Internetanwendungstechnik

Microsoft .NET

Gero Mühl

Technische Universität Berlin
Fakultät IV – Elektrotechnik und Informatik
Kommunikations- und Betriebssysteme (KBS)
Einsteinufer 17, Sekr. EN6, 10587 Berlin

Why Microsoft .NET ?

- Component-based software development still is complex
  - Different programming paradigms
  - Different programming languages
  - Different runtime environments
  - A variety of end devices and interfaces
- In addition there is the Internet
  - Web Clients
  - Web Services

.NET is …

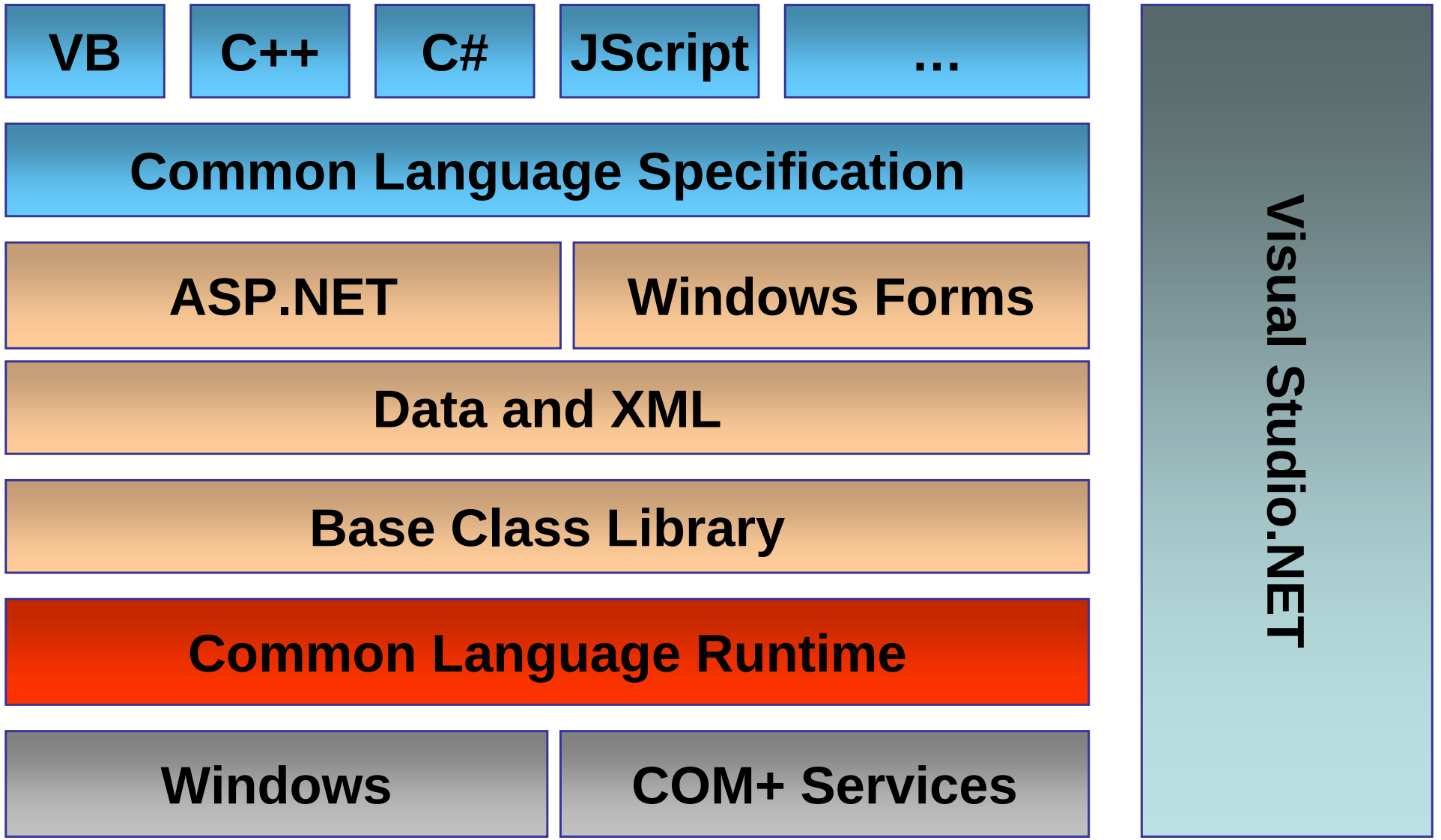
- ... a programming language and platform independent framework for building distributed applications
  - Classical Windows applications
  - Web-applications
  - Web Services
- … a marketing strategy of Microsoft
  http://www.microsoft.com/net/
- … a set of services and tools
  (e.g. Passport)
- Main Objective: Simplify development

.NET vs. JAVA

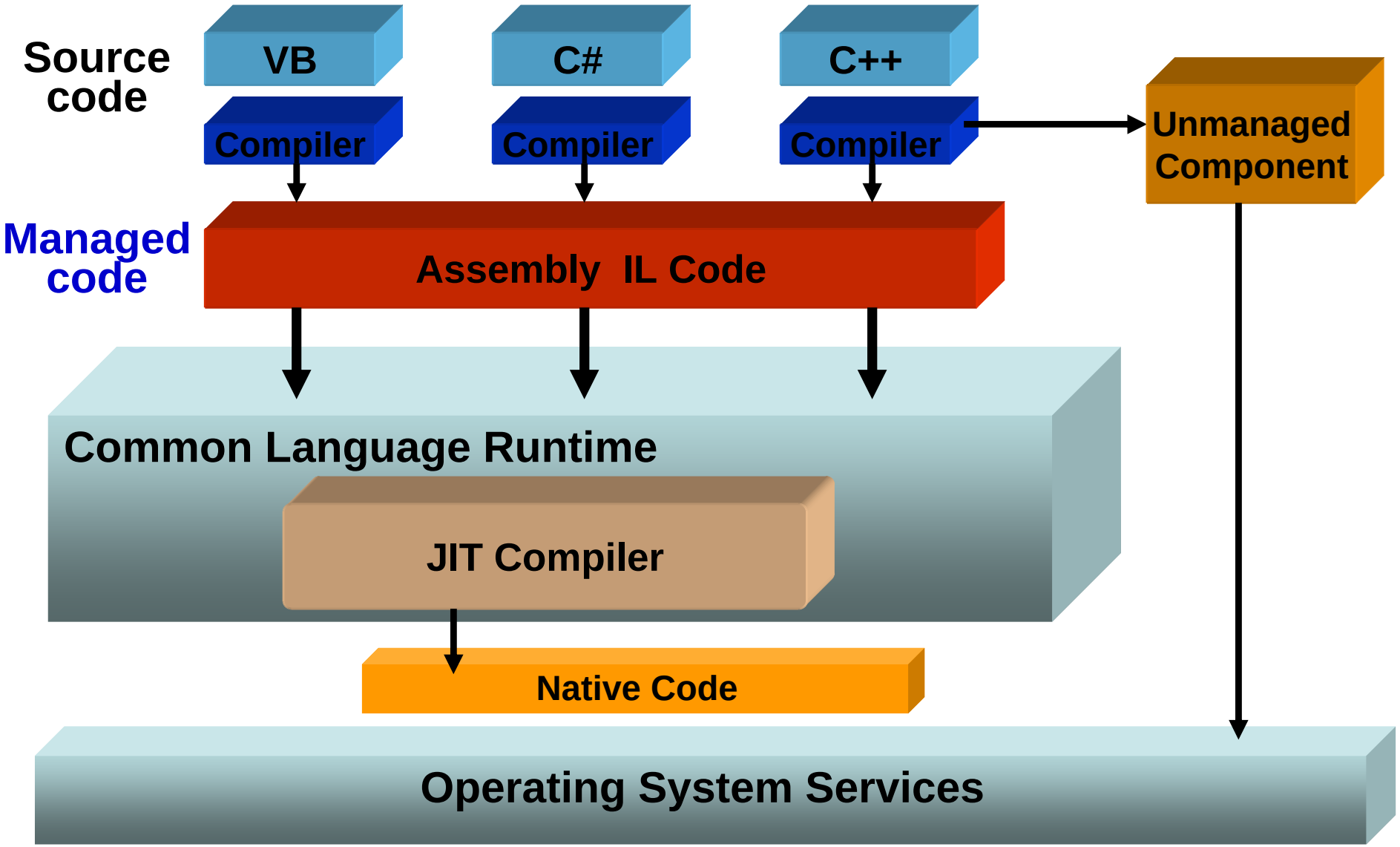
- Java Slogan:
  Write once (in Java) – run everywhere (on JRE)

