e) in c:\OIC\AspCs\Chap09 \Calculator\Default.aspx:line 26	0.00245310507341017	0.000191
aspx.page	End Raise PostBackEvent	0.00618486427744308	0.003732
aspx.page	Begin LoadComplete	0.00623570872834397	0.000051
aspx.page	End LoadComplete	0.00628180397229257	0.000046

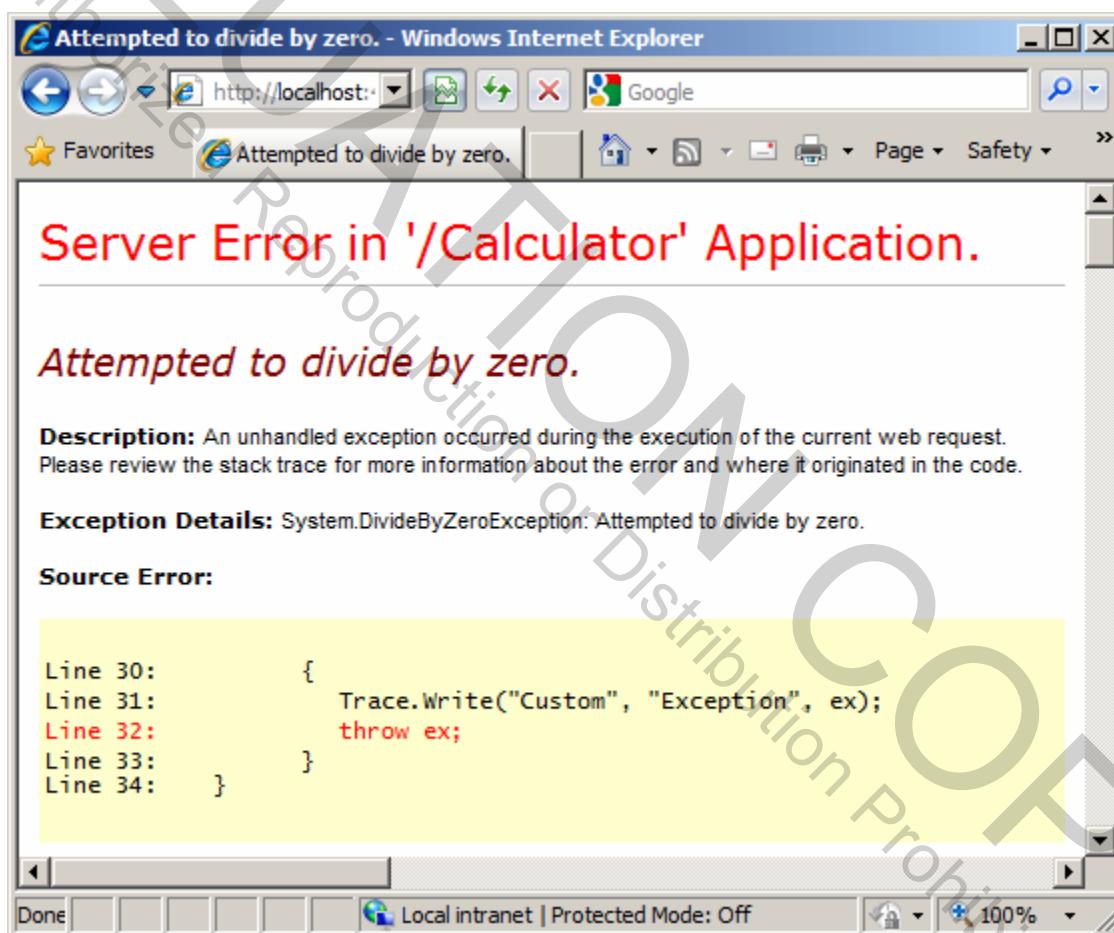
Errors in ASP.NET

- Another benefit to developing Web applications using ASP.NET is the robust exception handling provided in all .NET languages.
 - This is in contrast to the weak support for exceptions offered by the scripting languages used with ASP.
- Our sample *Calculator* page has already illustrated handling exceptions.
- But what happens if an uncaught exception is encountered?
- To see the result, you can throw an exception in our catch handler.

```
catch (Exception ex)
{
    Trace.Write("Custom", "Exception", ex);
    throw ex;
}
```

Uncaught Exception

- ASP.NET displays a generic error page for errors, including exceptions that are not caught in application code.
 - If we divide by zero in our modified **Calculator** page, we will see this error page:



Custom Error Pages

- Normally you would not want your users to see the generic error page displayed by ASP.NET.
- You can create custom error pages, which will be displayed as you direct.
 - A particular error page can be designated on a page-by-page basis by using the **ErrorPage** attribute of the **Page** directive.

```
<%@ Page Language="C#" Trace="false" Debug="true"  
    ErrorPage="PageError.html" %>
```

- A default error page can be provided for the entire application by using the **customErrors** element of the **Web.config** file.

```
<?xml version="1.0" encoding="utf-8" ?>  
<configuration>  
    <system.web>  
        <customErrors  
            defaultRedirect='GeneralError.html'  
            mode='On'>  
        </customErrors>  
        ...  
    </system.web>  
</configuration>
```

Lab 9

Error Pages for Calculator Application

In this lab you will create error pages for the Calculator example. The first error page is a general error page that applies to the entire application, and the second error page is specific to **Calculator..**

Detailed instructions are contained in the Lab 9 write-up at the end of the chapter.

Suggested time: 30 minutes

Summary

- You can debug ASP.NET applications created using Visual Studio in the same manner as you would debug other .NET applications.
- To perform tracing at the application level, enable tracing in the *Web.config* file.
- You can enable tracing at the page level with the *Trace* attribute of the *Page* directive.
- .NET exceptions provide a robust exception handling mechanism for ASP.NET application.
- You can provide custom error pages to be displayed for uncaught exceptions.

Lab 9

Error Pages for Calculator Application

Introduction

In this lab you will create error pages for the Calculator example. The first error page is a general error page that applies to the entire application, and the second error page is specific to **Calculator**.

Suggested Time: 30 minutes

Root Directory: OIC\AspCs

Directories:
Labs\Lab9\Error
Chap09\Calculator
Chap09\Error

(do your work here)
(contains backup of starter page)
(answer)

Instructions:

1. Bring up the starter page using Visual Web Developer.
2. Verify that if you try to divide by zero, no exception is thrown (it is caught). If the answer textbox is blank, it will remain blank. Also, verify that you can perform additions and divisions if divisor is not zero.
3. In the **catch** block, add code to rethrow the Exception object. Display the page again in the browser and observe the generic error page. (Notice that if you do not have debugging turned on for the page, the error page will give a message explaining how you can enable debugging.)
4. Create an HTML page **GeneralError.html** that displays a simple message saying there was an error, try again. This could be invoked by accessing a bad file name.
5. In **Web.config** add a **customErrors** element that will redirect to the general error page you created in the previous step.
6. Test in the browser. Observe that this page will be displayed when you try to divide by zero (and also if you have illegal data in one of the input textboxes.)
7. Create an HTML page **PageError.html** that displays a different message.
8. Hook this new error page to **Default.aspx** by using the **ErrorMessage** attribute of the **Page** directive.
9. Run again in the browser. When there is an input error, you should now see your new error page displayed in place of the original general error page you created