Microsoft .NET

- **what is .NET?**

- **"framework" for supporting web-based services**
  - single run-time environment for programs written in a variety of languages
  - web forms for interfaces on web pages
  - XML, SOAP, WSDL, UDDI, etc., for web services

- **development platform**
  - single intermediate language as target for all languages
  - common type system
    all languages produce interoperable objects and types
  - common language runtime environment
    base class libraries accessible to all languages
    just in time compilation
  - control of deployment and versioning
    the end of DLL hell?
  - IDE for writing programs
  - significant new language, C#
  - evolution of Visual Basic and other languages

Why bother / who cares?

- **primary focus of Microsoft software development**
  - next stage after COM
  - likely to have major impact on how computing is done
    certainly in Microsoft world

- **interesting comparisons and contrasts with Java and J2EE**

- **ties in with other topics of 333**
  - evolution of C, C++, Java -> C#
  - object-oriented programming
  - component-based software development
  - Visual Basic, user interfaces
  - web services
  - politics and economics of software

Java model

- **Java language**
  - derivative of C and C++
  - strictly object-oriented
  - garbage collection
- **compiled into intermediate language ("byte code")**
  - result stored in .class files
  - packages and JAR files for larger collections
- **interpreted by Java Virtual Machine on host**
  - local services provided by host system
  - enormous set of libraries in JRE
  - can be compiled into native instructions either ahead of time or "just in time"
- **largely portable**
  - types completely specified
  - main problems come from making use of services of host environment
  - "write once, run anywhere" is partially true

- **applets for running code in web pages**
- **Java Server Pages (JSP) for server-based web transactions**

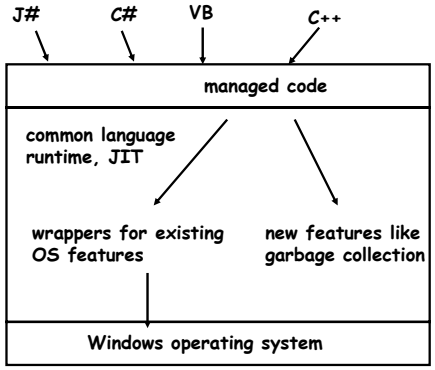
.NET model

- **multiple languages: C#, VB, C++, Jscript, …**
  - C# is a derivative of C, C++ and Java
  - VB.net is a significantly different version of VB
  - "managed extensions" for C++ that permit safe computation, garbage collection, etc.
- **all are object-oriented**

- **all languages compile into same intermediate language ("MSIL")**
  - types completely specified by Common Type System (CTS)
  - objects can interoperate if they conform to Common Language Specification (CLS) [a subset of CTS]
- **IL compiled into native machine instructions**
  - just in time compilation: no interpretation
  - local services provided by host system (Win 2K/XP)
  - enormous set of libraries
- **not portable**
  - tightly integrated into Windows environment
- **web forms for GUI components on web pages**
- **ASP.NET for server-based web transactions**

Common Language Runtime (CLR)

- **all languages compile into IL that uses CLR**
- **common services:**
  - memory management / garbage collection
  - exceptions
  - security
  - debugging, profiling
- **access to underlying operating system**



C# programming language

- **based on C, C++ and Java**
  - Microsoft does not stress the Java contribution
  - "An evolution of Microsoft C and Microsoft C++"
    (Visual Studio.NET documentation)

- **"C# has a high degree of fidelity to C and C++"**
  - everything is a class object (Java)
    no global functions, variables, constants
  - garbage collection; destructors called implicitly (Java)
  - arrays are managed types (Java)
  - updated primitive types (Java)
    char is Unicode character; string is a basic type
  - single inheritance and interfaces (Java)
  - ref, out parameter modifiers
  - try-catch-finally (Java)
  - delegate type (roughly, function pointers)
  - unsafe mode (pointers permitted)
  - some syntax changes:
    '.' instead of **->** and **::** (Java), switches don't fall through
    `foreach` statement
  - no need for forward declarations (Java)
  - no headers or #include (Java)
  - /// documentation comments (Java)

Visual J#

- **"Visual J# is a development tool that developers who are familiar with the Java-language syntax can use to build applications and services on the .NET Framework. It integrates the Java-language syntax into the Visual Studio .NET integrated development environment (IDE). Visual J# also supports most of the functionality found in Visual J++ 6.0, including Microsoft Extensions. Visual J# is not a tool for developing applications intended to run on a Java Virtual Machine. Applications and services built with Visual J# will run only in the .NET Framework. Visual J# has been independently developed by Microsoft. It is not endorsed or approved by Sun Microsystems, Inc. For more information, see Introducing Visual J#."**

  - from Microsoft's introduction to .NET

Separated at birth?

```
public class hello {
  public static void main(String[] args)
  {
     System.out.println("hello, world");
  }
}
```

```
using System;
public class hello {
  public static void Main(string[] args)
  {
     System.Console.WriteLine("hello, world");
  }
}
```