- .NET Slogan:
  Write in any language – run under .NET (on Windows?)

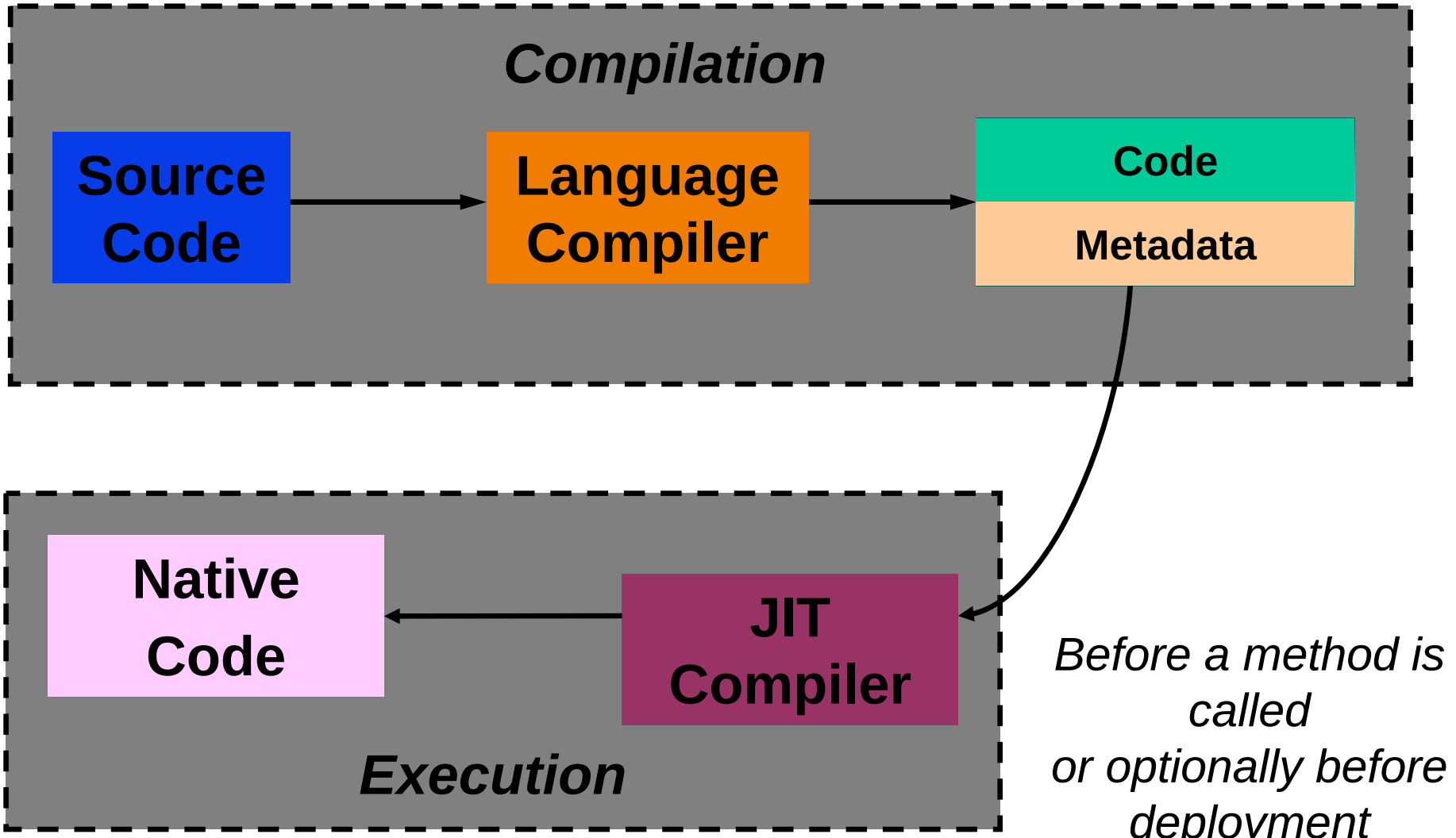
.NET Overview



Common Language Runtime (CLR)



Compile and Execute



Common Language Runtime (CLR)

- Runtime environment for .NET assemblies (managed code)
- Programming language independent
- Responsible for
  - Type-safety
  - Garbage collection
  - Exception handling
  - Sandboxing
  - Versioning
  - …
- Major components: Common Type System, Memory Managers, JIT Compiler, etc.

.NET Programming Languages

- Visual Basic
- C++
- C#
- Python
- COBOL
- Eiffel
- Haskell
- ML
- JScript
- Ada
- APL
- Pascal
- Perl
- SmallTalk
- Oberon
- Scheme
- Mercury
- Objective Caml
- Oz

Common Language Infrastructure (CLI)

- Subset of the CLR
  - ECMA standard (335)
- Standardized parts
  - Semantics for metadata
  - Microsoft Intermediate Language (MSIL)
  - Parts of the .NET base class library (except ADO.NET, ASP.NET)
- C#
  - ECMA standard (334)
  - ISO/IEC standard (23270)

Common Type System (CTS)

- A single type system shared by compilers, tools and the CLR
- Supports the types and operations found in many programming languages
- Enables interoperability between different programming languages through uniform type system
- A string in C# and VB.NET are identical!

