

Microsoft Visual Studio .NET

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The Microsoft .NET Framework

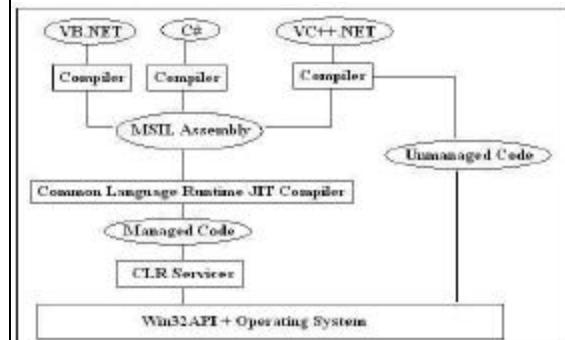
- The Common Language Runtime
- Common Language Specification
 - Programming Languages
 - C#, Visual Basic, C++, lots of others
- Managed Modules (Assemblies)
- MSIL
- The .NET Framework Class Library
 - Namespaces

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.NET Architecture



Compilation in the .NET Framework



Namespaces

- A group of classes and their methods
- FCL is composed of namespaces
- Namespaces are stored in DLL files called assemblies
- Included in a C# program with the using keyword
 - If not included, you must give the fully qualified name of any class method or property you use
 - System.Windows.Forms.MessageBox.Show(...)
- Something like packages in Java

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Some Important .Net Namespaces

• System	Core data/auxiliary classes
• System.Collections	Resizable arrays + other containers
• System.Data	ADO.NET database access classes
• System.Drawing	Graphical Output classes (GDI+)
• System.IO	Classes for file/stream I/O
• System.Net	Classes to wrap network protocols
• System.Threading	Classes to create/manage threads
• System.Web	HTTP support classes
• System.Web.Services	Classes for writing web services
• System.Web.UI	Core classes used by ASP.NET
• System.Windows.Forms	Classes for Windows GUI apps
• See online help on 'Class Library'	

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C#

- A new component & object oriented language
 - Emphasis on the use of classes
- Power of C plus ease of use of Visual Basic
- Combines the best aspects of C++ and Java
 - Conceptually simpler and more clear than C++
 - More structured than Visual Basic
 - More powerful than Java
- Syntax very similar to C/C++
 - No header files
- Managed pointers only
 - “Almost no pointers” ↗ “almost no bugs”

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C# Classes

- Can contain:
 - “Fields”: Data members (like C++ variables)
 - “Methods”: Code members (like C++ functions)
 - “Properties”: In-between members that expose data
 - To user program they look like data fields
 - Within the class they look like code methods
 - Often provide controlled access to private data fields
 - Validity checks can be performed
 - Values can be obtained or set after validity checks
 - » Using Accessor methods `get()` and `set()`
 - “Events”: Define the notifications a class is capable of firing in response to user actions

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Example: Square class

```
public class Square
{
    private int side_length = 1; // A Field

    public int Side_length // A Property
    {
        get { return side_length; }
        set
        {
            if (value>0)
                side_length = value;
            else
                throw (new ArgumentOutOfRangeException());
        }
    }

    public int area() // A Method
    {
        return (side_length * side_length);
    }

    public Square(int side) // The Constructor method
    {
        side_length = side;
    }
}
```

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Instantiating and Using the Square Class

```
Square sq = new Square(10); // Construct a Square object of
                           // side_length = 10
                           // Instantiates the object and invokes
                           // the class constructor
int x = sq.Side_length; // Retrieve object's Side_Length Property
sq.Side_length = 15; // Change object's Side_length Property
int sq_area = sq.area(); // Define an integer variable and use
                        // the class area() method to compute
                        // the area of the square
MessageBox.Show("Area= " + sq_area.ToString()); // Display result in a Message Box
                                                // Note use of ToString() method
                                                // to convert an integer to a string.
                                                // Show() is a static method of MessageBox
                                                // class
```



