Software Security

Introduction
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The Future
.NET Framework
Keeping Code Secure
Obfuscation
Software Security
.NET Security Model
ASP.NET
Conclusions

Author: Prof Bill Buchanan

Software Security

Introduction

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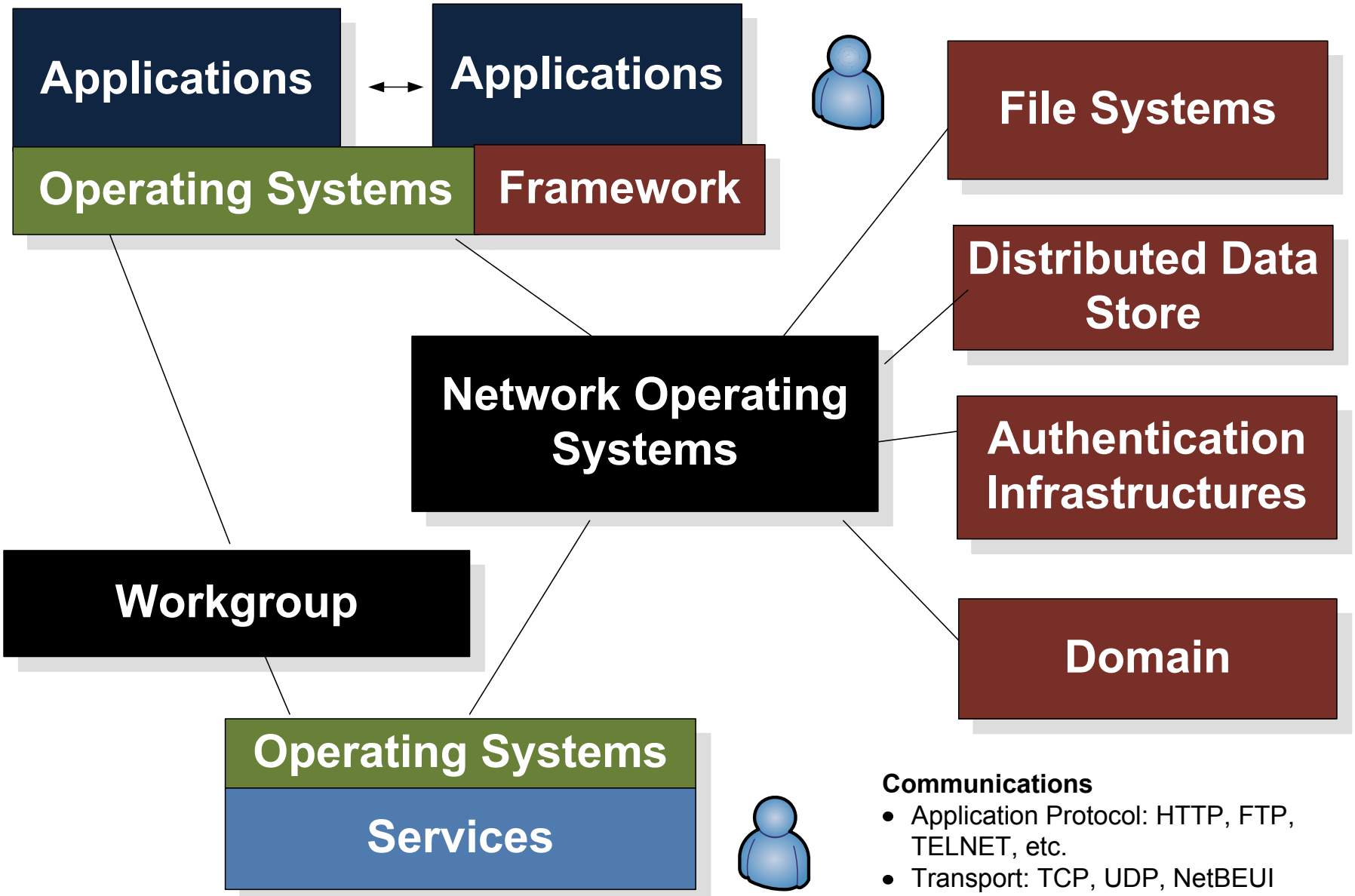

Communications

- Application Protocol: HTTP, FTP, TELNET, etc.
- Transport: TCP, UDP, NetBEUI
- Network: IP, IPX.

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Lack of education in secure methods.

Lack of integration with the OS.

Lack of thought in the design process.

Lack of testing.

Lack of understanding of IP (Intellectual Property) protection.

Poor development environments.

Lack of understanding of encryption/ authentication.

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Lack of support for different hardware
Programs were compiled to x86 code.

Weak integration with Internet/WWW
Code and WWW code where seen as separate entities

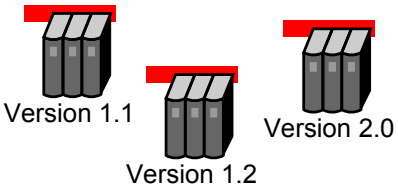
```
Code.asp
<%
     val1 = 10
     val2 = 20
     result = Cstr(val1) + Cstr(val2)
     response.write "<BR>Value is " & result
     result = val1 + val2
     response.write "<BR>Value is " & result
%>
```

Old Programs

Difficult to integrate different languages

Lack of security Integration
Most programs where written with little care about security

Poor version control for system components



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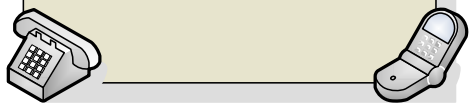
Issues?

Poor robustness
Where applications often crash

Too much support for legacy code



Poor integration with different data sources, such as XML, databases, and text files.

Old Programs

Difficult deployments

Lack of sharing between applications

Poor pre-run checking
This is where applications often crashed on run-time

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Software Flaws

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Non-intentional. These can be:

- **Validation flaws**. The code fails to check for valid input data.
- **Domain flaws**. This is where data leaks from one program to another.
- **Serialisation flaws**. This is where data changes while being passed from one program to another.
- **Identification/Authentication flaws**. This is where there is a lack of identification for processes or users.
- **Boundary condition flaws**. This is where resource access is not checked, and can thus allow an external hacker to use up resources.
- **Logic flaws**.

Bug

Trap-door

Intentional. This can either be caused by malious code (such as a Trojan or back-door programs).

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Best Practice

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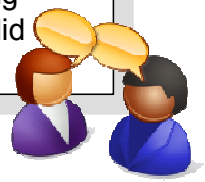
Best practice

Principle of least privilege

Processes and scripts should run with the least privilege possible, to minimize damage

Never trust user input

All user input check be checked before it is used. This includes checking for correct number/string format, including valid characters.



Defence-in-depth

Checkpoints should be added for authentication and authorization at software interfaces, and interfaces within modules.

Use secure defaults

Sometimes developers encounter security problems in running and applications. It is important that these are fully tested before reducing the security.

Never rely on obfuscation

Obfuscation of code just makes it more difficult to determine its operation. If an intruder wants to "crack" a program, then normally can, so other methods of securing the code should be employed.

If it's not used … disable it!

Any services which can be accessed can be compromised, thus, if they are not needed, they should be disabled.

Authenticate at the front-end

In terms of resources, it is often better to authentication at the front-end rather than the back-end

System is only as secure as the weakest link

The overall security of a system is only as strong as its weakest link.

Never trust external systems

External systems should always be seen as a potential risk, and should never be fully trusted.

Reduce Surface Area

This should minimize the information that can be accessed from outside, and to handle errors in a graceful way.

Based on Microsoft ASP.NET Good Practice Guide

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The Future

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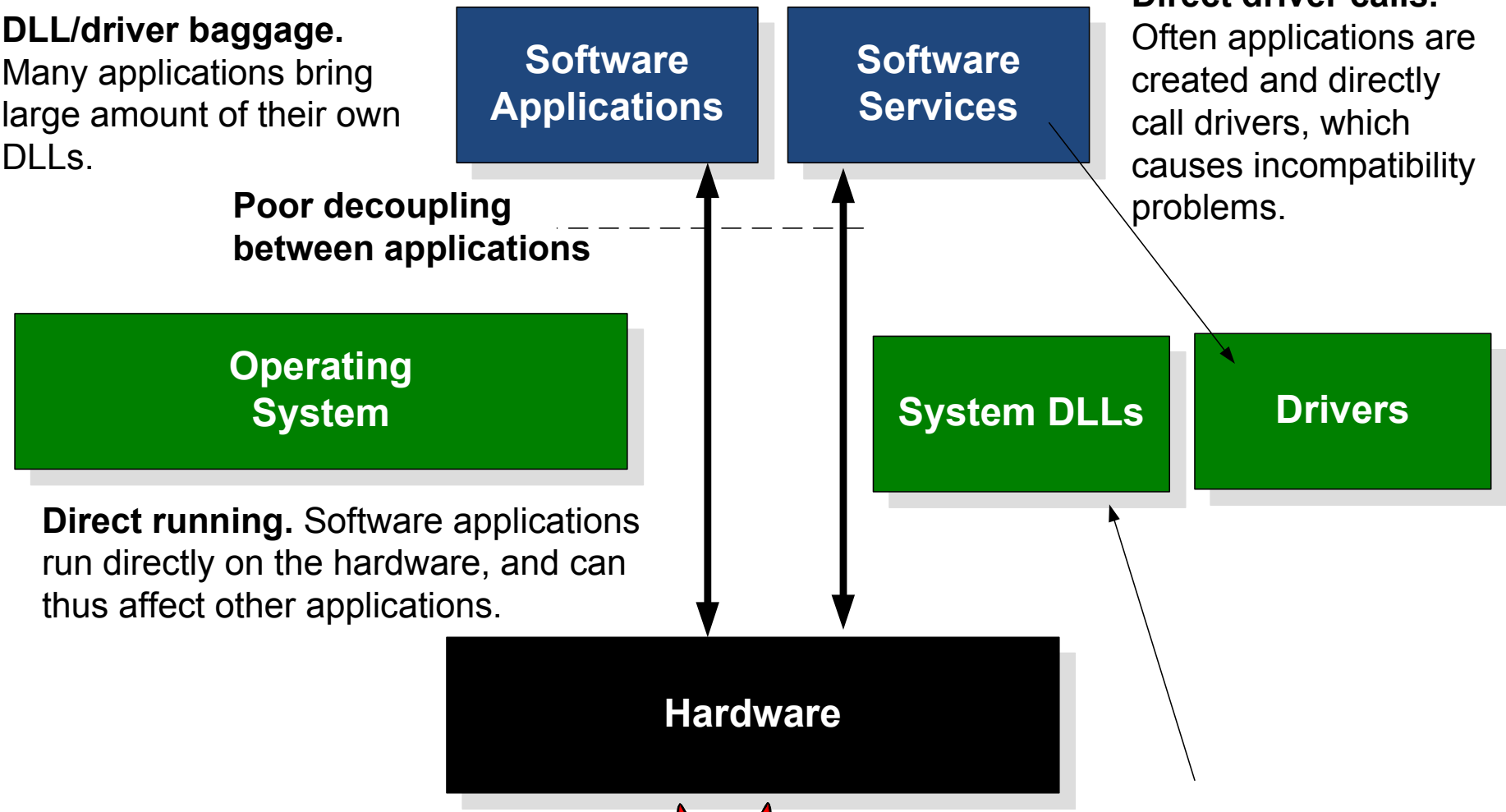
Binding to OS. Some applications are bound to the OS version, and do not work with other OSs or versions.

Bind to hardware. Often application programs are compiled to a certain hardware/architecture.

DLL/driver baggage. Many applications bring large amount of their own DLLs.

Direct driver calls. Often applications are created and directly call drivers, which causes incompatibility problems.



Direct running. Software applications run directly on the hardware, and can thus affect other applications.

DLL Hell. This is where DLL can be replaced with incorrect ones, such as being overwritten with malious ones or wrong version