Common Type System (CTS)

- Two different types
  - Value types (stack allocation)
    - Byte, Char, Int, Boolean, Structure, Single, Double, Enum
  - Reference types (heap allocation)
    - Class, Interface, Array, String, Delegate
- Single inheritance for objects
- Multiple inheritance for interfaces
- A VB.NET class can inherit from a C# class
- Software written for the CLR is referred to as managed code

Common Language Specification (CLS)

- Subset of the CTS
- A set of specifications that language and library designers need to follow to be compliant with the .NET Framework
- Contract between language designers and the .NET Framework to ensure interoperability

MS Intermediate Language (MSIL)

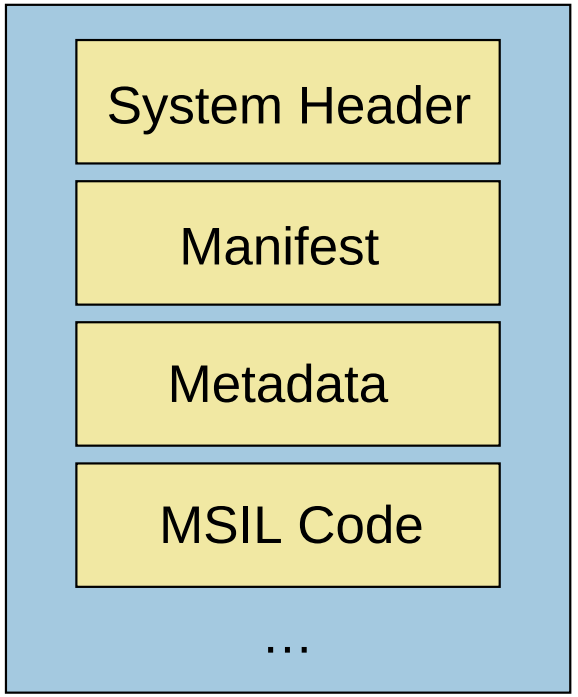
- Common target language for all .NET compilers
  → programming language independence
- High-level, strongly-typed, stack-based assembler language
- Supports CTS
- Integrated support for complex data types and object as well as inheritance and polymorphism
- MSIL code is never interpreted
- JIT Compiler translates on demand MSIL code into native code for actual target platform → platform independence

MSIL Tools

- MSIL Assembler (`Ilasm.exe`)
  - Generates executable from MSIL
- MSIL Disassembler (`Ildasm.exe`)
  - Creates MSIL code from executable
- Native Image Generator Tool (`Ngen.exe`)
  - Compiles MSIL to machine code in lieu of JIT compiler

Assemblies

- .NET applications consist of assemblies which are a logical unit of functionality
- .NET implementation of the component concept
- All .NET compilers generate assemblies
- An assembly contains all necessary information in one `.EXE` or `.DLL` file
- Security and versioning checks by the CLR are based solely on assemblies
- Private vs. shared assemblies



Assemblies

- System Header (6 Bytes)
  - just calls **`_CorExeMain()`** or **`_CorDllMain()`**
- Manifest
  - Assembly name and version number
  - List of all assembly modules (files)
  - List of external (referenced) assemblies
  - Security and versioning information
  - Exported types
  - …
- Metadata
  - Information about types, interfaces, method signatures, fields, properties, events …

Base Class Library (BCL)

- Common for all languages
- Accessible from all languages
- Powerful API for
  - Collections
  - Threading
  - File I/O
  - Reflection
  - Serialization
  - Security
  - Graphical User Interface (GUI)
  - XML/SOAP
  - …

Interoperability Example

```
using System;
public class App {
  public static void Main() {
    Console.WriteLine("Hi");
  }
}
```

C#

```
IMPORT System;
MODULE App;
BEGIN
  System.Console.WriteLine('Hi');
END App.
```

Oberon, Zonnon

Base Class Library

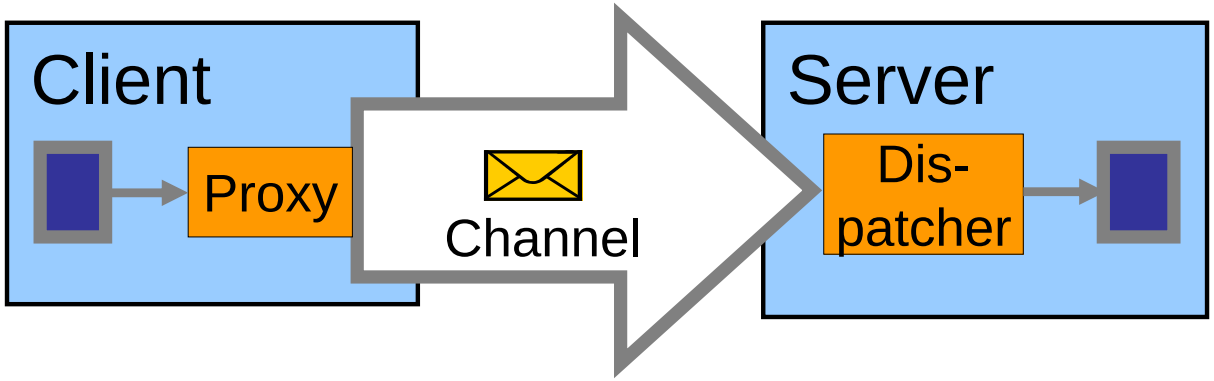
```
namespace System
{
  ...
  class Console
  {
    ...
    public static WriteLine(...);
  }
  ...
}
```