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Windows Forms

- A Windows Form: just a window
- Forms depend on classes in namespace ‘System.Windows.Forms’
- Form class is in ‘System.Windows.Forms’:
 - The heart of every Windows Forms application is a class derived from Form
 - An instance of this derived class represents the application’s main window
 - Inherits many properties and methods from Form that determine the look and behavior of the window
 - E.g., Text property to change window’s caption
- Application: Another important class from ‘System.Windows.Forms’
 - Its static method Run() drives the Windows Form application
 - Argument is the Form to be run
 - Invoked in the program’s entry point function: Main()
 - Causes the program to enter the message loop
 - Form passed to Run() has code to post a quit message when form is closed
 - Returns to Main() when done and program terminates properly

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A Simple Windows Form App in C# -- HelloWorld

```
using System.Windows.Forms; // the namespace containing
                           // the Form class
public class HelloWorld : System.Windows.Forms.Form
{
    // our class derived from Form
    public HelloWorld() // our class constructor
    {
        this.Text = "Hello World"; // Set this form's Text Property
    }

    static void Main() // Application's entry point
    {
        Application.Run(new HelloWorld()); // Run our form
    }
}
```

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Compiling a C# Application from the Command Line

- Start a Command Window with the proper paths to the compiler/linker set
 - Easiest way: From Task Bar:
 - 'Start' | 'All Programs' | 'Microsoft Visual Studio .NET' | 'Visual Studio .NET Tools' | 'Visual Studio .NET Command Prompt'
 - Starts the DOS Box Command Window
 - Navigate to the directory containing the source code file(s)
 - From the command prompt invoke the C# compiler and linker
 - For example, to build an executable from the C# source file myprog.cs, type one of the following:


```
csc myprog.cs           (easiest way, creates a console app)
csc /target:exe myprog.cs (also creates a console application)
csc /t:winexe myprog.cs  (creates a Windows executable)
csc /t:winexe /r:System.dll,System.Windows.Forms.dll,System.Drawing.dll
myprog.cs                (to provide access to needed .NET DLLs)
```

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Using Visual Studio to Develop a Simple C# Application “Manually”

- Start Visual Studio as usual
- 'File' | 'New' | 'Project' | 'Visual C# Projects' | 'Empty Project'
- To create the program
 - 'Project' | 'Add New Item'
 - Categories: 'Local Project Items'
 - Templates: 'Code File'
 - This will bring up the code editor
 - Type in or copy and paste the C# source code
- But you must also provide access to some additional .NET Common Language Runtime DLLs
- Do this by adding 'References':
 - 'Project' | 'Add Reference'
 - Select: System.dll and System.Windows.Forms.dll
- Build project as usual ('Build' | 'Build Solution')

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Using Visual Studio's Designer to Develop a Simple C# Application

- Start Visual Studio as usual
- 'File' | 'New' | 'Project' | 'Visual C# Projects' | 'Windows Application'
 - Gives a "designer view" of the Windows Form the project will create
 - Also skeleton code: Right click on form & select 'View Code' to see it
 - Note how it's broken up into 'Regions' (+ and - boxes on the left)
 - These can be expanded and contracted
 - Expand the 'Windows Form Designer generated code' Region
 - Note the Form properties that have been preset
 - Change the 'Text' property to "This is a Test"
 - Reactivate the Designer View by clicking on the 'Form1.cs [design]' tab
 - Note how the caption of the form has changed
 - Look at the 'Properties' window
 - Find the 'Text' Property and change it by Typing 'Hello World'
 - Resize the form (drag its corners) – note how the Size property changes
 - Change the Background Color in the Properties Box to red:
 - Click on BackColor' | down arrow | "custom" tab | red color box
 - Go back to 'Code View' and note changes that have been made
- Build and run the app

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.NET Managed Modules (Assemblies)