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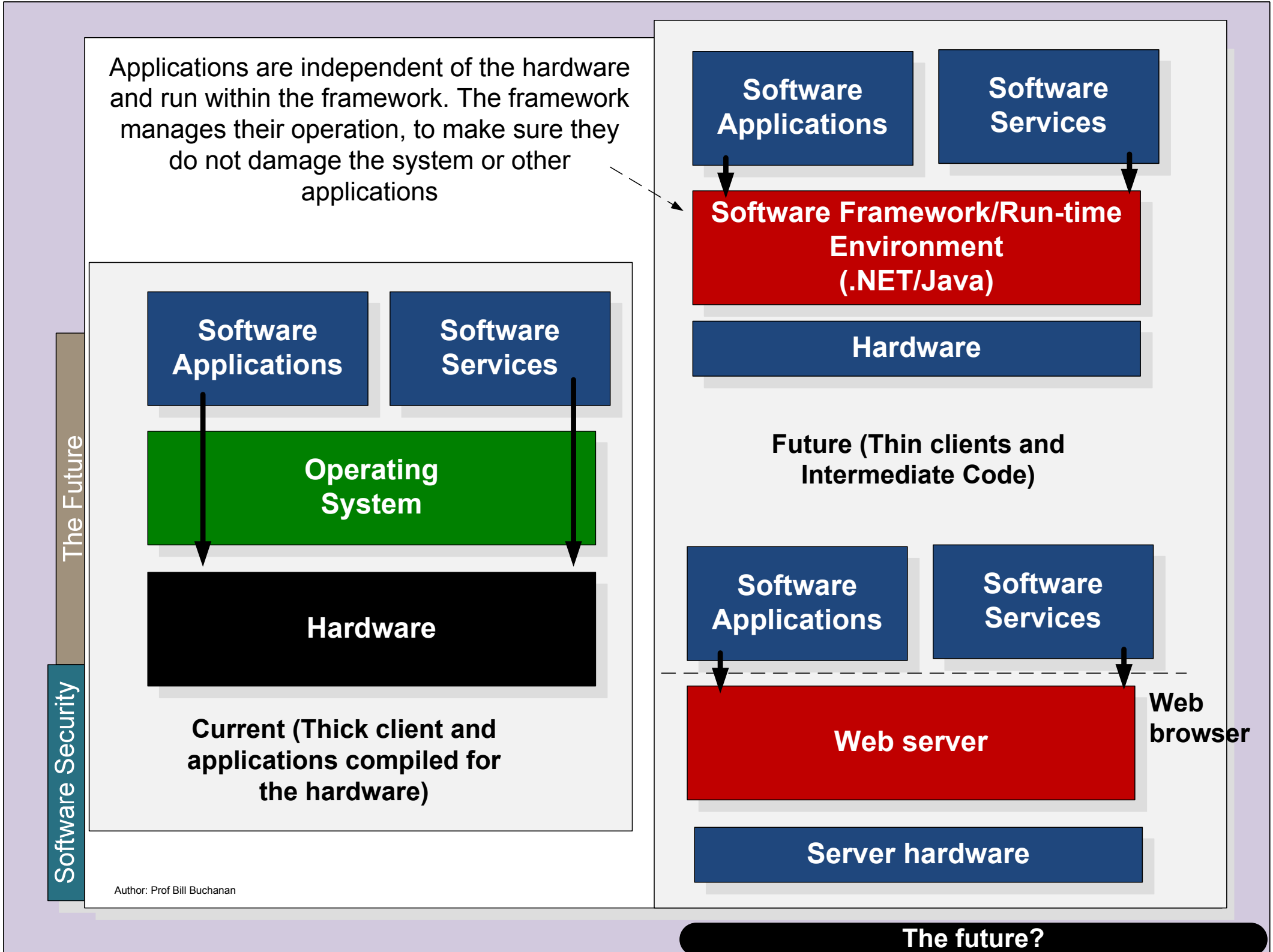
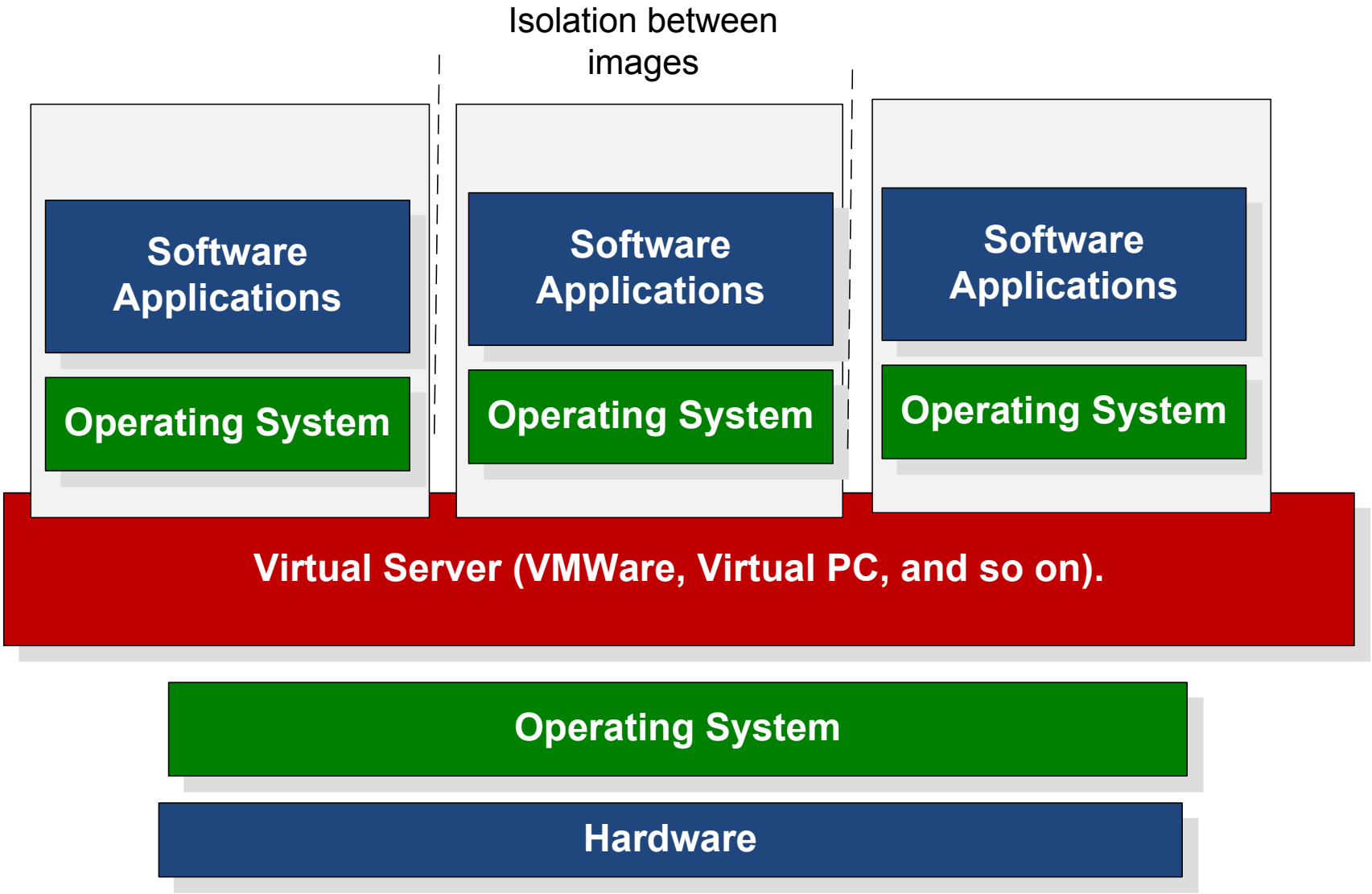

Applications are independent of the hardware and run within the framework. The framework manages their operation, to make sure they do not damage the system or other applications
Software Applications
Software Services
Operating System
Hardware
Current (Thick client and applications compiled for the hardware)
Software Applications
Software Services
Software Framework/Run-time Environment (.NET/Java)
Hardware
Future (Thin clients and Intermediate Code)
Software Applications
Software Services
Web server
Web browser
Server hardware
The Future
Software Security
Author: Prof Bill Buchanan
The future?



Virtualisation images allow multiple Oss to run on a single OS.

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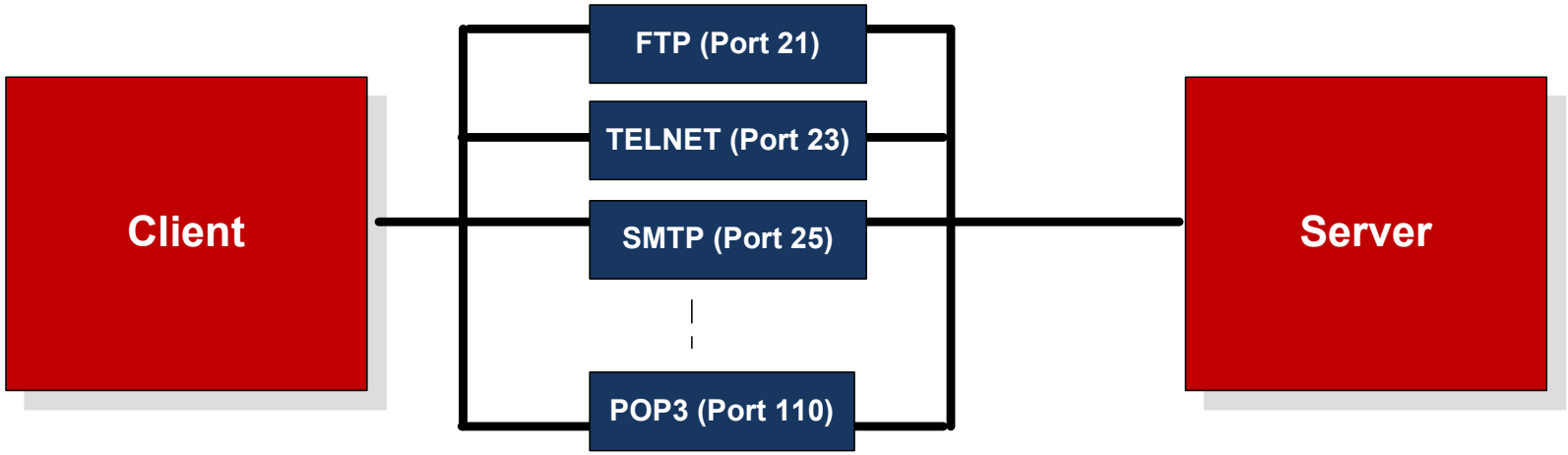
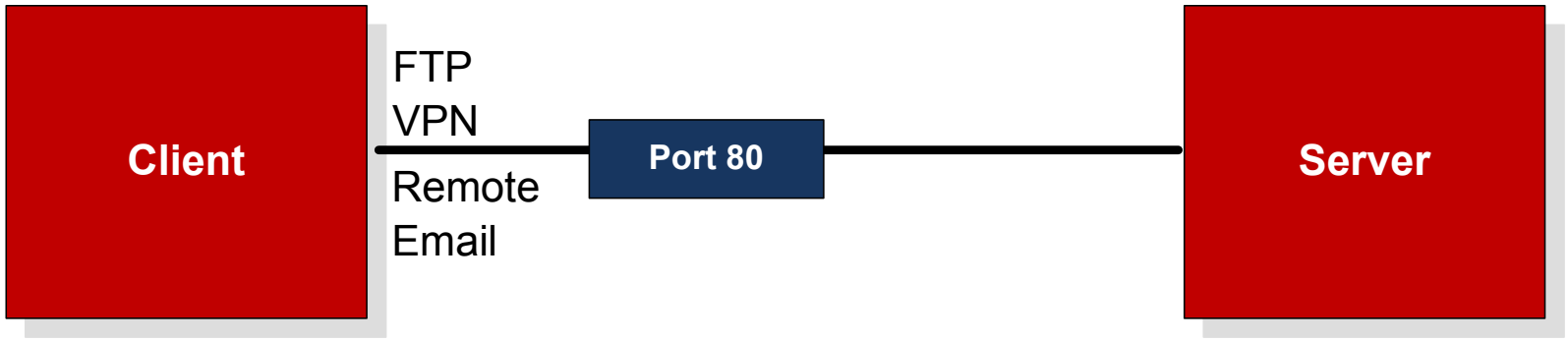


Applications use a wide range of TCP ports to communicate. Each of these ports could be blocked.



Applications communicate for a wide range of services through port 80 (Web port)… port 80 traffic is allowed through the firewall … but can cause security problems as the firewall cannot check the usage

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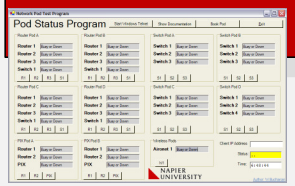
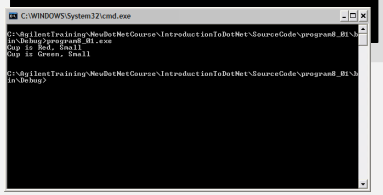
The Future

Integrated Programs (with logic, interface and data store in a Windows package)

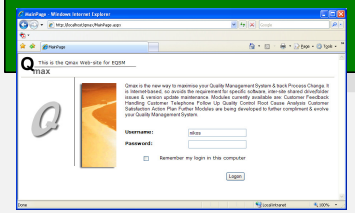


Integrated console program (with logic, interface and data store) in a console application)



Integrated mobile application (with logic, interface and data store) in a mobile application)

Integrated Web page (with logic, interface and data store in a Web package)



Windows interface

Console interface

Mobile interface

Web interface

User services

Business logic and data store can be shared between applications

Shared business logic

Business services

Shared data store

Data services

Software Security

Three-tiered architecture

Software Security

The Future - .NET?

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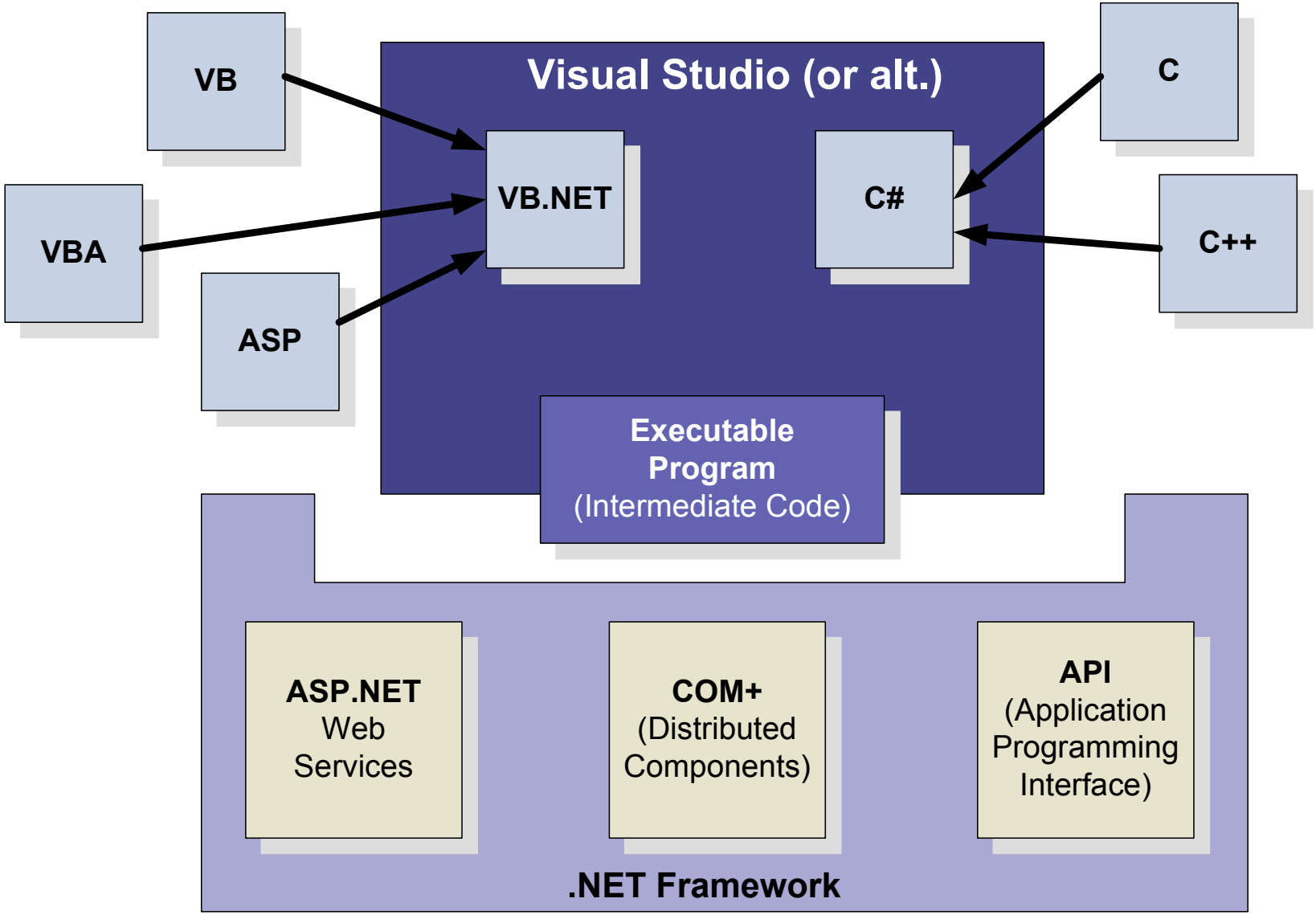