.NET Remoting

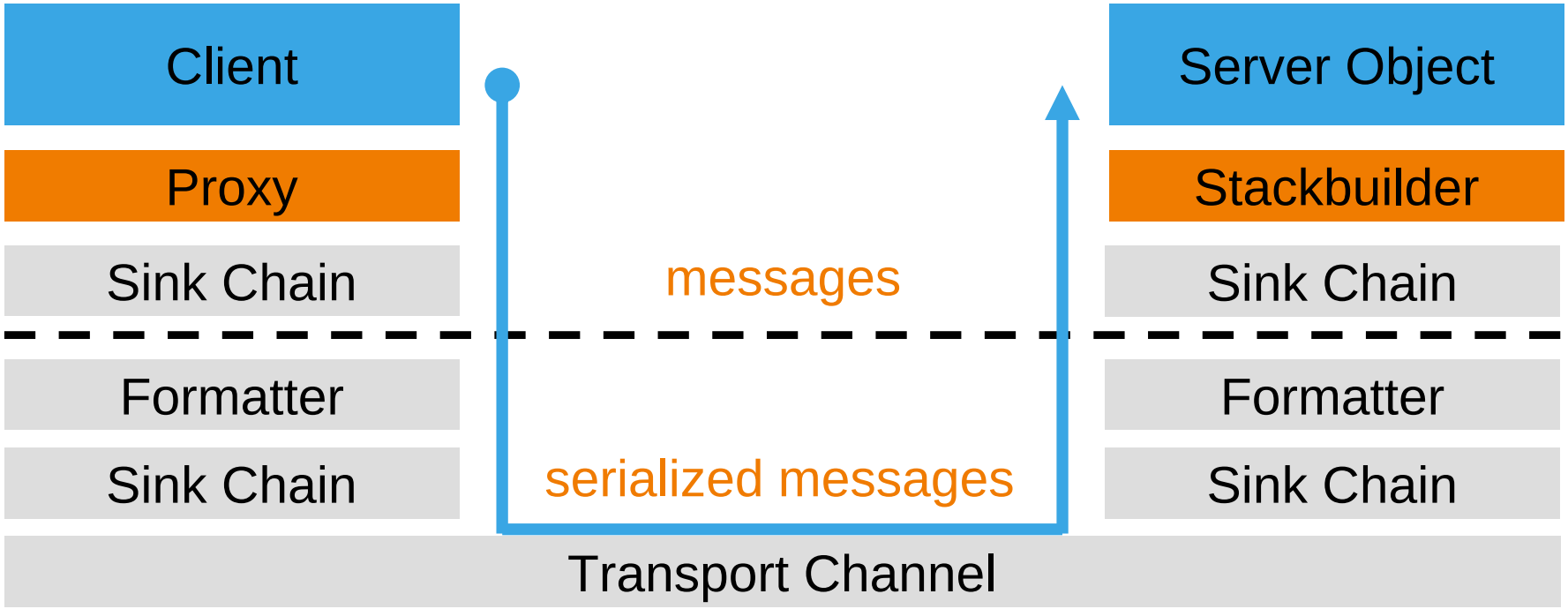
- .NET Remoting = middleware part of .NET
- Features
  - very modular, customizable
  - inherently component-based
  - many interceptor points
  - support for meta-data and reflection
  - contexts for application objects
- Comparable to CORBA, Java RMI, DCOM etc.

.NET Remoting Architecture

- Messages: What?
- Formatter: How?
- Channels: Whereto?
- Proxy: Generates messages from client‘s method calls
- Dispatcher: Generates method invocations out of messages



.NET Remoting Message Path



Message

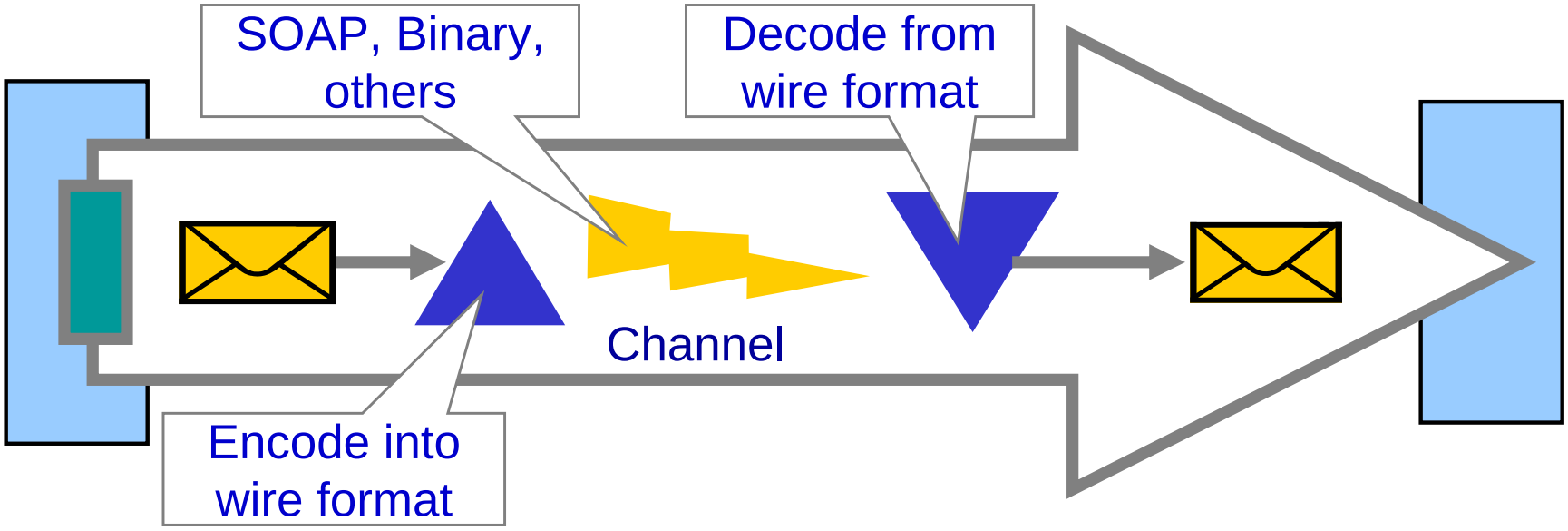
- Messages are objects
  - implement `IMessage` interface
  - simple value tables {Key, Value}
- .NET message types
  - Constructor calls
  - Method calls
  - Pre-defined types have pre-defined values in value table
- Calls
  - Synchronous: request / response
  - Asynchronous: delayed response or no response

Channel

- Channels carry messages
- TCP channel
  - for LAN communications
  - permanent socket connection
- HTTP channel
  - for Internet communications
  - no permanent connection necessary
- Custom channels
  - IPX, Pipes, QoS enabled (TU Berlin) …
- Channels may implement customized sinks, e.g.
  - for monitoring and logging
  - for extended security checking
  - for message compression

Formatter

- Formatter serialize .NET Objects into a specific wire format
  - .NET formatters: SOAP and binary formatter
  - other formatters: IIOP, RMI, ORPC, …
- dynamically invoked by channels
- selection of channel and formatter depends on message context



Kinds of Remote Objects

- Server-activated objects (SAO)
  - Singleton (well-known object)
    - only one object instance for all clients
    - object created at server start
  - Single-call
    - each invocation generates a new object which is afterwards deleted
    - prevents unwanted resource consumption
  - Published (like Singleton but created manually)
- Client-activated objects (CAO)
  - each client has its own object; this might not scale!

RMI vs. .NET

Java RMI	.NET Remoting
Object and proxy must have common interface	transparent proxy, type conversion on demand
RemoteException need to be declared and caught	not needed
Explicit registration of object at *rmiregistry*	not needed
not supported	remote constructor

. . . and many more. . .