- The result of building a program with any of the compilers capable of generating MSIL
 - Microsoft provides: C#, J#, Visual Basic, Managed C++, Jscript
 - Also ILASM (Intermediate Language Assembler)
 - Third parties provide other compilers that generate MSIL
- 'Executables' (assemblies) designed to be run by the CLR
- Contain 4 important elements stored in the "Manifest":
 - A Windows Portable Executable (PE) file header
 - A CLR header containing important information about the module
 - Metadata describing everything inside the module and its external dependencies
 - Means every managed module is "self describing"
 - One of the keys to language interoperability
 - The MSIL instructions generated from the source code
- Can examine Assemblies with a tool called ILDASM

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The ILDASM Disassembler

- Used to examine an assembly's metadata and code
- Start a Command Window with proper path to ILDASM set
 - Easiest way: From Task Bar:
 - 'Start' | 'All Programs' | 'Microsoft Visual Studio .NET' | 'Visual Studio .NET Tools'
 - Starts the DOS Box Command Window
 - Navigate to the directory containing the assembly (.exe)
 - Invoke ILDASM
 - e.g., for HelloWorld program:
ILDASM HelloWorld.exe
 - Displays a window showing the assembly's Manifest and the classes in the assembly

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A Session with ILDASM

- Double Click on 'Manifest'
 - List of assemblies that module depends on
 - Assembly name
 - Modules that make up the assembly
 - Because HelloWorld is a single-file assembly, there is only one
- Expand HelloWorld class
 - Class contains two methods:
 - A constructor (.ctor)
 - Main ('S' means it's a static method)
 - Expand Main
 - .entrypoint a directive indicating it's where execution starts
 - Code instantiates a HelloWorld object and calls Application.Run for the form
 - Expand .ctor
 - Calls parent Form's constructor
 - Puts "Hello World" string on stack and calls set_Text to set the form's Text property

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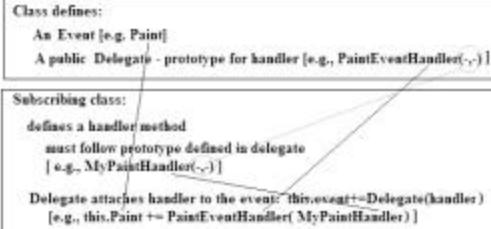
Events, Delegates, and Handlers

- **Events:** Results of user actions
- But in .NET events are also “class notifications”
- Classes define and publish a set of events that other classes can subscribe to
 - When an object changes its state (the event occurs), all other objects that subscribe to the event are notified
- Events are processed by event handler methods
- The arguments to an event handler must match those of a function prototype definition called a delegate:
 - A method to whom event handling is delegated
 - A type-safe wrapper around a callback function
 - Can be thought of as a managed (safe) function pointer
 - Not a raw memory address, but wraps the function's address
 - Helps avoid program crashes when the function is called back
 - Permits any number of handler methods for a given event

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Events, Delegates, Handlers

Events, Delegates, and Handlers in .NET



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An Example – Handling a Paint Event

- Form class has a Paint event to handle window exposures
- The delegate is PaintEventHandler, defined as:

```
public delegate void PaintEventHandler(object objSender, PaintEventArgs pea);
```

 - First argument: sender object (where event occurred)
 - Second argument: provides event data
 - A class with properties 'Graphics' and 'ClipRectangle'
 - Graphics contains instantiation of Graphics class (GDI+)
 - » The class used to draw on a form (like a Device Context)
 - ClipRectangle: Specifies area of window that needs to be redrawn
- Any Paint handler method must have these arguments
- And the Paint handler must be “attached” to the Paint event of the Form class (i.e., delegated to the handler)

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Defining the Event Handler and Attaching it to the Event

- Defining the form's Paint event handler method:

```
private void MyPaintHandler(object objsender, PaintEventArgs pea)
{
    // event handling code goes here
};
```
- Attaching the handler to the form's Event (delegating it to the event handler):

```
form.Paint += new PaintEventHandler(MyPaintHandler);
```
- A handler can also be “detached” from an event:

```
object.event -= new delegate(method);
```

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Drawing Text in response to a Paint Event