.NET Framework

Software Security

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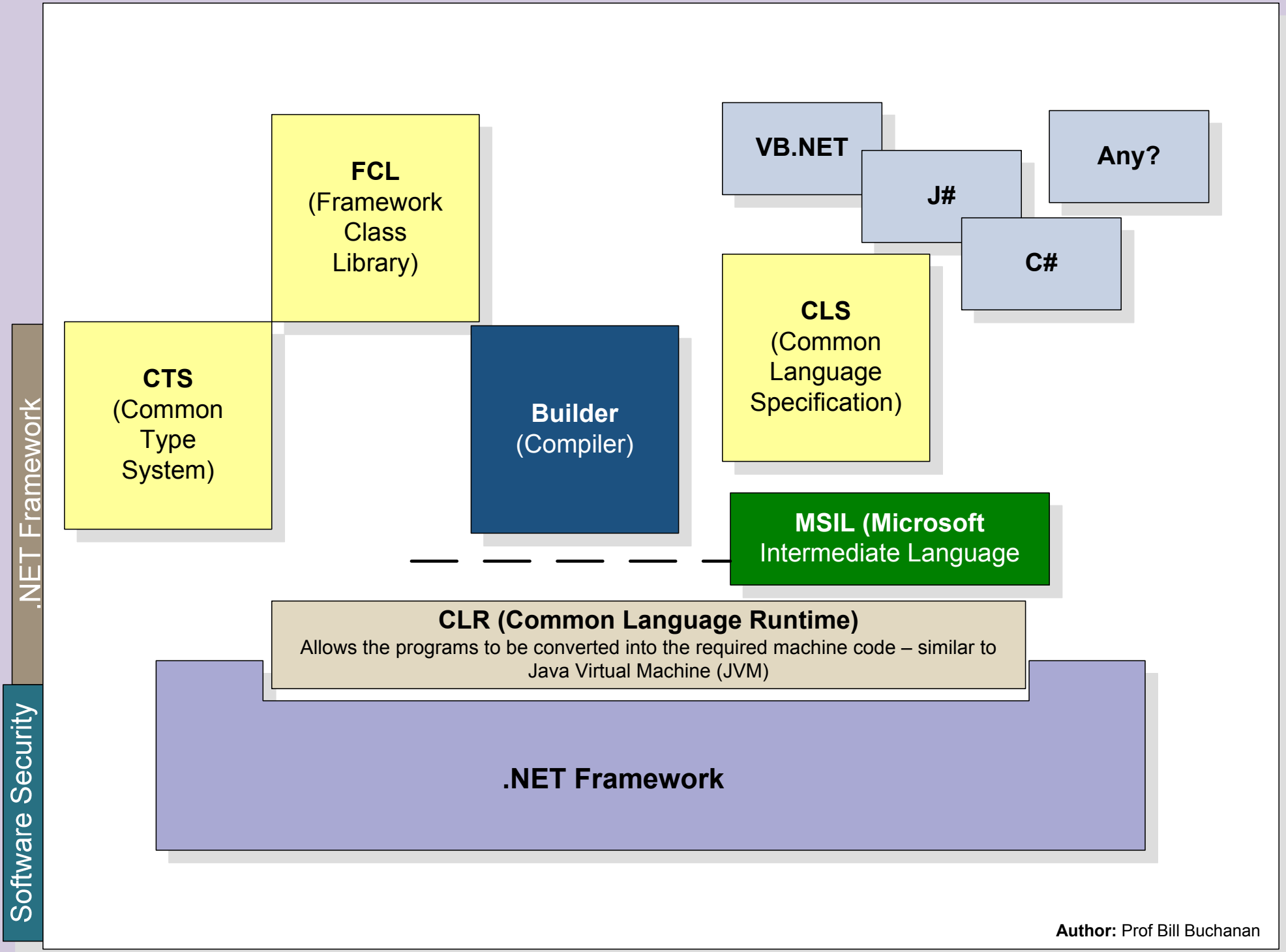

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```
 Volume in drive C has no label.
 Volume Serial Number is 1A83-0D9D

 Directory of C:\WINDOWS\Microsoft.NET\Framework\v1.1.4322

21/02/2003  08:24             7,680 Accessibility.dll
21/02/2003  06:00            98,304 alink.dll
20/02/2003  20:19            24,576 aspnet_filter.dll
20/02/2003  20:19           253,952 aspnet_isapi.dll
20/02/2003  20:19            40,960 aspnet_rc.dll
20/02/2003  20:09            77,824 CORPerfMonExt.dll
21/02/2003  11:21           626,688 cscomp.dll
21/02/2003  08:24            12,288 cscompmgd.dll
21/02/2003  08:24            33,792 CustomMarshalers.
29/07/2002  12:11           219,136 c_g18030.dll
21/02/2003  11:21           524,288 diasymreader.dll
19/03/2003  02:52           245,760 envdte.dll
20/02/2003  20:16           798,720 EventLogMessages.
20/02/2003  20:06           282,624 fusion.dll
21/02/2003  08:24             7,168 IEExecRemote.dll
21/02/2003  08:24            32,768 IEHost.dll
21/02/2003  08:24             4,608 IIEHost.dll
21/02/2003  08:25         1,564,672 mscorcfg.dll
20/02/2003  20:09            77,824 mscordbc.dll
20/02/2003  20:09           233,472 mscordbi.dll
20/02/2003  20:09            86,016 mscorie.dll
20/02/2003  20:06           311,296 mscorjit.dll
20/02/2003  20:09            98,304 mscorld.dll
21/02/2003  08:26         2,088,960 mscorlib.dll
20/02/2003  19:43           131,072 mscormmc.dll
20/02/2003  20:06            65,536 mscorpe.dll
20/02/2003  20:09           143,360 mscorrc.dll
20/02/2003  20:09            81,920 mscorsec.dll
20/02/2003  20:09            77,824 mscorsn.dll