Example: Remote Object Implementation

```
public class HelloWorld : MarshalByRefObject
{

  public HelloWorld() {}

  public string SayHello()
  {
    return “Hello World!”;
  }
}
```

Example: Client Mainline

```
public class Client
{
  public static void Main(string args[])
  {
    RemotingConfiguration.Configure(“client.xml”);
    HelloWorld hello = new HelloWorld ();
    Console.WriteLine(hello.SayHello());
  }
}
```

Example: Server Mainline

```
public class Server
{

  public static void Main(string args[])
  {

    RemotingConfiguration.Configure(“server.xml”);

    Console.ReadLine();

  }
}
```

Example: Client Configuration

```
<configuration>
  <system.runtime.remoting>
    <application>

      <client url="tcp://localhost:4711/HelloWorld">
        <activated type="HelloWorld, server"/>
      </client>

    </application>
  </system.runtime.remoting>
</configuration>
```

Example: Server Configuration

```
<configuration>
  <system.runtime.remoting>
    <application>

      <channels>
        <channel ref="tcp" port="4711">
      </channels>

      <service>
        <activated type="HelloWorld, server"/>
      </service>

    </application>
  </system.runtime.remoting>
</configuration>
```

How it works

- Client side proxy created automatically
  - No IDL
  - No IDL-compiler, …
  - Uses reflection and reflection emit at runtime
- Generic server side proxy
  - Stackbuilder dispatches method invocations
  - Uses reflection
- Almost everything configured using XML-Files
- But: may need interface definition
  - Don‘t want to ship implementation with client

Microsoft .NET

ASP.NET

ASP.Net Overview

- ASP.NET is a server-side technology
- ASP.NET provides services for creation (i.e. debugging), deployment and execution of
  - Web applications
  - Web services
- Web applications are built using Web Forms
  - Creation should be as easy as building Visual Basic applications

Key Features of ASP.NET

- Web Forms
- Web Services
- Built on .NET Framework
- Simple programming model
- Complete object model
- Maintains page state
- Multibrowser support
- XCOPY deployment
- XML configuration
- Session management
- Caching
- Debugging
- Extensibility
- Separation of code and UI
- Security
- ASPX, ASP side by side
- Simplified form validation
- Cookieless sessions

Architecture

- ASP.NET is built upon
  - .NET Framework
  - Microsoft Internet Information Server (IIS)
- MONO builds a Apache binding
  - ASP.NET 1.0 & 1.1 are completely supported
  - ASP.NET 2.0 is supported (except WebParts)
  - Currently working on ASP.NET AJAX

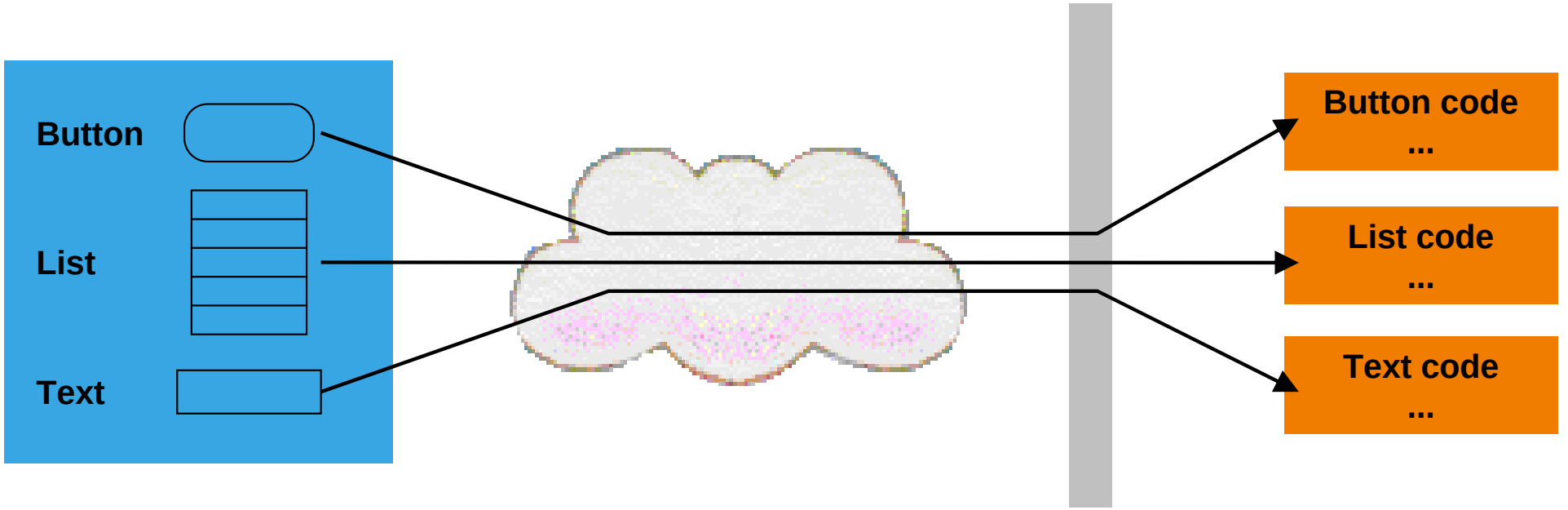
Example: HelloWorld.aspx

```
<html>
  <%@ Page language="c#" %>
  <head></head>

<script runat="server">
  public void B_Click(object sender, System.EventArgs e)
  {
    Label1.Text = "Hello, the time is " + DateTime.Now;
  }
</script>

  <body>
    <form method="post" runat="server">
      <asp:Button onclick="B_Click" Text="Push Me“
        runat="server" /> <p>
      <asp:Label id="Label1" runat="server" />
    </form>
  </body>
</html>
```

Programing Model

- Server-side programming model
- Based on controls and events
  - Just like Visual Basic
  - Not “data in, HTML out”
- Higher level of abstraction than ASP
- Requires less code
- More modular, readable, and maintainable

Controls and Events



ASP.NET Object Model

- Code executes on the web server in page or control event handlers
- Controls are objects, available in server-side code
  - Derived from `System.Web.UI.Control`
  - Similar to `System.Windows.Forms.Control`
- The web page is an object, too
  - Derived from `System.Web.UI.Page` which is a descendant of `System.Web.UI.Control`
  - A page can have methods, properties, etc.