- Drawing namespace contains many classes and structures for drawing on a window
- Some of them:
 - Bitmap, Brush, Brushes, Color, Font, Graphics, Icon, Image, Pen, Pens, Point, Rectangle, Size
 - See online help: 'ClassName class' 'all members'
- **Graphics Class**
 - Represents a GDI+ drawing surface
 - Like a device context
 - Contains many graphics drawing methods
 - See Help on 'Graphics class', 'all members'
 - Obtaining a graphics object:
 - In Paint event handler, use second argument:
 - PaintEventArgs is a Graphics object
 - Code: `Graphics g = pea.Graphics`

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Using DrawString() to Draw Text

- Graphics.DrawString() has lots of overloaded versions
- Simplest:

```
DrawString(string str, Font font, Brush brush, float x, float y);
```

 - string class: an alias for System.String
 - Defines a character string
 - Has many methods to manipulate a string
 - Font class: gives a Windows Form program access to many fonts with scalable sizes
 - A Form has a default Font: It's one of the Form's properties
 - Or you can instantiate a new Font object: Lots of possibilities (we'll see later)
 - Brush or Brushes class: color/style of characters
 - Lots of different color properties, e.g. Brushes.Black
 - Or can create one of a specified Color
 - `Brush br = new SolidBrush(Color.FromArgb(r,g,b));`
 - `Brush br = new SolidBrush(Color.Red);`
 - x,y : Location to draw string on window client area

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Hello_in_window Example Program

- Responds to Paint Event by displaying 'Hello World' in window's client area using several different Brushes
- Manual Project
 - Define Handler and Attach it to Paint event manually
- Designer Project
 - Select the Paint event in the form's Properties window
 - Click on lightning bolt
 - Attachment of handler done automatically
 - Skeleton handler code generated automatically

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An Alternative to Installing Event Handlers

- In any class derived from 'Control' (e.g. 'Form') its protected OnPaint() and other event handlers can be overridden:

```
protected override void OnPaint(PaintEventArgs pea)
{
    // Painting code goes here
};
```

– Avoids having to attach the handler to the event
- See HelloWorld_override example program

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A Separate Class for Main()

- An alternative way of organizing a Windows Form application:
 - Define the Form in one class
 - Place the Main() function in another class
 - Must be done manually
 - Designer gives the single class program template
 - See SeparateMain1 example program

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Inheriting Form Classes

- Just as your Form inherits from 'System.Windows.Forms.Form', you can set up a new Form that inherits from a previously defined Form
- Be sure its Main() includes keyword 'new'
- And that Visual Studio knows which class' Main() is the entry point:
 - In project's Properties box select 'Property Pages' icon
 - 'Common Properties' | 'General' | Application' | 'Startup Object'
 - Select 'InheritHelloWorld'
- See HelloWorld_inherit example

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Multiple Handlers

- An advantage of the delegate mechanism is that multiple handlers of the same event can be used
- Just attach each handler to the event
 - For example:

```
Form.Paint += new PaintEventHandler(PaintHandler1);
Form.Paint += new PaintEventHandler(PaintHandler2);
```
- And then write the handlers
- Each time the event occurs, all handlers will be called in sequence
- See TwoPaintHandlers example

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Some other GDI+ Drawing Methods

- DrawArc();
- DrawEllipse();
- DrawLine()
- DrawPolygon();
- DrawRectangle();
- FillEllipse();
- FillPolygon();
- FillRectangle()
- Lots of others in 'Graphics' class
 - See online help on various overloaded forms of calling these functions

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Random Rectangles Example Program

- Makes use of FillRectangle() GDI+ method
- ‘Random’ class contains many methods to generate random numbers
 - Random r = new Random();
 - Instantiates a new Random object and seeds the pseudo-random number generator
 - The ‘Next()’ method actually generates the number
 - Many overloaded forms of Next()
 - Getting a random color:
Color c = Color.FromArgb(r.Next(256), r.Next(256), r.Next(256));
- Use Form’s ClientSize Property to get width and height of window
- Draw filled rectangle with random size and color:
 - Use FillRectangle() and Math.Min(), Math.Abs()

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