         20/02/2003  20:07         2,494,464 mscorsvr.dll
```

.NET Program
Uses the framework for a whole host of classes: encryption, Web, networking, forms, etc.

.NET Framework

Mscorlib.dll
Arrays, File I/O, System, Security, Etc.

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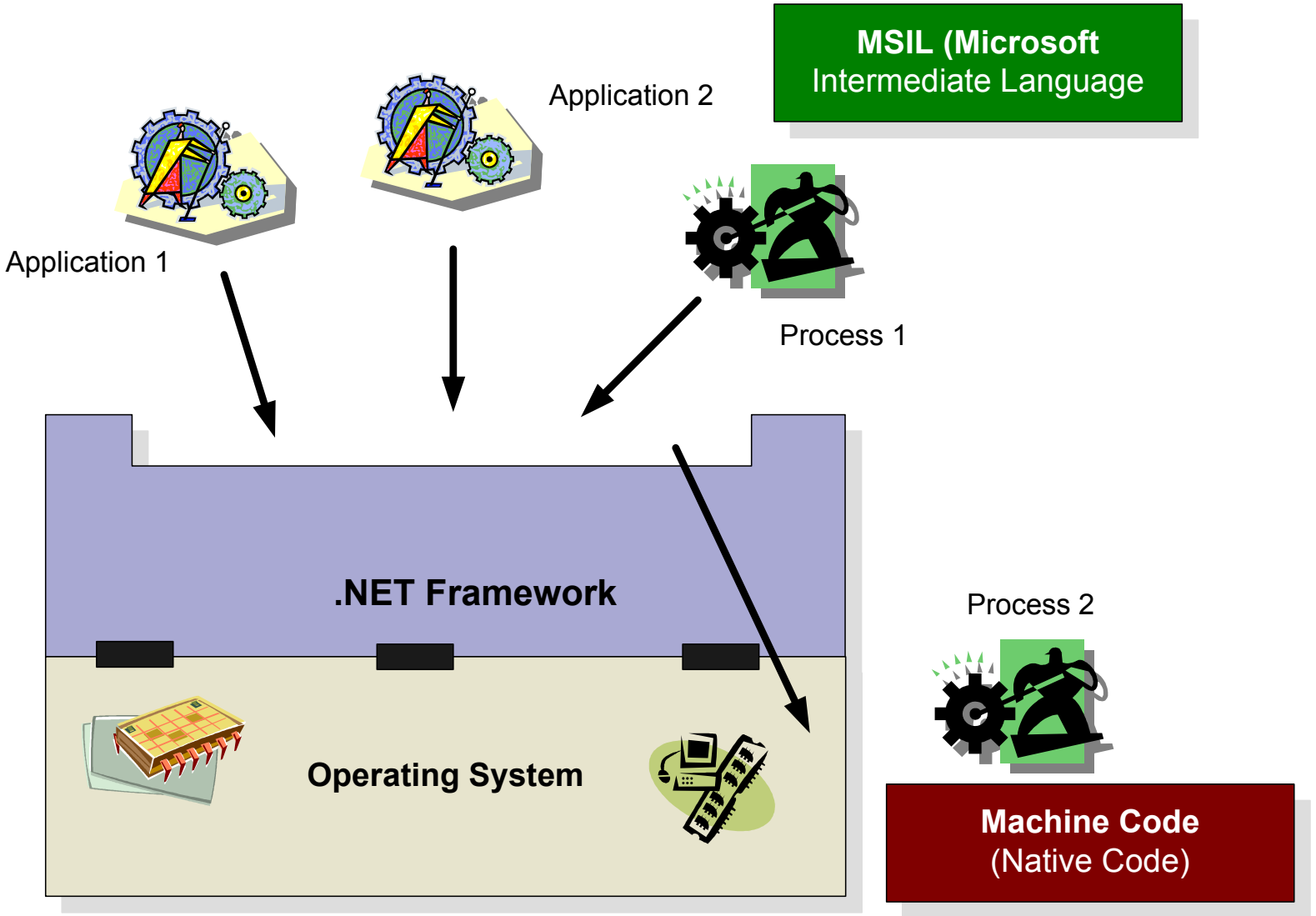

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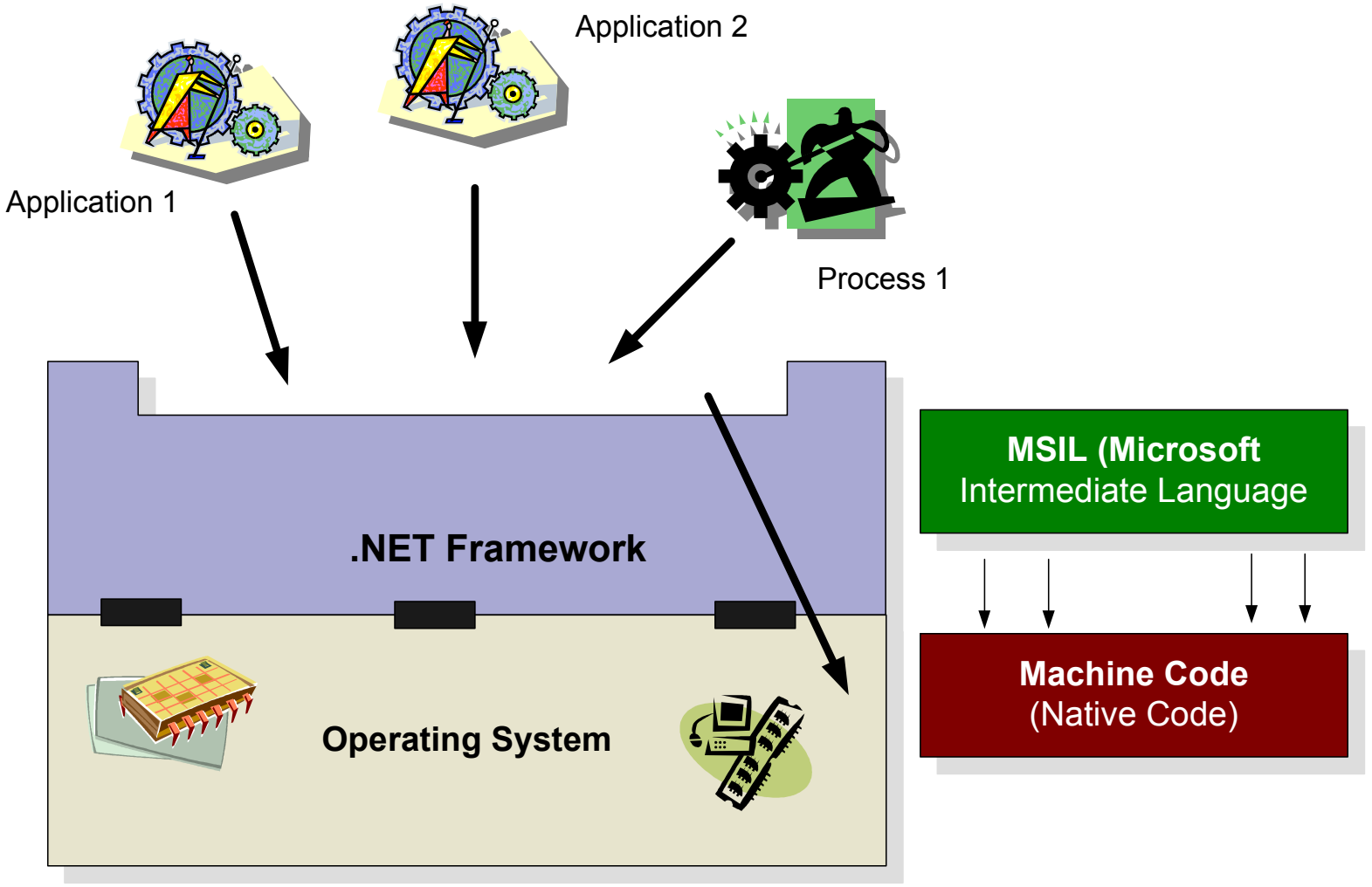

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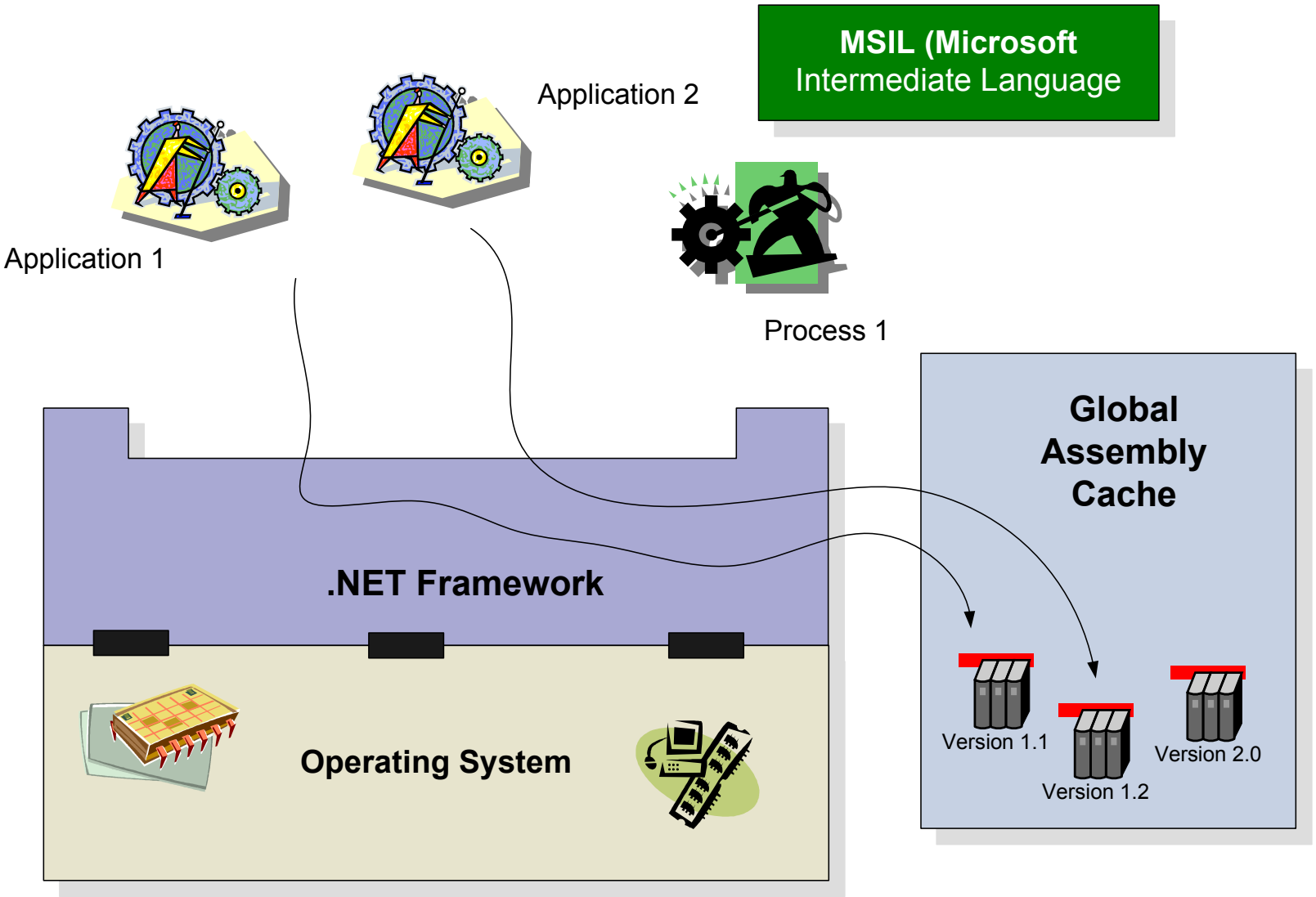

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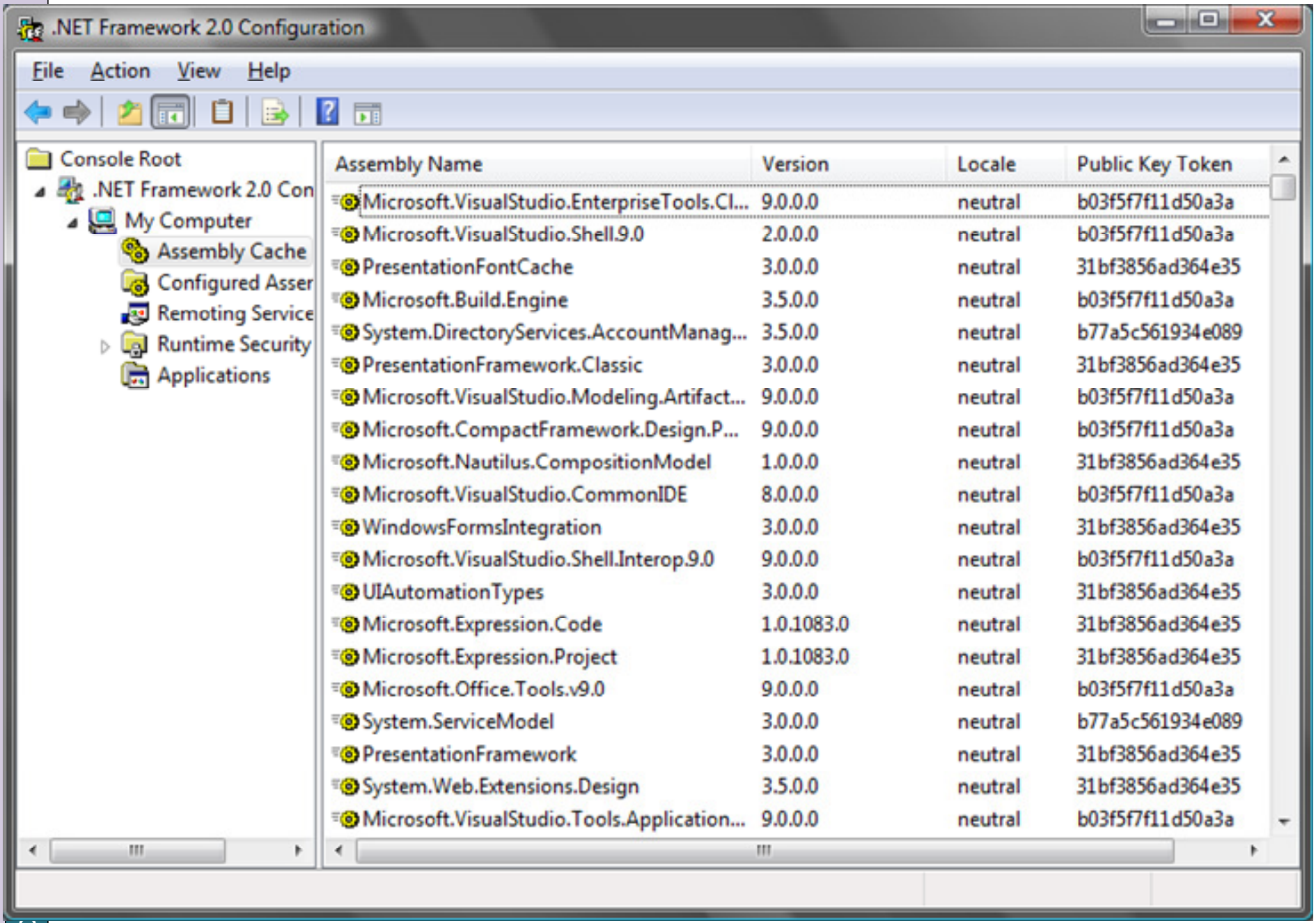
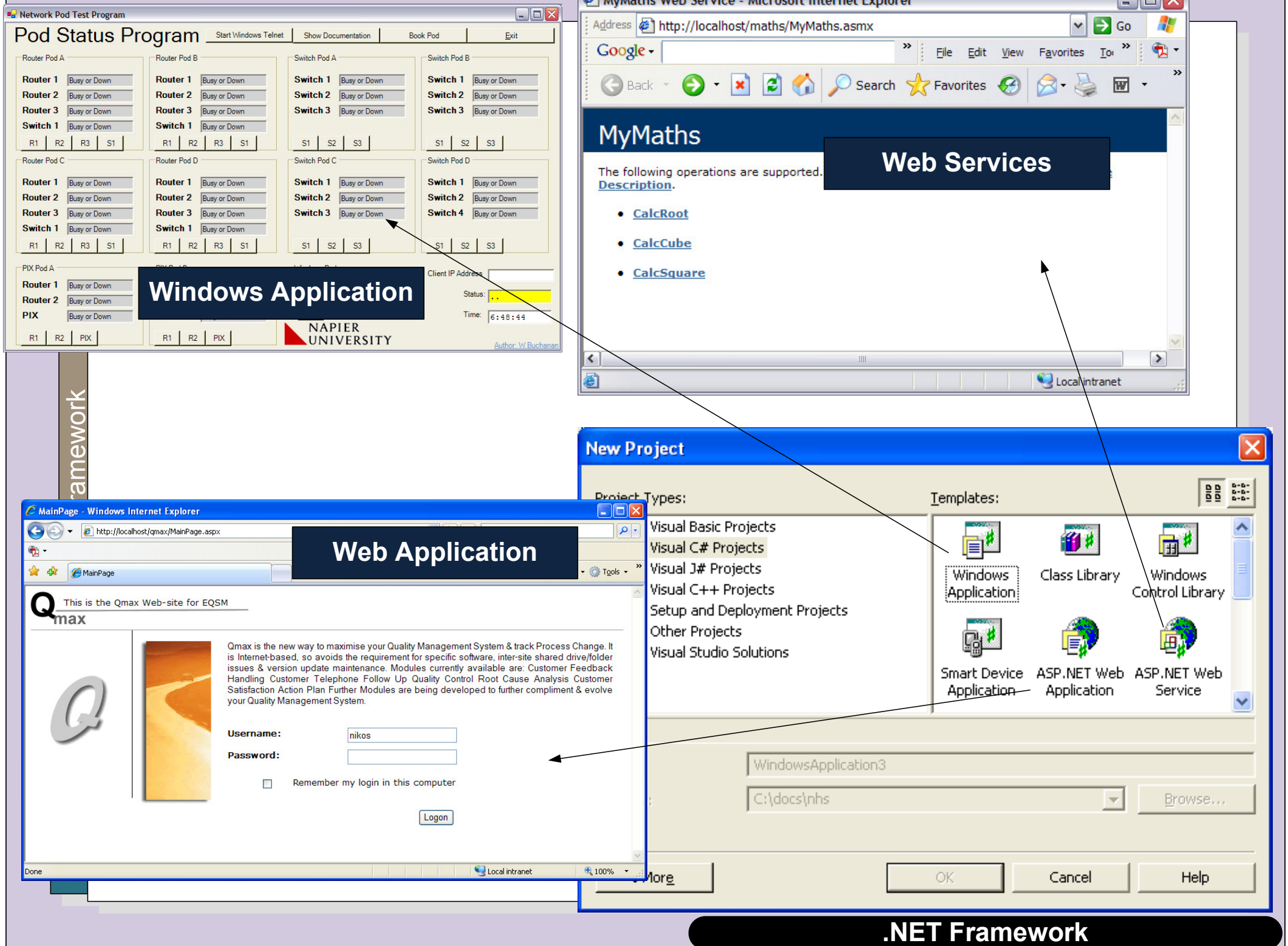
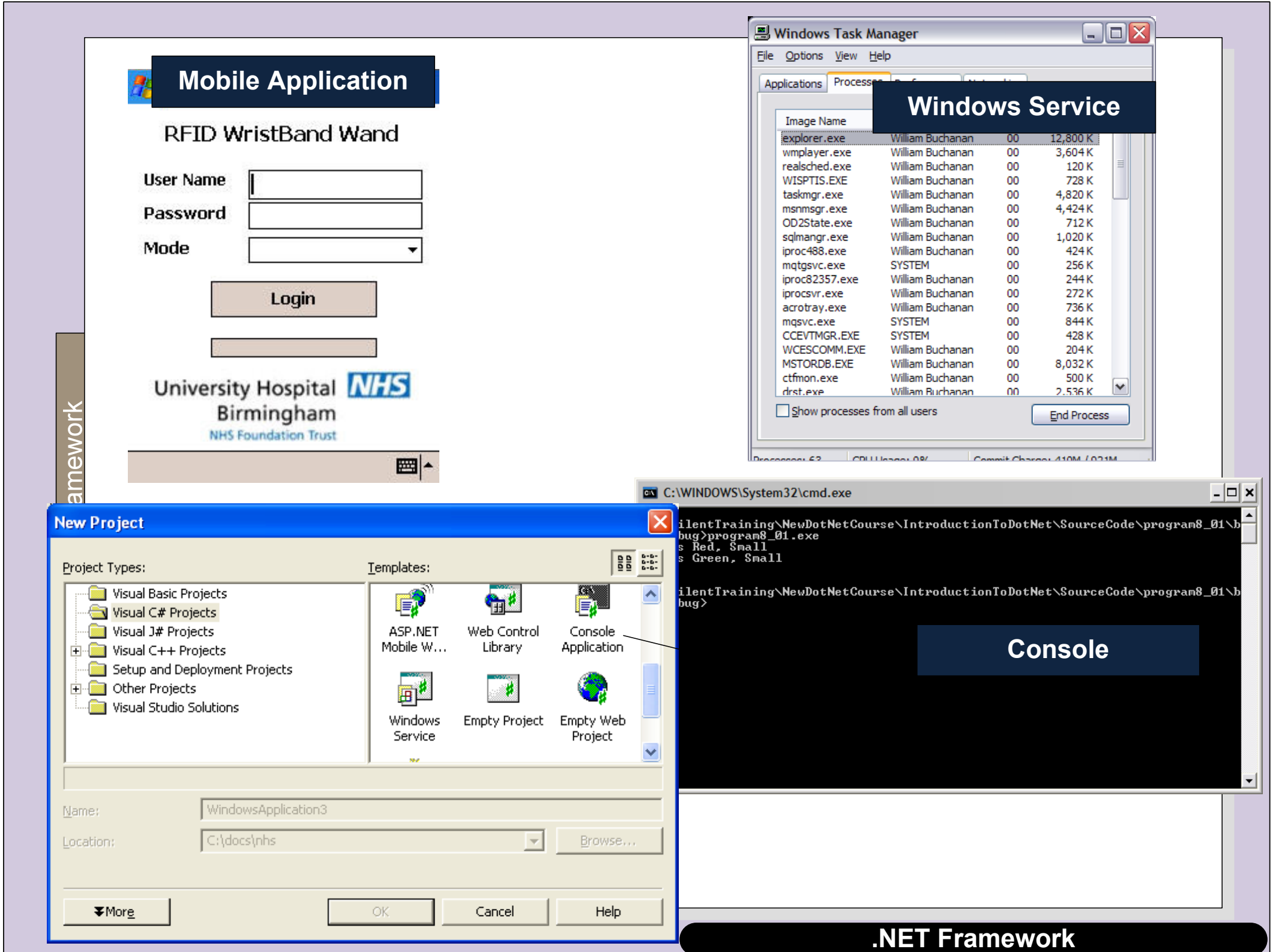
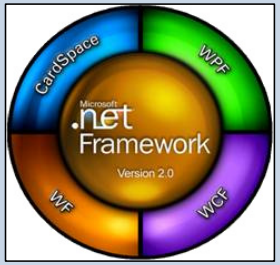

.NET Framework 2.0 Configuration
File Action View Help
Console Root
.NET Framework 2.0 Con
My Computer
Assembly Cache
Configured Asser
Remoting Service
Runtime Security
Applications
Assembly Name | Version | Locale | Public Key Token
Microsoft.VisualStudio.EnterpriseTools.Cl... | 9.0.0.0 | neutral | b03f5f7f11d50a3a
Microsoft.VisualStudio.Shell.9.0 | 2.0.0.0 | neutral | b03f5f7f11d50a3a
PresentationFontCache | 3.0.0.0 | neutral | 31bf3856ad364e35
Microsoft.Build.Engine | 3.5.0.0 | neutral | b03f5f7f11d50a3a
System.DirectoryServices.AccountManag... | 3.5.0.0 | neutral | b77a5c561934e089
PresentationFramework.Classic | 3.0.0.0 | neutral | 31bf3856ad364e35
Microsoft.VisualStudio.Modeling.Artifact... | 9.0.0.0 | neutral | b03f5f7f11d50a3a
Microsoft.CompactFramework.Design.P... | 9.0.0.0 | neutral | b03f5f7f11d50a3a
Microsoft.Nautilus.CompositionModel | 1.0.0.0 | neutral | 31bf3856ad364e35
Microsoft.VisualStudio.CommonIDE | 8.0.0.0 | neutral | b03f5f7f11d50a3a
WindowsFormsIntegration | 3.0.0.0 | neutral | 31bf3856ad364e35
Microsoft.VisualStudio.Shell.Interop.9.0 | 9.0.0.0 | neutral | b03f5f7f11d50a3a
UIAutomationTypes | 3.0.0.0 | neutral | 31bf3856ad364e35
Microsoft.Expression.Code | 1.0.1083.0 | neutral | 31bf3856ad364e35
Microsoft.Expression.Project | 1.0.1083.0 | neutral | 31bf3856ad364e35
Microsoft.Office.Tools.v9.0 | 9.0.0.0 | neutral | b03f5f7f11d50a3a
System.ServiceModel | 3.0.0.0 | neutral | b77a5c561934e089
PresentationFramework | 3.0.0.0 | neutral | 31bf3856ad364e35
System.Web.Extensions.Design | 3.5.0.0 | neutral | 31bf3856ad364e35
Microsoft.VisualStudio.Tools.Application... | 9.0.0.0 | neutral | b03f5f7f11d50a3a


Network Pod Test Program
Pod Status Program
Start Windows Telnet
Show Documentation
Book Pod
Exit
Router Pod A
Router Pod B
Switch Pod A
Switch Pod B
Router Pod C
Router Pod D
Switch Pod C
Switch Pod D
PIX Pod A
Busy or Down
Client IP Address
Status:
Time:
6:48:44
NAPIER UNIVERSITY
Author: W Buchanan
Windows Application
MyMaths Web Service - Microsoft Internet Explorer
http://localhost/maths/MyMaths.asmx
MyMaths
The following operations are supported.
Description.
CalcRoot
CalcCube
CalcSquare
Local intranet
Web Services
MainPage - Windows Internet Explorer
http://localhost/qmax/MainPage.aspx
Web Application
This is the Qmax Web-site for EQSM
Qmax is the new way to maximise your Quality Management System & track Process Change. It is Internet-based, so avoids the requirement for specific software, inter-site shared drive/folder issues & version update maintenance. Modules currently available are: Customer Feedback Handling Customer Telephone Follow Up Quality Control Root Cause Analysis Customer Satisfaction Action Plan Further Modules are being developed to further compliment & evolve your Quality Management System.
Username:
nikos
Password:
Remember my login in this computer
Logon
Done
Local intranet
100%
New Project
Project Types:
Visual Basic Projects
Visual C# Projects
Visual J# Projects
Visual C++ Projects
Setup and Deployment Projects
Other Projects
Visual Studio Solutions
Templates:
Windows Application
Class Library
Windows Control Library
Smart Device Application
ASP.NET Web Application
ASP.NET Web Service
WindowsApplication3
C:\docs\nhs
Browse...
More
OK
Cancel
Help
.NET Framework


Mobile Application
RFID WristBand Wand
User Name
Password
Mode
Login
University Hospital Birmingham
NHS Foundation Trust
Windows Task Manager
File Options View Help
Applications Processes
Image Name
explorer.exe William Buchanan 00 12,800 K
wmplayer.exe William Buchanan 00 3,604 K
realsched.exe William Buchanan 00 120 K
WISPTIS.EXE William Buchanan 00 728 K
taskmgr.exe William Buchanan 00 4,820 K
msnmsgr.exe William Buchanan 00 4,424 K
OD2State.exe William Buchanan 00 712 K
sqlmangr.exe William Buchanan 00 1,020 K
iproc488.exe William Buchanan 00 424 K
mqtgsvc.exe SYSTEM 00 256 K
iproc82357.exe William Buchanan 00 244 K
iprocsvr.exe William Buchanan 00 272 K
acrotray.exe William Buchanan 00 736 K
mqsvc.exe SYSTEM 00 844 K
CCEVTMGR.EXE SYSTEM 00 428 K
WCESCOMM.EXE William Buchanan 00 204 K
MSTORDB.EXE William Buchanan 00 8,032 K
ctfmon.exe William Buchanan 00 500 K
Show processes from all users
End Process
Windows Service
C:\WINDOWS\System32\cmd.exe
ilentTraining\NewDotNetCourse\IntroductionToDotNet\SourceCode\program8_01\b
bug>program8_01.exe
s Red, Small
s Green, Small
ilentTraining\NewDotNetCourse\IntroductionToDotNet\SourceCode\program8_01\b
bug>
Console
New Project
Project Types:
Templates:
Visual Basic Projects
Visual C# Projects
Visual J# Projects
Visual C++ Projects
Setup and Deployment Projects
Other Projects
Visual Studio Solutions
ASP.NET Mobile W...
Web Control Library
Console Application
Windows Service
Empty Project
Empty Web Project
Name: WindowsApplication3
Location: C:\docs\nhs
Browse...
More
OK
Cancel
Help
.NET Framework

.NET Framework Version 3.0 (Nov 2006, WinFX)

- Windows CardSpace
- Windows Presentation Foundation
- Windows Communication Foundation
- Windows Workflow Foundation



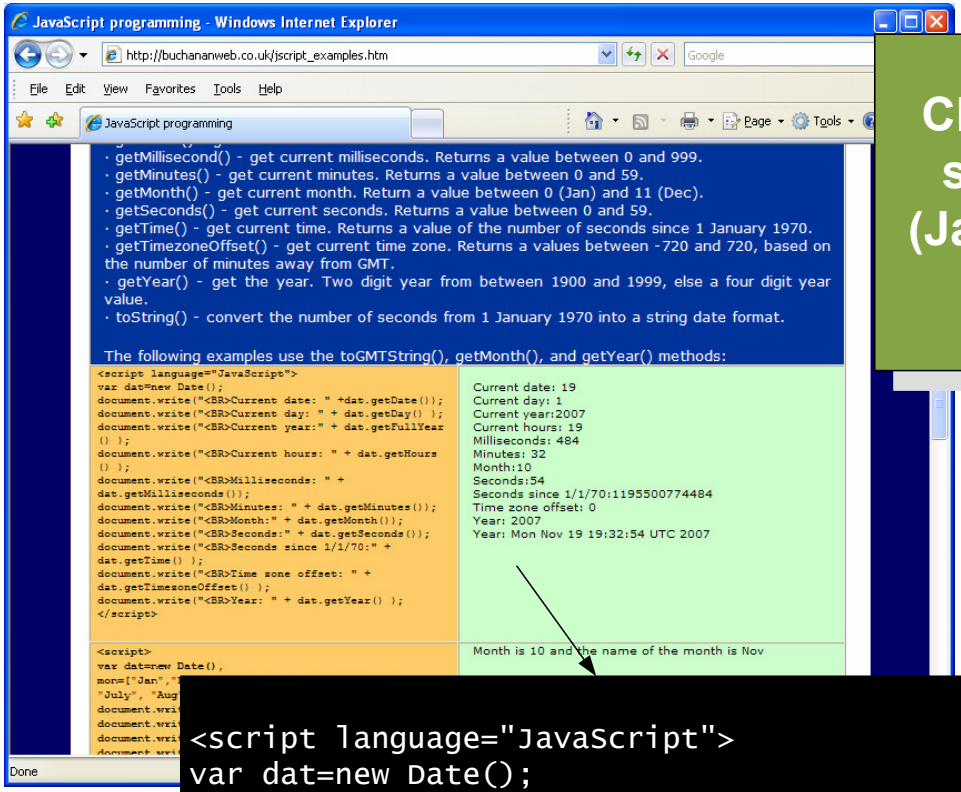
.NET Framework Version 2.0 (Nov 2005)

- Bug fixes.
- 64-bit support.
- Language support for generics.
- New controls.
- ASP.NET components.
- Bluetooth.

.NET Framework 1.0
Jan 2002

.NET Framework 1.1
(April 2003)

- Bug fixes.
- .NET Compact Framework



Client-side scripting (JavaScript/ Ajax)

Server-side Scripting (ASP/PHP)

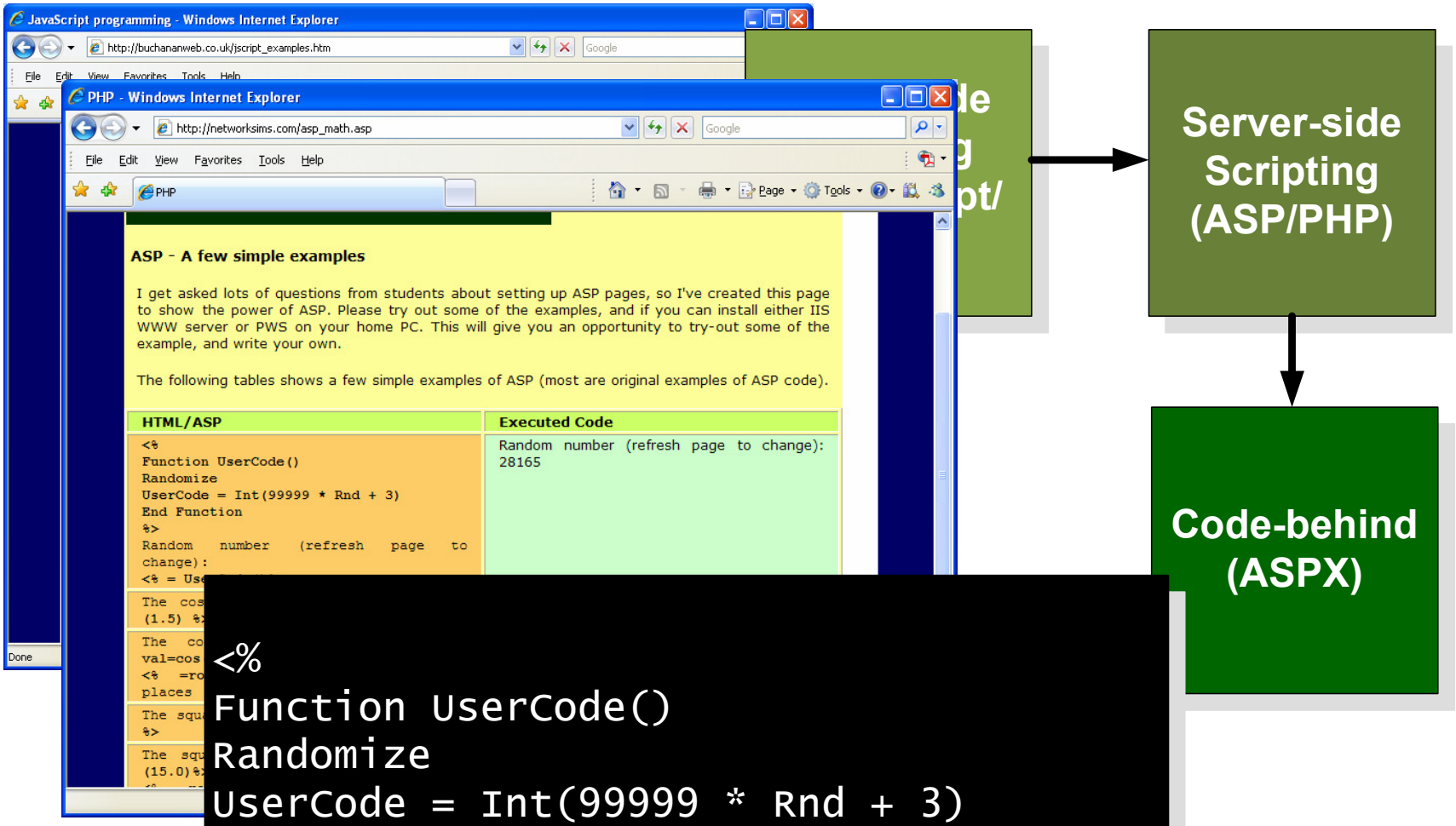
Code-behind (ASPX)