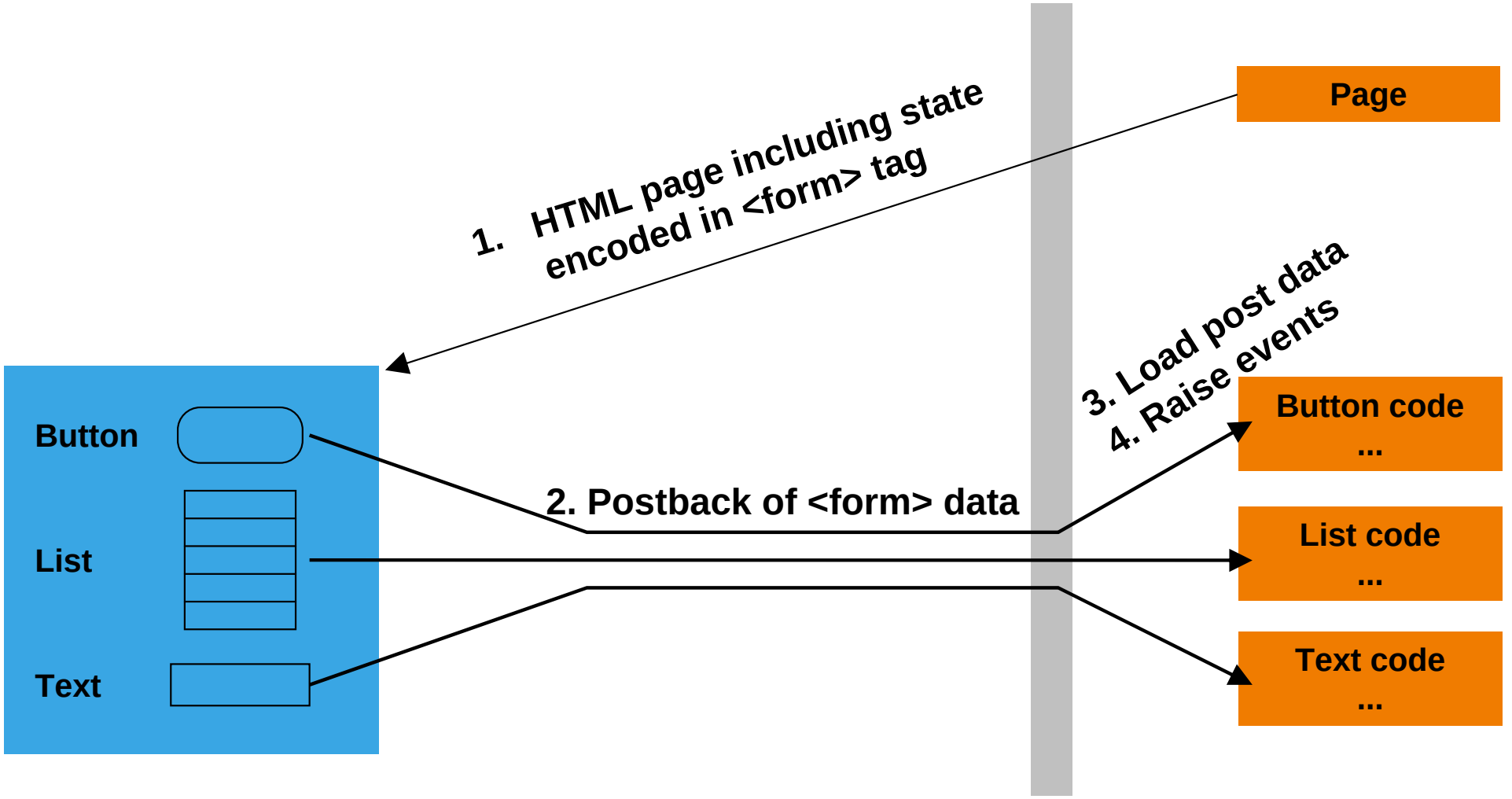
Postback

- Page object generates an HTML form
- Upon user action (e.g. button pressed) the event is posted back to the server
  - Not all possible events are posted back
  - For example, mouse move or key press are not posted back because of performance issues
- In ASP and other server-side technologies the state of the page is lost upon postback...
  - Unless you explicitly write code to maintain state
  - This is tedious, bulky and error-prone

Postback

- By default, ASP.NET maintains the state of all server-side controls during a postback
  - Can use `method="post"` or `method="get"`
- Server-side control objects are automatically populated during postback
  - No state stored on server
  - Works with all browsers

Postback


Page
1. HTML page including state encoded in <form> tag
3. Load post data
4. Raise events
Button code
...
Button
2. Postback of <form> data
List code
...
List
Text code
...
Text
Browser
ASP.NET
Event handlers

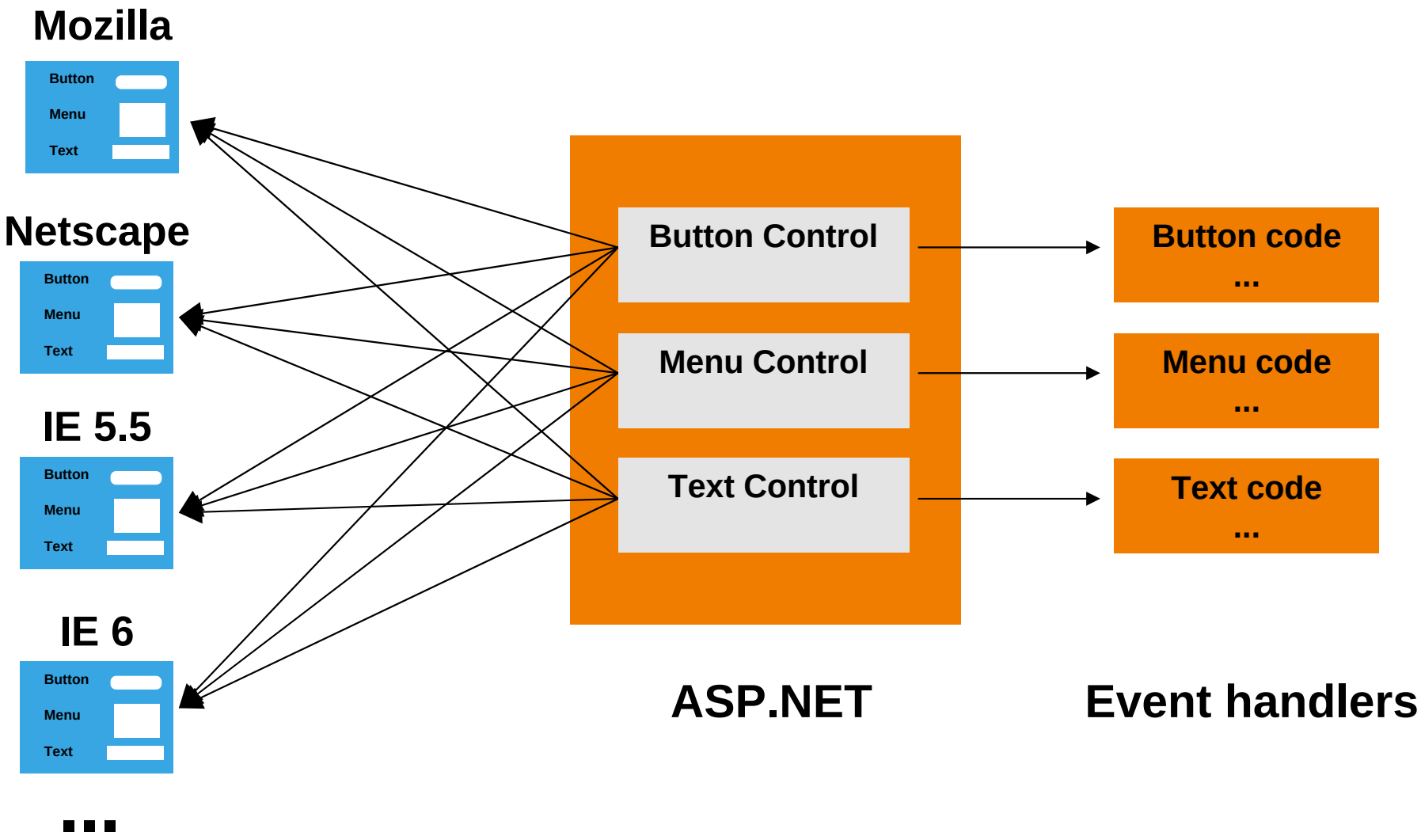
Server Side Controls

- Multiple sources to obtain controls
  - Built-in
  - 3rd party
  - User-defined
- Controls range in complexity and power
  - Button
  - Text
  - Drop down
  - Calendar
  - Data grid
  - …
- Can be populated via data binding