"echo" in Java and C#

```
public class echo {
   public static void main(String[] args) {
      for (int i = 0; i < args.length; i++)
         System.out.println(
            "Arg[" + i + "] = ["
                        + args[i] + "]");
   }
}
```

```
using System;
public class echo {
   public static void Main(string[] args) {
      for (int i = 0; i < args.Length; i++)
         Console.WriteLine(
            "Arg[{0}] = [{1}]", i, args[i]);
   }
}
```

fmt in Java

```
import java.io.*;
import java.util.*;

public class f {
  String line = "";
  String space = "";
  int maxlen = 60;

  public static void main(String args[]) {
    f t = new f();
    t.runf();
  }
  public void runf()  {
    String s;
    try {
        BufferedReader in = new BufferedReader(
                new InputStreamReader((System.in)));
        while ((s = in.readLine()) != null) {
          String wds[] = s.split("[   ]+");
          for (int i = 0; i < wds.length; i++)
                addword(wds[i]);
        }
    } catch (Exception e) {
        System.err.println(e); //eof
    }
    printline();
  }
  public void addword(String w) {
    if (line.length() + w.length() > maxlen)
        printline();
    line += space + w;
    space = " ";
  }
  public void printline() {
    if (line.length() > 0)
        System.out.println(line);
    line = "";
    space = "";
  }
```

fmt in C#

```
using System;
using System.IO;

namespace fmtcs
{
  class fmt {
     int maxlen = 60;
     string line = "";

     static void Main(string[] args) {
        new fmt(args[0]);
     }
     fmt(string f) {
        string inline;
        Stream fin = File.OpenRead(f);
        StreamReader sr = new StreamReader(fin);
        for (inline = sr.ReadLine(); inline != null;
                              inline = sr.ReadLine()) {
           string[] inwords = inline.Split(null);
           for (int i = 0; i < inwords.Length; i++)
                                addword(inwords[i]);
        }
        printline();
     }
     void addword(string w) {
        if (line.Length + w.Length > maxlen)
           printline();
           if (line.Length > 0)
              line += " ";
           line += w;
     }
     void printline() {
        if (line.Length > 0) {
           Console.WriteLine(line);
           line = "";
        }
     }
  }
}
```

Accessors (get/set members)

- **syntax looks like public class variables**
- **semantics defined by calling get and set methods**

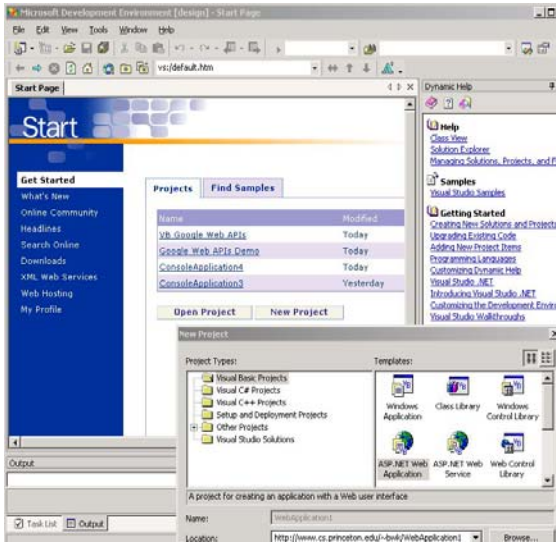
```
class Thing {
  static bool fldstate;

  public static bool fldok {
       get { return fldstate; }
       set { fldstate = value; }
  }
}

  Thing v;

  if (v.fldok)
       v.fldok = false;
```

Indexers (get/set [] members

- **syntax looks like array access (v[i])**
- **semantics defined by calling get and set members with a subscript**

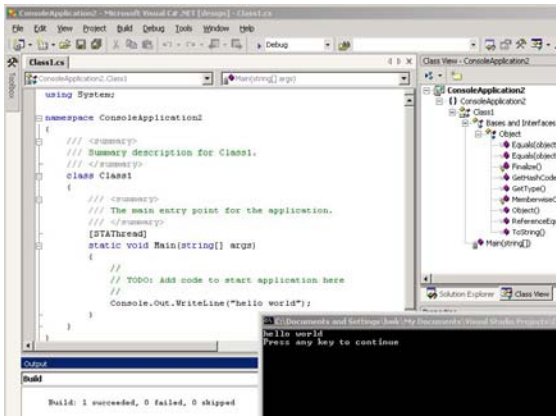
```
public class Awkarray {
  public Hashtable ht = new Hashtable();
  public Awk this[string name] {
    get {
      if (!ht.Contains(name))
        ht.Add(name, new Awk());
      return (Awk) ht[name];
    }
    set { ht.Add(name, value); }
  }

  Awkarray aa = new Awkarray();

  if (aa["whatever"] != null)
       aa["whatever"] = "a string";
```