```
<script language="JavaScript">
var dat=new Date();
document.write("<BR>Current date: " +dat.getDate());
document.write("<BR>Current day: " + dat.getDay() );
document.write("<BR>Current year:" + dat.getFullYear() );
document.write("<BR>Current hours: " + dat.getHours() );
document.write("<BR>Milliseconds: " + dat.getMilliseconds());
document.write("<BR>Minutes: " + dat.getMinutes());
document.write("<BR>Month:" + dat.getMonth());
document.write("<BR>Seconds:" + dat.getSeconds());
document.write("<BR>Seconds since 1/1/70:" + dat.getTime() );
document.write("<BR>Time zone offset: " +
dat.getTimezoneOffset() );
document.write("<BR>Year: " + dat.getYear() );
</script>
```

.NET Framework

Software Security

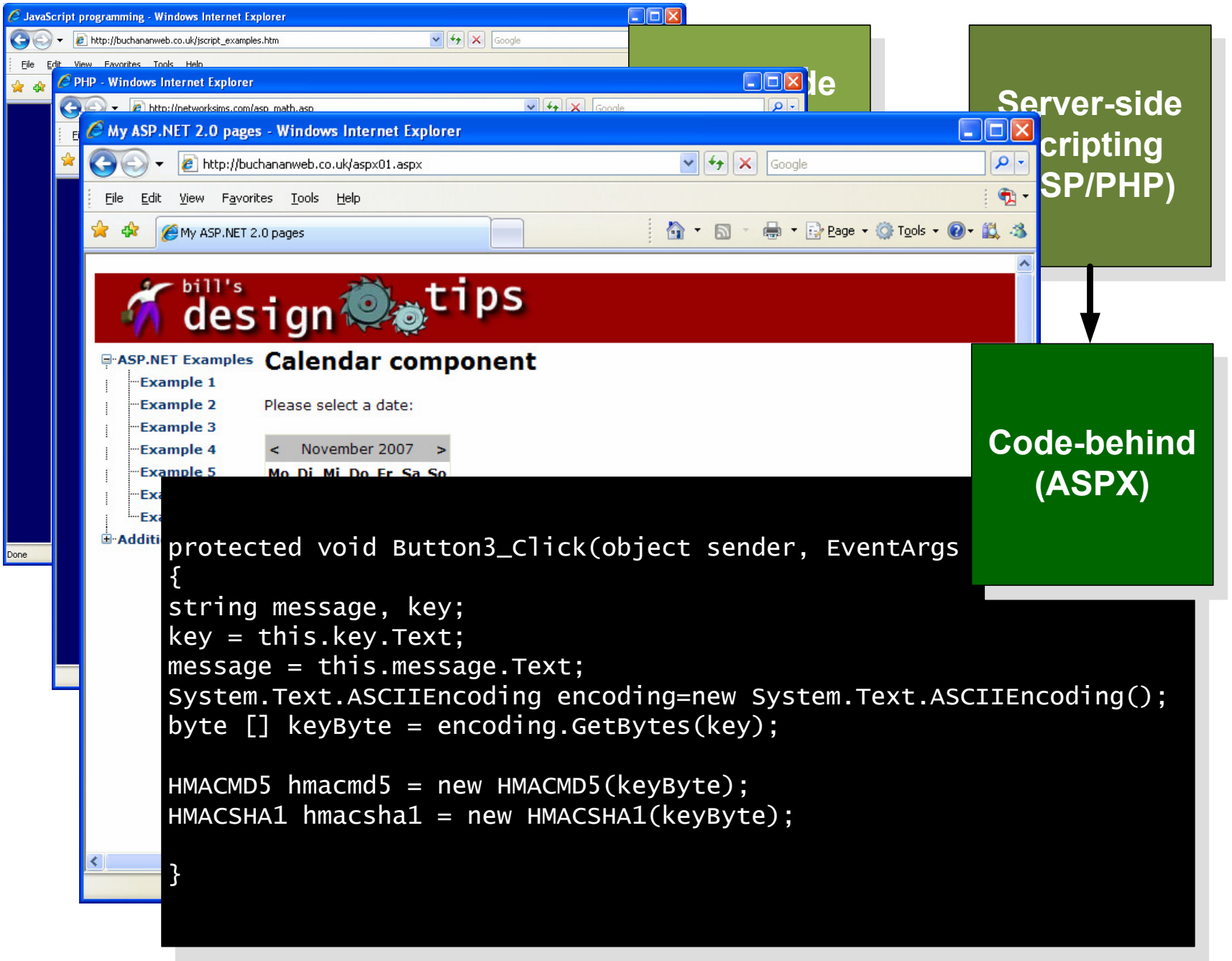
1st generation: JavaScript



.NET Framework

Software Security

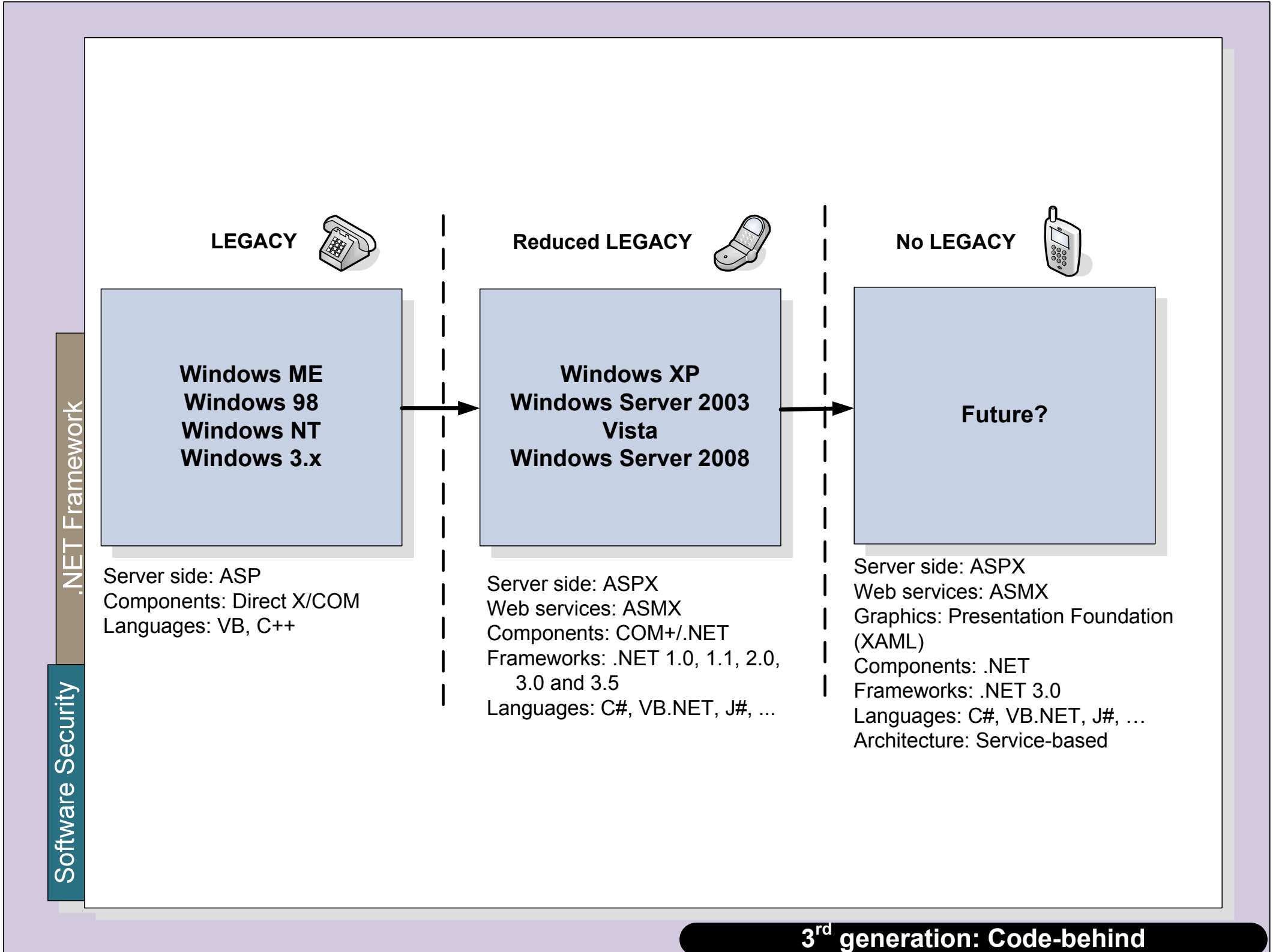
2nd generation: ASP/PHP/Integrated code



.NET Framework

Software Security

3rd generation: Code-behind


LEGACY
Reduced LEGACY
No LEGACY
Windows ME
Windows 98
Windows NT
Windows 3.x
Windows XP
Windows Server 2003
Vista
Windows Server 2008
Future?
Server side: ASP
Components: Direct X/COM
Languages: VB, C++
Server side: ASPX
Web services: ASMX
Components: COM+/.NET
Frameworks: .NET 1.0, 1.1, 2.0, 3.0 and 3.5
Languages: C#, VB.NET, J#, ...
Server side: ASPX
Web services: ASMX
Graphics: Presentation Foundation (XAML)
Components: .NET
Frameworks: .NET 3.0
Languages: C#, VB.NET, J#, …
Architecture: Service-based
.NET Framework
Software Security
3rd generation: Code-behind

Software Security

Keeping Code Secure

Author: Prof Bill Buchanan

Code security

Software Security