Automatic Browser Compatibility

- Controls can provide automatic browser compatibility
- Can target uplevel or downlevel browsers
  - Uplevel browsers support additional functionality, such as JavaScript and DHTML
  - Downlevel browsers support HTML 3.2

Automatic Browser Compatibility



Code-behind Pages

- Two styles of creating ASP.NET pages
  - UI and code in .aspx file
  - UI in .aspx file, code in code-behind page
    - Supported in Visual Studio.NET

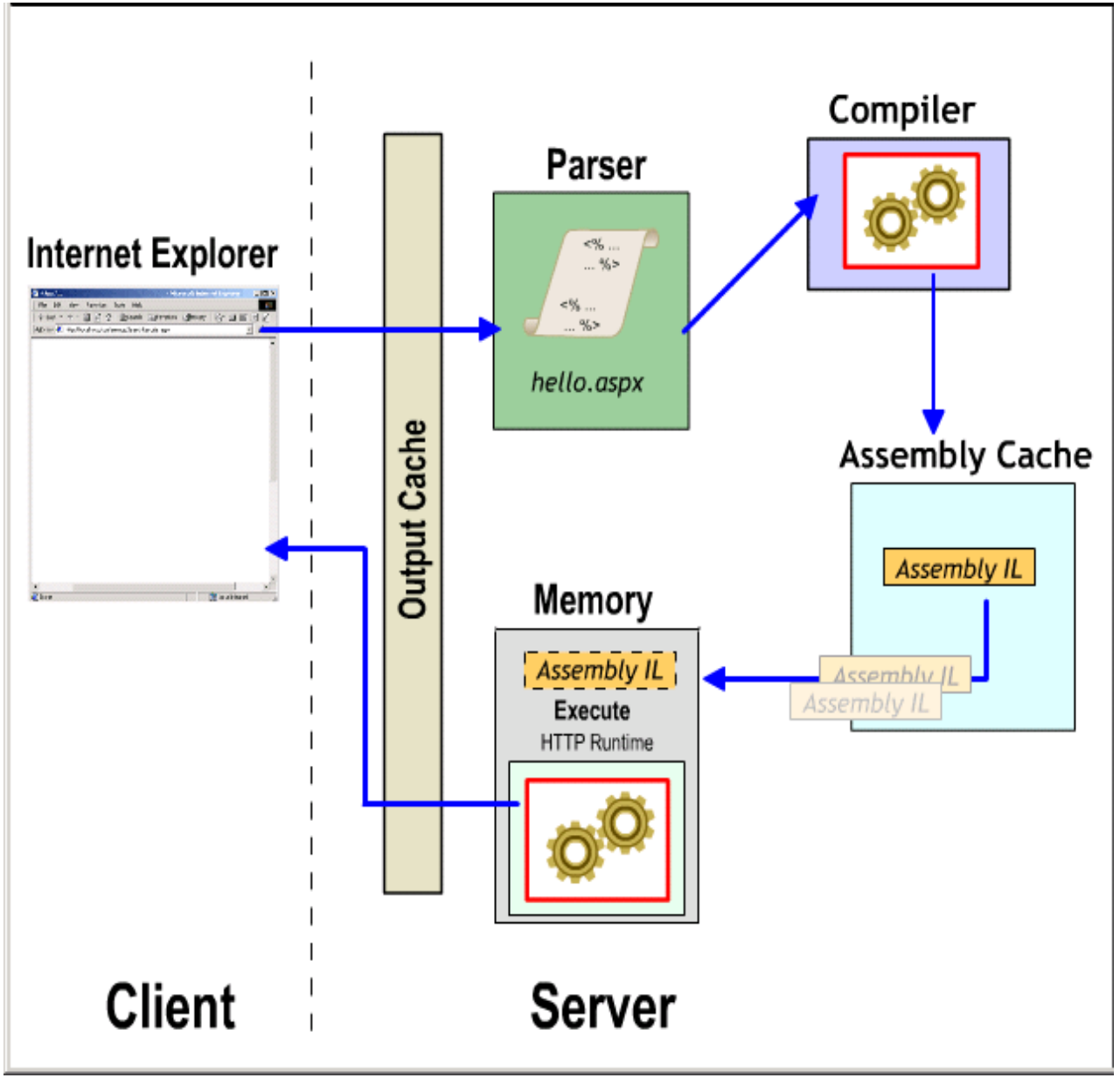
- Code-behind pages allow you to separate the user interface design from the code
  - Allows programmers and designers to work independently
  - Direktive

```
<%@ Codebehind="WebForm1.cs"
    Inherits="WebApplication1.WebForm1" %>
```

Automatic Compilation

- Just edit the code and hit the page
  (edit, save, and run)
- ASP.NET will automatically compile
  the code into an assembly
- Compiled code is cached in the
  CLR Assembly Cache
- Subsequent page hits use compiled assembly
- If the text of the page changes
  then the code is recompiled

Automatic Compilation



Page Syntax

- The most basic page is just static text
  - Any HTML page can be renamed `.aspx`
- Pages may contain:
  - Directives: `<%@ Page Language="C#" %>`
  - Server controls: `<asp:Button runat="server">`
  - Code blocks: `<script runat="server">…</script>`
  - Server side comments: `<%-- --%>`
  - Render code: `<%= %>`
    - Use is discouraged; use `<script runat="server">` with code in event handlers instead

Page Directive

- `<%@ Page Language="C#" … %>`
- Lets you specify page-specific attributes, e.g.
  - `AspCompat`: Compatibility with ASP
  - `Buffer`: Controls page output buffering
  - `CodePage`: Code page for this .aspx page
  - `ContentType`: MIME type of the response
  - `ErrorPage`: URL if unhandled error occurs
  - `Inherits:` Base class of Page object
  - `Language`: Programming language
  - `Trace`: Enables tracing for this page
  - `Transaction`: COM+ transaction setting
- Only one page directive per .aspx file

Server Code Blocks

- Server code lives in a script block marked `runat="server"`

```
<script language="C#" runat="server">
<script language="VB" runat="server">
<script language="Jscript" runat="server">
```

- Script blocks can contain
  - Variables, methods, event handlers, properties
  - They become members of a custom **Page** object

Page Import Directive

- Adds code namespace reference to page
  - Avoids having to fully qualify .NET types and class names
  - Equivalent to the C# `using` directive

```
<%@ Import Namespace="System.Data" %>
<%@ Import Namespace="System.Net" %>
<%@ Import Namespace="System.IO" %>
```