Visual Studio.NET: the IDE



Visual Studio.NET

- **handles multiple languages**
- **completely integrated with languages and run-time environment**
  - can run compilers, etc., from command line too
- **extensive online help**



fmt in VB.NET

```
Module Module1
    Dim line As String
    Sub Main(ByVal args As String())
        Dim inline As String, words As String()
        Dim i As Integer
        line = ""
        FileOpen(1, args(0), OpenMode.Input)
        While Not EOF(1)
            inline = LineInput(1)
            words = inline.Split(Nothing)
            For i = 0 To words.Length - 1
                addword(words(i))
            Next i
        End While
        FileClose(1)
        printline()
    End Sub
    Sub addword(ByVal w As String)
        If line.Length + w.Length > 60 Then
            printline()
        End If
        If line.Length > 0 Then
            line = line & " "
        End If
        line = line & w
    End Sub
    Sub printline()
        If line.Length > 0 Then
            Console.WriteLine(line)
            line = ""
        End If
    End Sub
End Module
```

Other languages

- **VB changes**
  - now object-oriented
  - some obsolete features finally deleted (GOSUB)
  - library changes
  - arrays now origin 0, not 1 (upper limit is n, not n-1)
  - wizard to upgrade from previous version

- **managed extensions for C++**
  - garbage collected classes

```
__gc class M { public: int i; };
int main() {
   while (true)
          M *m = new M;
      // runs forever without exhausting heap
}
```

  - __gc pointers point to managed items only
  - __value classes for small items with short lifetimes
  - System::String type: `S"this is a string"`
  - etc.

Other worlds

- **access to COM object from .NET client**
  - .NET client calls COM object through a wrapper
    RuntimeCallableWrapper
  - callable at runtime (no prearrangement needed)
  - wrapper makes COM object look like it is a .NET object
  - and makes .NET client look like a COM client

- **access to .NET components from COM**
  - less common case, probably
  - COM object calls .NET object through a wrapper
    COM Callable Wrapper
  - makes .NET object look like a COM object

Assemblies

- **"fundamental unit of deployment, version control, reuse, activation scoping, and security permissions for a .NET-based application"**
  VS.NET documentation

- **collection of type and resource info**
- **(usually? always?) packaged as a .exe or .dll**
  - may contain other files, including .exe and .dll
  - executable parts are in MSIL, not native code

- **each assembly contains a "manifest" with**
  - name, version of the assembly
  - file table: other files in the assembly
  - external dependencies

- **greatly reduce need for Windows registry**
  - program and components self-contained
  - can often remove an application just by removing the files

Deployment, versioning

- **prior to .NET, installing an application requires**
  - copying files to multiple directories
  - making entries in registry
  - adding shortcuts to desktop and menus
- **backing up, moving, removing an application requires an installer program**

- **"DLL Hell": shared libraries get out of sync with apps that need them**
  - new installation breaks existing programs that rely on properties of old DLL
  - new installation overwrites newer DLL with older one

- **assemblies provide strong internal naming/typing**
  - ensure that the right library is being used
  - assembly can specify versions of external references that it needs to work properly
  - CLR loads proper one
  - can have old and new versions working side by side

J2EE **(Java 2 Enterprise Edition)**

- **Java comes in 3 editions**
  - J2SE standard edition (what we all use)
  - J2ME embedded edition (phones, PDAs, ...)
  - J2EE enterprise edition (big systems)
  - same language but different libraries and programming models

- **J2EE aimed at e-commerce**
  - browse through offerings
  - select item, gather billing & shipping info
  - check inventory (maybe trigger supply chain)
  - validate financial info
  - arrange shipping, get tracking number
  - ...
- **usually complicated multi-tier structures**
  - need toolkit of subsystems for building system
    naming & directory services
    distributed objects
    database access, concurrency control, transaction integrity
    security
  - need help in integrating and packaging components
    (Java components called "beans")

J2SE/J2EE vs .NET

- **technical**
  - trying to solve similar problems
  - Java is a single language solution
  - .NET supports multiple languages
  - Java builds on existing environments; portable
  - .NET deeply embedded in Windows, only runs there
  - JSP similar to ASP

  - creating web services more integrated in .NET:
    every program is potentially a web service

- **non-technical**
  - monopoly vs. benevolent dictatorship?
  - Sun is concerned that Microsoft will cut the ground out from under it as an enterprise software system
    lawsuit charges anti-trust violations, unfair competition that tries to damage Java (filed March 2002)
  - April 2004: Sun & Microsoft settle all legal issues, Microsoft pays Sun $1.6B

Tentative conclusions

- **C# is a reasonable language**
  - easy to pick up basics if know Java
  - easy to convert Java statements to C#
  - batch mode compilation is easy
- **VB.NET is too complicated**
  - each new release has made it more complicated
  - wizard helps upgrade process but can't handle lots of things
- **C/C++ are not much changed**
  - some minor problems compiling old programs
- **Visual Studio.NET feels smoother and easier than Visual Studio 6**
  - all languages are handled in a uniform way
  - good integration of visual and textual
  - some remarkable omissions (layout managers!)
- **likely to be too hard to adapt or upgrade most existing programs to .NET**
  - they may not port to older versions of Windows
- **a reasonable choice for brand new implementations**