```
using System;

namespace simple
{
    class Class1
    {
        static void Main(string[] args)
        {
            string name;

            System.Console.Write("What is your name?");
            name=System.Console.ReadLine();
            System.Console.WriteLine("Hello " + name);
        }
    }
}
```

EXE

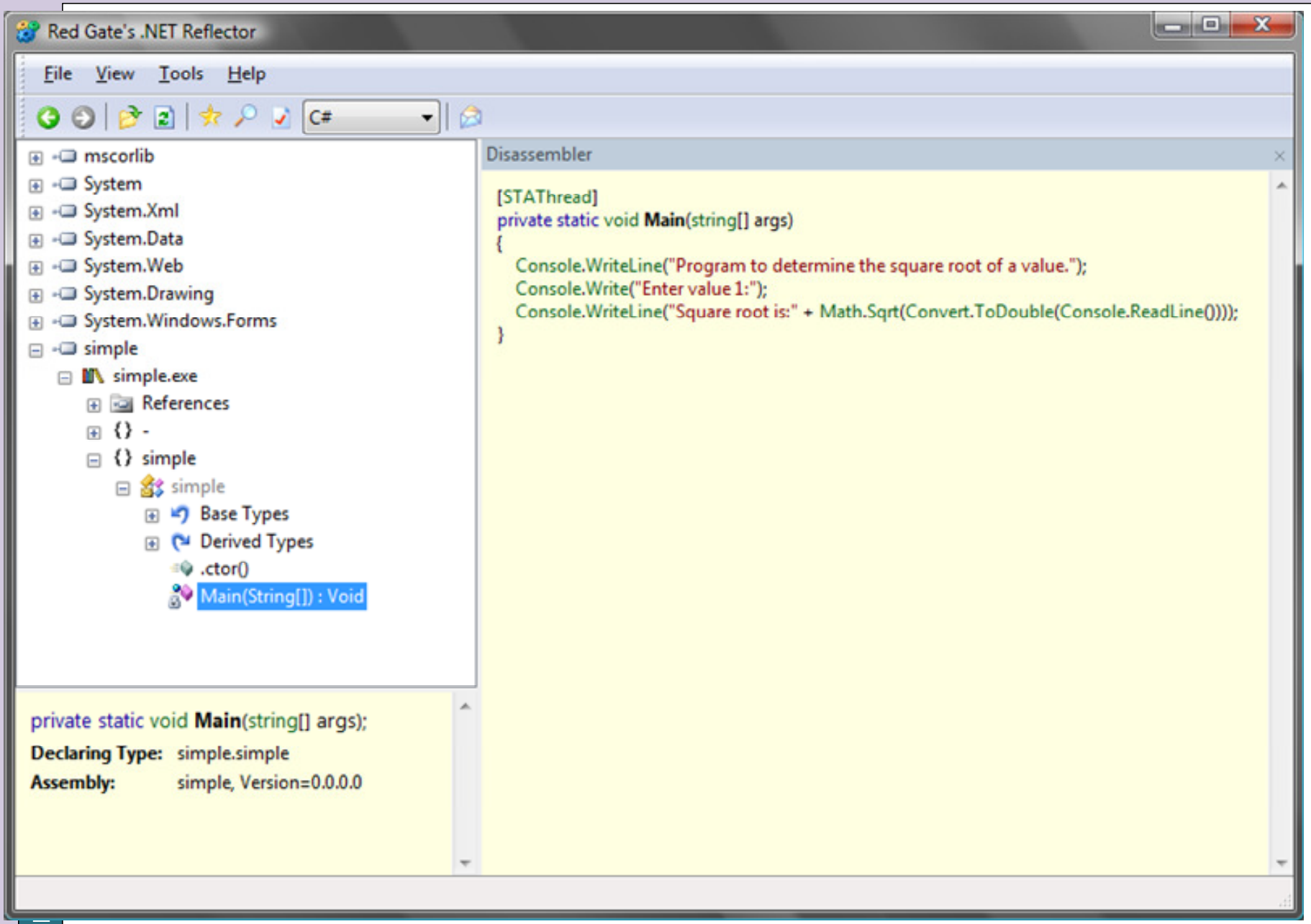
```
  .locals init ([0] string name)
  IL_0000:  ldstr      "What is your name\?"
  IL_0005:  call       void [mscorlib]System.Console::Write(string)
  IL_000a:  call       string [mscorlib]System.Console::ReadLine()
  IL_000f:  stloc.0
  IL_0010:  ldstr      "Hello "
  IL_0015:  ldloc.0
  IL_0016:  call       string [mscorlib]System.String::Concat(string,
                                                              string)
  IL_001b:  call       void [mscorlib]System.Console::WriteLine(string)
  IL_0020:  ret
} // end of method Class1::Main
```

Code to EXE

```
F:\docs\src\simple\test>dir
 Volume in drive F has no label.
 Volume Serial Number is 2886-0553

 Directory of F:\docs\src\simple\test

25/07/2008  01:20    <DIR>          .
25/07/2008  01:20    <DIR>          ..
28/01/2007  17:06               437 simple.cs
               1 File(s)            437 bytes
               2 Dir(s)  113,418,530,816 bytes free

F:\docs\src\simple\test>csc simple.cs
Microsoft (R) Visual C# 2008 Compiler version 3.5.21022.8
for Microsoft (R) .NET Framework version 3.5
Copyright (C) Microsoft Corporation. All rights reserved.


F:\docs\src\simple\test>dir
 Volume in drive F has no label.
 Volume Serial Number is 2886-0553

 Directory of F:\docs\src\simple\test

15/09/2008  16:37    <DIR>          .
15/09/2008  16:37    <DIR>          ..
28/01/2007  17:06               437 simple.cs
15/09/2008  16:37             4,096 simple.exe
               2 File(s)          4,533 bytes
               2 Dir(s)  113,418,526,720 bytes free

F:\docs\src\simple\test>simple
Program to determine the square root of a value.
Enter value 1:9
Square root is:3
```

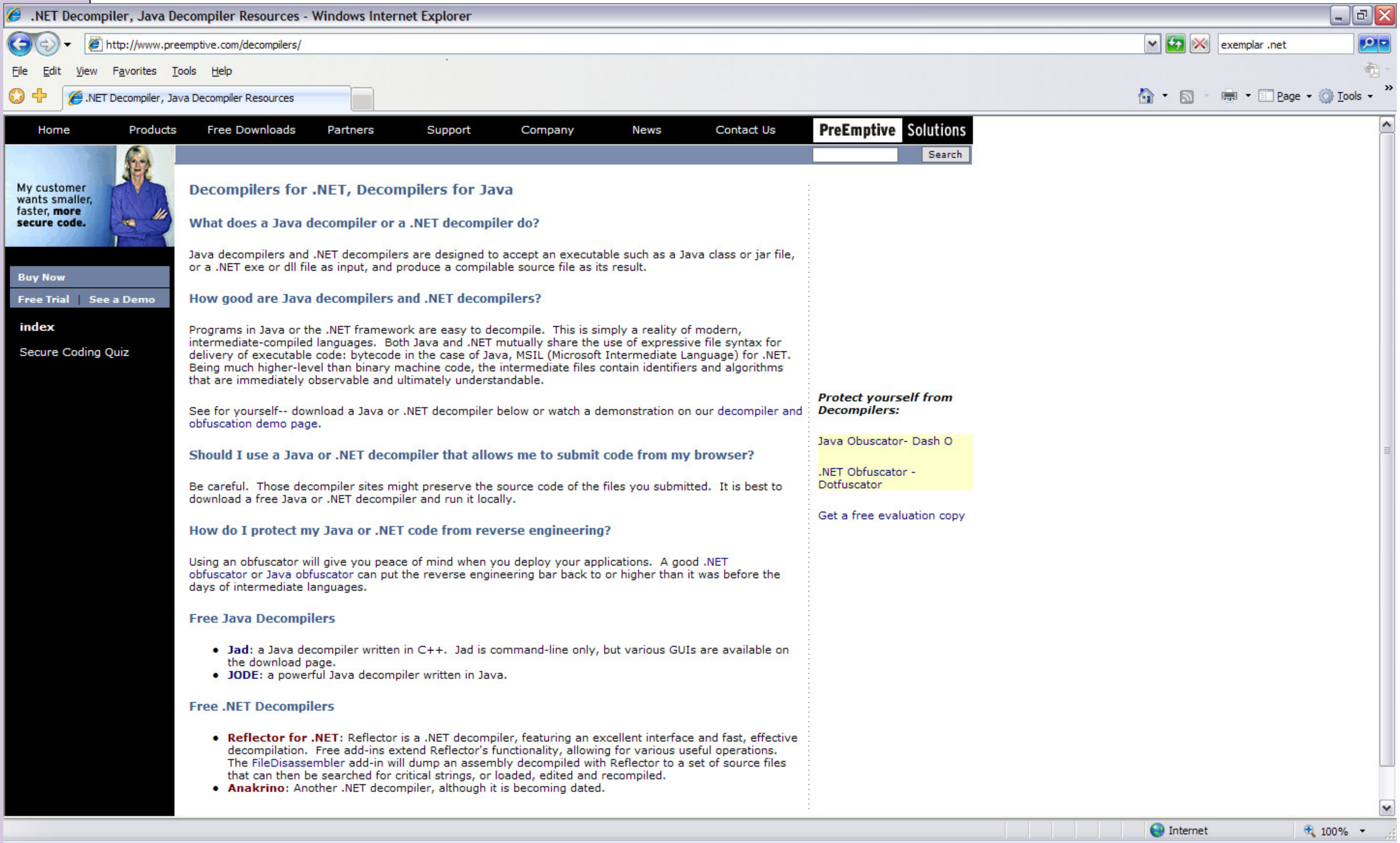
Run program