Page Class

- The `Page` object is always available when handling server-side events
- Provides a large set of useful properties and methods, including:
  - `Application, Cache, Controls, EnableViewState, ErrorPage, IsPostBack, IsValid, Request, Response, Server, Session, Trace, User, Validators`
  - `DataBind(), LoadControl(), MapPath(), Validate()`

Server Control Syntax

- Controls are declared as HTML tags with `runat="server"` attribute

```
<input type="text" id="text2" runat="server" />
<asp:calendar id="myCal" runat="server" />
```

- Tag identifies which type of control to create
  - Control is implemented as an ASP.NET class
- The `id` attribute provides programmatic identifier
  - It names the instance available during postback
  - Just like Dynamic HTML

Server Control Properties

- Tag attributes map to control properties

```
<asp:button id="c1" Text="Foo" runat="server">
<asp:ListBox id="c2" Rows="5" runat="server">
```

- Tags and attributes are case-insensitive
- Control properties can be set programmatically

```
c1.Text = "Foo";
c2.Rows = 5;
```

Maintaining State

- Controls maintain their state across multiple postback requests by default
  - Implemented using a hidden HTML field: `__VIEWSTATE`
  - Works for controls with input data (e.g. `TextBox`, `CheckBox`), non-input controls (e.g. `Label`, `DataGrid`), and hybrids (e.g. `DropDownList`, `ListBox`)
- Can be disabled per control or entire page
  - Set `EnableViewState="false"`
  - Lets you minimize size of `__VIEWSTATE`

Events

- Controls reacts to events
  - Enables clean code organization
  - Avoids the “Monster IF” statement
  - Less complex than ASP pages
- Code can respond to page events
  - e.g. `Page_Load`, `Page_Unload`
- Code can respond to control events
  - `Button1_Click`
  - `Textbox1_Changed`

Event Lifecycle

Initialize ..... **Page_Init**

Restore Control State .....

Load Page ..... **Page_Load**

Control Events

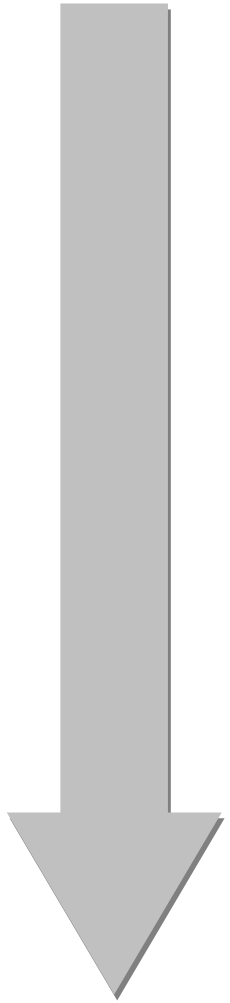
1. Change Events ..... **Textbox1_Changed**

2. Action Events ..... **Button1_Click**

Save Control State .....

Render .....

Unload Page ..... **Page_Unload**



Page Loading

- `Page_Load` fires at beginning of request
  - Controls are already initialized
  - Input control values already populated

```
protected void Page_Load(Object s, EventArgs e)
{
  message.Text = textbox1.Text;
}
```

Page Loading

- `Page_Load` fires on every request
  - Use `Page.IsPostBack` to execute conditional logic
  - If a Page/Control is maintaining state then only initialize it when `IsPostBack` is false

```
protected void Page_Load(Object s, EventArgs e)
{

if ( !Page.IsPostBack )
 {
    // Executes only on initial page load
    Message.Text = "initial value";
 }

// Rest of procedure executes on every request
}
```

Server Control Events

- Change Events
  - By default, these execute only on next action event
  - E.g. `OnTextChanged`, `OnCheckedChanged`
  - Change events fire in random order
- Action Events
  - Cause an immediate postback to server
  - E.g. `OnClick`
- Works with any browser
  - No client script required, no applets, no ActiveX® Controls

How Postback works on Client Side

```
<form name="Form1" method="post" action="WebForm1.aspx" id="Form1">

  <a href="javascript:__doPostBack('Firstcontrol1','dec')">
    Decrease Number
  </a>

  <input type="hidden" name="__EVENTTARGET" value="" />
  <input type="hidden" name="__EVENTARGUMENT" value="" />

  <script language="javascript">
  <!--
    function __doPostBack(eventTarget, eventArgument) {
      var theform;
      theform = document.Form1;
      theform.__EVENTTARGET.value = eventTarget;
      theform.__EVENTARGUMENT.value = eventArgument;
      theform.submit();
    }
  // -->
  </script>

</form>
```

Wiring Up Control Events

- Control event handlers are identified by the tag

```
<asp:button onclick="btn1_click" runat=“server”>
<asp:textbox onchanged="text1_changed"
                                    runat=“server”>
```

- Event handler code

```
protected void btn1_click(Object s, EventArgs e)
{
  Message.Text = "Button1 clicked";
}
```

Event Arguments

- Events pass two arguments
  - The sender, declared as type `Object`
    - Usually the object representing the control that generated the event
    - Allows you to use the same event handler for multiple controls
  - Arguments, declared as type `EventArgs`
    - Provides additional data specific to the event
    - `EventArgs` itself contains no data; a class derived from `EventArgs` will be passed
    - Read the fine manual to find out which subclass of `EventArgs` you have to expect

Change Events & AutoPostBack

- Usually only action events trigger a postback
- Some controls can send postbacks for change events
  - CheckBox
  - ListControl
  - TextBox
- Postback is sent after the user
  - 1. changed a value
  - 2. tabbed out of the control
- Example
  - Automatically sum up values entered in text boxes

Change Events & AutoPostBack

```
<%@ Page Language="C#" AutoEventWireup="True" %>
<html><head>
  <script runat="server">
    protected void Page_Load(Object sender,EventArgs e)
    {
      int Answer = Convert.ToInt32(Value1.Text) +
                   Convert.ToInt32(Value2.Text);
      AnswerMessage.Text = Answer.ToString();
    }
  </script></head>
  <body><form runat="server">
    <asp:TextBox ID="Value1" AutoPostBack="True"
                 runat="server"/>
    <asp:TextBox ID="Value2" AutoPostBack="True"
                 runat="server"/>
    <asp:Label ID="AnswerMessage" runat="server"/>
  </form></body>
</html>
```

Page Unloading

- `Page_Unload` fires after the page is rendered
  - Don’t try to add to output
- Useful for logging and clean up

```
protected void Page_Unload(Object s, EventArgs e)
{
   MyApp.LogPageComplete();
}
```

Bibliography

- Matthias Lohrer. *Einstieg in ASP.NET*. Galileo Computing, 2002. http://www.galileocomputing.de/openbook/asp/

- Eric Gunnerson. *C# – Tutorial und Referenz*. Galileo Computing, 2002. http://www.galileocomputing.de/openbook/csharp/

Fragen?