```
F:\docs\src\simple\test>exemplar simple.exe > list.cs

F:\docs\src\simple\test>dir
 Volume in drive F has no label.
 Volume Serial Number is 2886-0553

 Directory of F:\docs\src\simple\test

15/09/2008  16:38    <DIR>          .
15/09/2008  16:38    <DIR>          ..
15/09/2008  16:38               451 list.cs
28/01/2007  17:06               437 simple.cs
15/09/2008  16:37             4,096 simple.exe

F:\docs\src\simple\test>type list.cs
namespace simple {
        class simple {

                [STAThread]
                private static void Main(string[] args) {
                        double local0;
                        double local1;

                        Console.WriteLine("Program to determine the
square root of a value.");
                        Console.Write("Enter value 1:");
                        local0 = Convert.ToDouble(Console.ReadLine());
                        local1 = Math.Sqrt(local0);
                        Console.WriteLine("Square root is:" + local1);
                }

                public simple() : base() {
                }
        }
}
```



Softwa

Disassembler


.NET Decompiler, Java Decompiler Resources - Windows Internet Explorer

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Secure Coding Quiz

Decompilers for .NET, Decompilers for Java

What does a Java decompiler or a .NET decompiler do?

Java decompilers and .NET decompilers are designed to accept an executable such as a Java class or jar file, or a .NET exe or dll file as input, and produce a compilable source file as its result.

How good are Java decompilers and .NET decompilers?

Programs in Java or the .NET framework are easy to decompile. This is simply a reality of modern, intermediate-compiled languages. Both Java and .NET mutually share the use of expressive file syntax for delivery of executable code: bytecode in the case of Java, MSIL (Microsoft Intermediate Language) for .NET. Being much higher-level than binary machine code, the intermediate files contain identifiers and algorithms that are immediately observable and ultimately understandable.

See for yourself-- download a Java or .NET decompiler below or watch a demonstration on our decompiler and obfuscation demo page.

Should I use a Java or .NET decompiler that allows me to submit code from my browser?

Be careful. Those decompiler sites might preserve the source code of the files you submitted. It is best to download a free Java or .NET decompiler and run it locally.

How do I protect my Java or .NET code from reverse engineering?

Using an obfuscator will give you peace of mind when you deploy your applications. A good .NET obfuscator or Java obfuscator can put the reverse engineering bar back to or higher than it was before the days of intermediate languages.

Free Java Decompilers

- **Jad**: a Java decompiler written in C++. Jad is command-line only, but various GUIs are available on the download page.
- **JODE**: a powerful Java decompiler written in Java.

Free .NET Decompilers

- **Reflector for .NET**: Reflector is a .NET decompiler, featuring an excellent interface and fast, effective decompilation. Free add-ins extend Reflector's functionality, allowing for various useful operations. The FileDisassembler add-in will dump an assembly decompiled with Reflector to a set of source files that can then be searched for critical strings, or loaded, edited and recompiled.
- **Anakrino**: Another .NET decompiler, although it is becoming dated.

Protect yourself from Decompilers:

Java Obuscator- Dash O

.NET Obfuscator - Dotfuscator

Get a free evaluation copy

Internet | 100%

Softw

Dotfuscator

Software Security

Obfuscation

Author: Prof Bill Buchanan

```
#include <stdio.h> main(t,_,a)char
*a;{return!0<t?t<3?main(-79,-13,a+main(-87,1-_,
main(-86,0,a+1)+a)):1,t<_?main(t+1,_,a):3,main(-
94,-27+t,a)&&t==2?_<13? main(2,_+1,"%s %d %d\
n"):9:16:t<0?t<-72?main(_,t, "@n'+,#'/*{}w+/
w#cdnr/+,{}r/*de}+,/*{*+,/w{%+,/w#q#n+,/#{l,+,/
n{n+,/+#n+,/#\ ;#q#n+,/+k#;*+,/'r :'d*'3,}{w+K
w'K:'+}e#';dq#'l \ q#'+d'K#!/
+k#;q#'r}eKK#}w'r}eKK{nl]'/#;#q#n'){)#}w'){){nl]'/
+#n';d}rw' i;# \ ){nl]!/n{n#'; r{#w'r nc{nl]'/
#{l,+'K {rw' iK{;[{nl]'/w#q#n'wk nw' \
iwk{KK{nl]!/w{%'l##w#' i; :{nl]'/
*{q#'ld;r'}{nlwb!/*de}'c \ ;;{nl'-{}rw]'/
+,}##'*}#nc,',#nw]'/+kd'+e}+;#'rdq#w! nr'/ ')
}+}{rl#'{n' ')# \ }'+}##(!!/") :t<-
50?_==*a?putchar(31[a]):main(-
65,_,a+1):main((*a=='/')+t,_,a+1)
:0<t?main(2,2,"%s"):*a=='/'||main(0,main(-61,*a,
"!ek;dc i@bK'(q)-[w]*%n+r3#l,{}:\nuwloca-O;m
.vpbks,fxntdCeghiry"),a+1);}
```

What does this program do?

On the first day of Christmas,
my true love sent to me
A partridge in a pear tree.
On the second day of Christmas,
my true love sent to me
Two turtle doves,
And a partridge in a pear tree….

Elimination of all whitespace.
Use of conditional and list expression instead of the more familiar if-then-else statement and statement blocks.
A simple encoding of the poem's strings.
Encoding of multiple "functions" into the single function main

Identifier Renaming

This involves renaming all the classes, methods, and fields to short names, or even non-printing names

Before

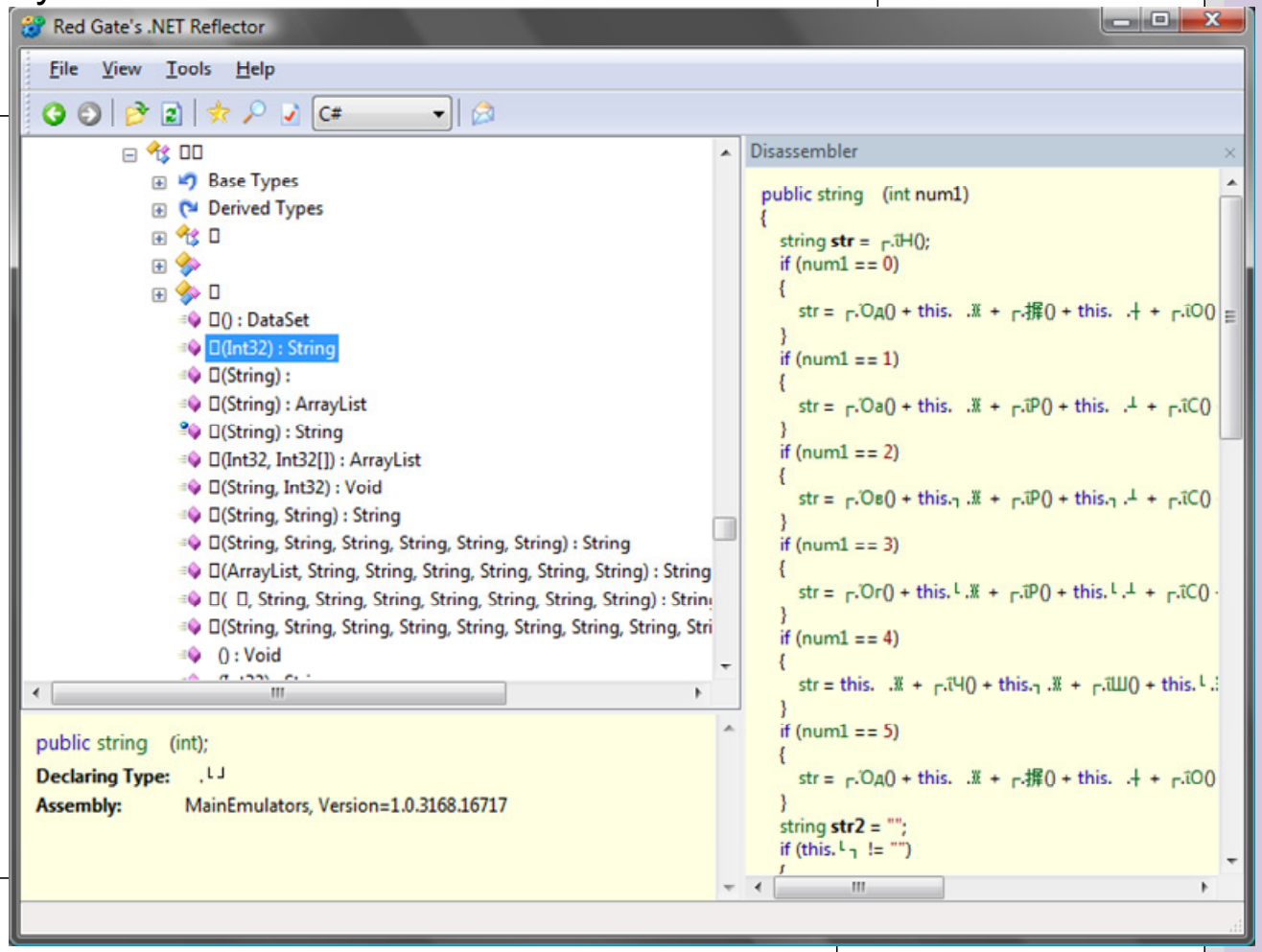
```
namespace Emulator {
        public class gen_switch {
          public ArrayList32logging59
          public ArrayList32level5Commands59
          public string32level5Name59
          public ArrayList32level69Commands59
          public string32level69Name59
          public ArrayList32level39Commands59
          public string32level39Name59
          public ArrayList32level16Commands59
          public string32level16Name59
          public ArrayList32level17Commands59
          public string32level17Name59
          public ArrayList32level25Commands59
          public string32level25Name59
```

After

```
C:\netwsims>exemplar mainemulators.exe
namespace ☺ {
        public class ☺ {
                public ArrayList32☺59
                public ArrayList32☻59
                public string32☺59
                public ArrayList32♥59
                public string32☻59
                public ArrayList32♦59
                public string32♥59
                public ArrayList32♣59
                public string32♦59
                public ArrayList32♠59
                public string32♣59
                public ArrayList32♫59
```

Author: Prof Bill Buchanan

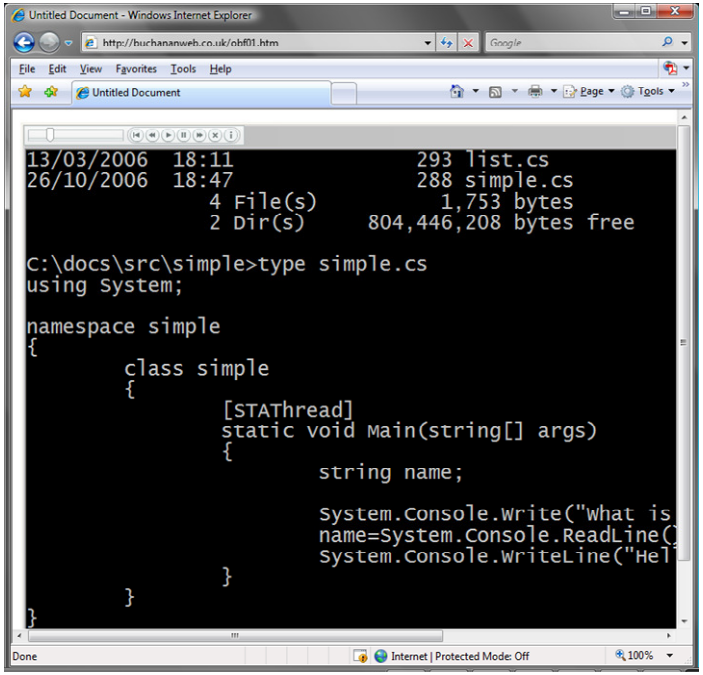
String Encryption
A standard way that many “crackers” work is to search for key strings within a program. String encryption is used to encrypt strings through an encryption method, so that they cannot be search for.

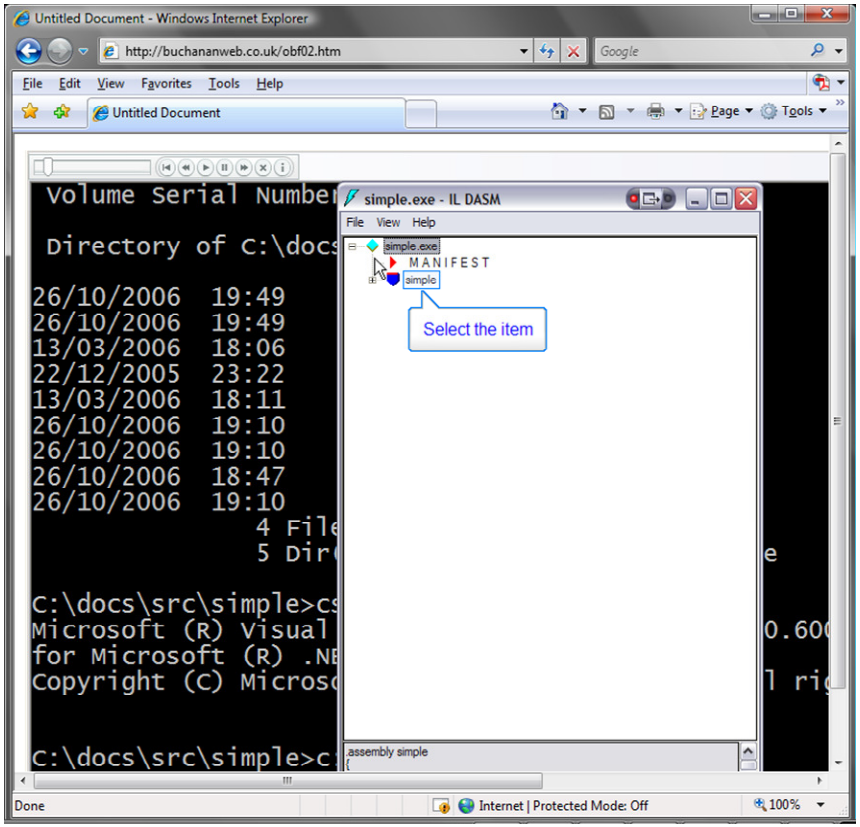


Flow obfuscation
This involves scrambling the flow of the program, so that it is difficult to determine its actual operation.

View demo of Obfuscation

http://buchananweb.co.uk/obf01.htm





View demo of Obfuscation2

http://buchananweb.co.uk/obf02.htm

```
using System;

namespace simple
{
    class Class1
    {
        static void Main(string[] args)
        {
            string name;

            System.Console.Write("What is your name?");
            name=System.Console.ReadLine();
            System.Console.WriteLine("Hello " + name);
        }
    }
}
```

EXE

```
  .locals init ([0] string name)
  IL_0000:  ldstr      "What is your name\?"
  IL_0005:  call       void [mscorlib]System.Console::Write(string)
  IL_000a:  call       string [mscorlib]System.Console::ReadLine()
  IL_000f:  stloc.0
  IL_0010:  ldstr      "Hello "
  IL_0015:  ldloc.0
  IL_0016:  call       string [mscorlib]System.String::Concat(string,
                                                              string)
  IL_001b:  call       void [mscorlib]System.Console::WriteLine(string)
  IL_0020:  ret
} // end of method Class1::Main
```

Class1::Main : void(string[])

```
.method private hidebysig static void  Main(string[] args) cil managed
{
  .entrypoint
  .custom instance void [mscorlib]System.STAThreadAttribute::.ctor() = ( 01
  // Code size       33 (0x21)
  .maxstack  2
  .locals init ([0] string name)
  IL_0000:  ldstr      "What is your name\?"
  IL_0005:  call       void [mscorlib]System.Console::Write(string)
  IL_000a:  call       string [mscorlib]System.Console::ReadLine()
  IL_000f:  stloc.0
  IL_0010:  ldstr      "Hello "
  IL_0015:  ldloc.0
  IL_0016:  call       string [mscorlib]System.String::Concat(string,
                                                              string)
  IL_001b:  call       void [mscorlib]System.Console::WriteLine(string)
  IL_0020:  ret
} // end of method Class1::Main
```

Variables have been renamed

```
) cil managed

te::.ctor() = ( 01
  .maxstack  2
  .locals init (string V_0)
  IL_0000:  ldstr      "What is your name\?"
  IL_0005:  call       void class [mscorlib]System.Console::Write(string)
  IL_000a:  call       string class [mscorlib]System.Console::ReadLine()
  IL_000f:  stloc.0
  IL_0010:  ldstr      "Hello "
  IL_0015:  ldloc.0
  IL_0016:  call       string string::Concat(string,
                                             string)
  IL_001b:  call       void class [mscorlib]System.Console::WriteLine(string
  IL_0020:  ret
} // end of method a::Main
```

Classes have been renamed

Class1::Main : void(string[])

```
.method private hidebysig static void  Main(string[] args) cil managed
{
  .entrypoint
  .custom instance void [mscorlib]System.STAThreadAttribute::.ctor() = ( 01
  // Code size       33 (0x21)
  .maxstack  2
  .locals init ([0] string name)
  IL_0000:  ldstr      "What is your name\?"
  IL_0005:  call       void [mscorlib]System.Console::Write(string)
  IL_000a:  call       string [mscorlib]System.Console::ReadLine()
  IL_000f:  stloc.0
  IL_0010:  ldstr      "Hello "
  IL_0015:  ldloc.0
  IL_0016:  call       string [mscorlib]System.String::Concat(string,
                                                              string)
  IL_001b:  call       void [mscorlib]System.Console::WriteLine(string)
  IL_0020:  ret
} // end of method Class1::Main
```

Variables have been renamed

Microsoft Visual C++ Runtime Library

Runtime Error!

Program: c:\exemplar.exe

This application has requested the Runtime to terminate it in an unusual way.
Please contact the application's support team for more information.

OK

```
  .maxstack
  .locals i
  IL_0000:
  IL_0005:
  IL_000a:
  IL_000f:
  IL_0010:  ldstr      "Hello "
  IL_0015:  ldloc.0
  IL_0016:  call       string string::Concat(string,
                                             string)
  IL_001b:  call       void class [mscorlib]System.Console::WriteLine(string
  IL_0020:  ret
} // end of method a::Main
```

Classes have been renamed

Obfuscation

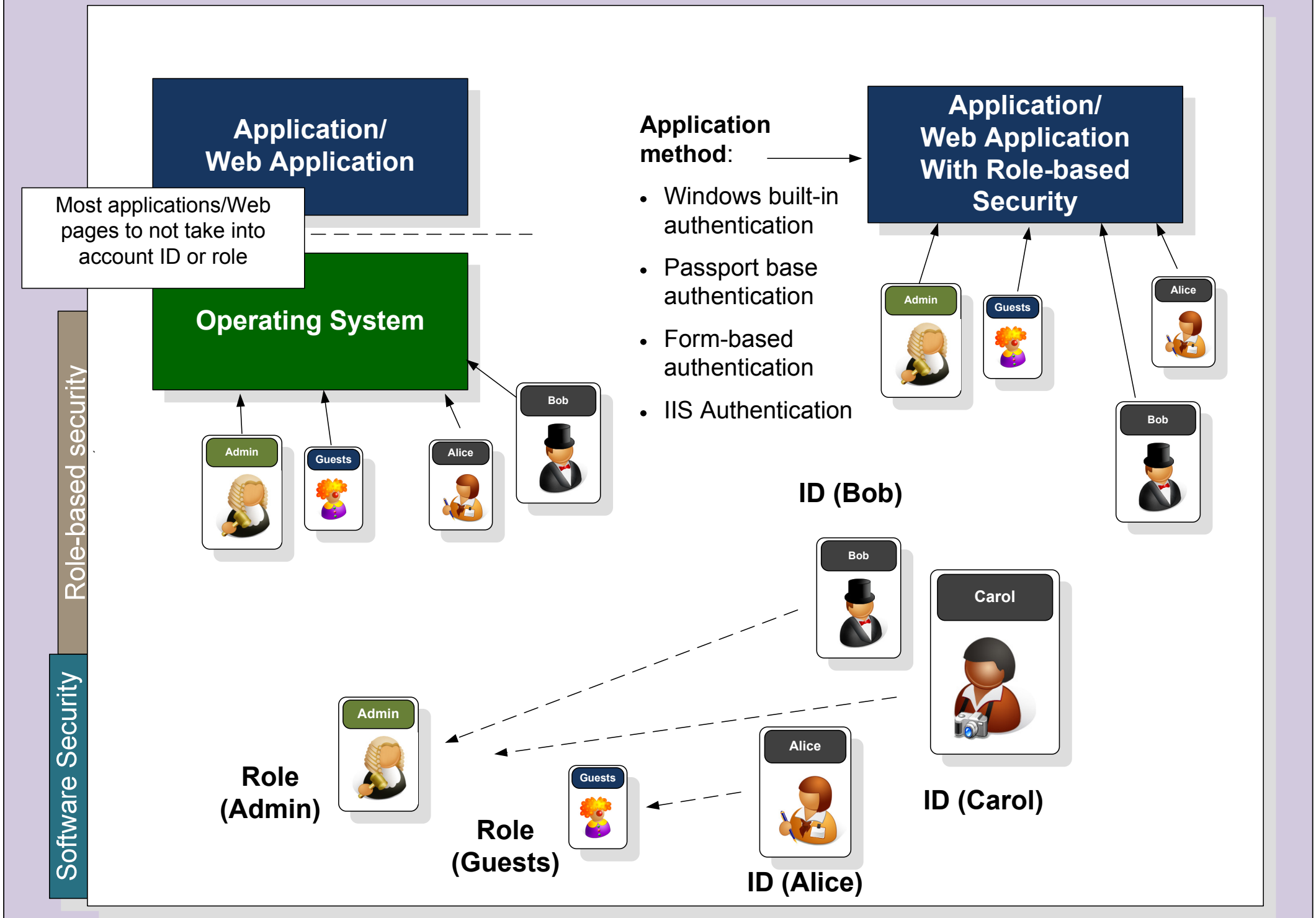
Software Security

Example

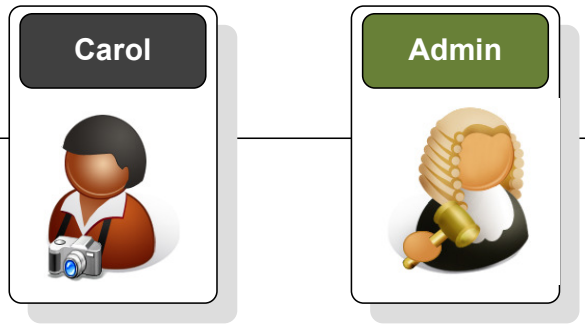
Software Security

Role-based security

Author: Prof Bill Buchanan


Application/
Web Application
Most applications/Web pages to not take into account ID or role
Operating System
Admin
Guests
Alice
Bob
Application method:
Windows built-in authentication
Passport base authentication
Form-based authentication
IIS Authentication
Application/
Web Application
With Role-based
Security
Admin
Guests
Alice
Bob
ID (Bob)
Bob
Carol
Admin
Role
(Admin)
Guests
Role
(Guests)
Alice
ID (Carol)
ID (Alice)
Role-based security
Software Security
Role-based security

```
using System;
using System.Security;
using System.Security.Principal;
namespace ConsoleApplication3
{
    class Class1
    {
        static void Main(string[] args)
        {
            WindowsIdentity myID = WindowsIdentity.GetCurrent();
            System.Console.WriteLine("Your ID: " + myID.Name);
            System.Console.WriteLine("Authentication: " +
                                                myID.AuthenticationType);
            WindowsPrincipal myPrin = new WindowsPrincipal(myID);
            if (myPrin.IsInRole(WindowsBuiltInRole.Administrator))
                System.Console.WriteLine("You're an Administrator ");
            else
                System.Console.WriteLine("You're not an Administrator");
            Console.ReadLine();
        }
    }
}
```



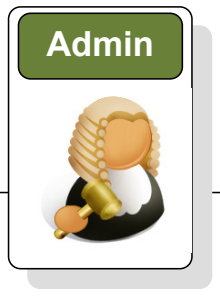
A major problem with software is that security is left to the operating system. With .NET, the developer can integrate role-based security into the program/Web application.

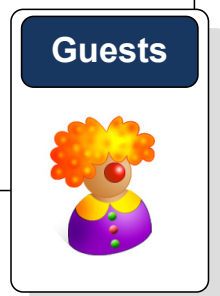
Code security

Software Security

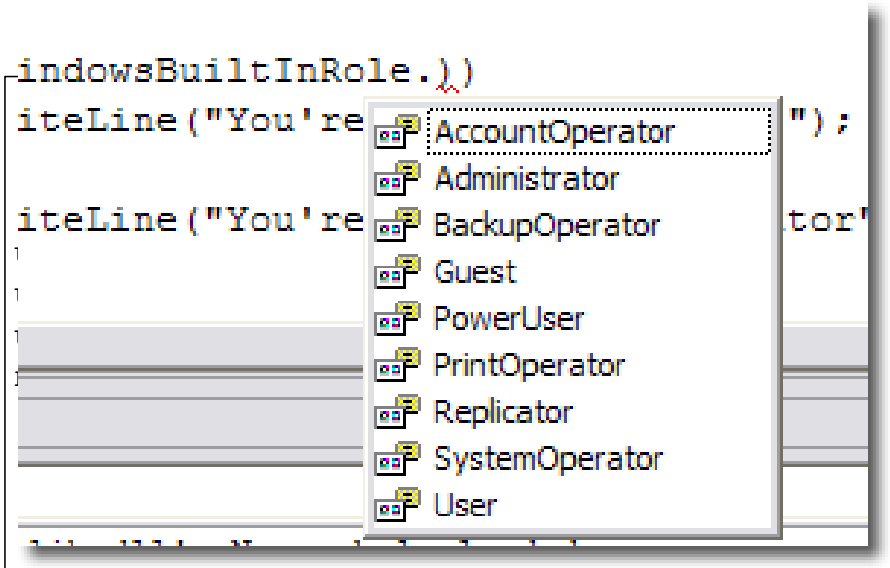
```
using System;
using System.Security;
using System.Security.Principal;
namespace ConsoleApplication3
{
     class Class1
     {
          static void Main(string[] args)
          {
               WindowsIdentity myID = WindowsIdentity.GetCurrent();
               System.Console.WriteLine("Your ID: " + myID.Name);
               System.Console.WriteLine("Authentication: " +
                                        myID.AuthenticationType);
- WindowsIdentity.GetCurrent();
                                    lowsPrincipal(myID);
ine("Your ID: " + myID.);          lRole.Administrator))
ine("Authentication:               're an Administrator ");
onType);

in = new WindowsPrin               're not an Administrator");

indowsBuiltInRole.Ad
iteLine("You're an A

iteLine("You're not
```

AuthenticationType
Equals
GetHashCode
GetType
Impersonate
IsAnonymous
IsAuthenticated
IsGuest
IsSystem
Name

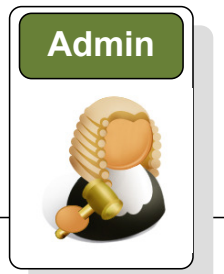


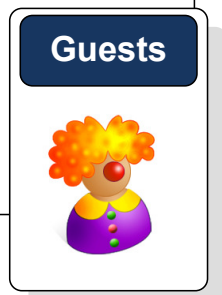


Role-based security




```
        {
            WindowsIdentity myID = WindowsIdentity.GetCurrent();
            System.Console.WriteLine("Your ID: " + myID.Name);
            System.Console.WriteLine("Authentication: " +
                                                    myID.AuthenticationType);
            WindowsPrincipal myPrin = new WindowsPrincipal(myID);
            if (myPrin.IsInRole(WindowsBuiltInRole.Administrator))
                System.Console.WriteLine("You're an Administrator ");
            else
                System.Console.WriteLine("You're not an Administrator");
            Console.ReadLine();
        }
    }
}
```



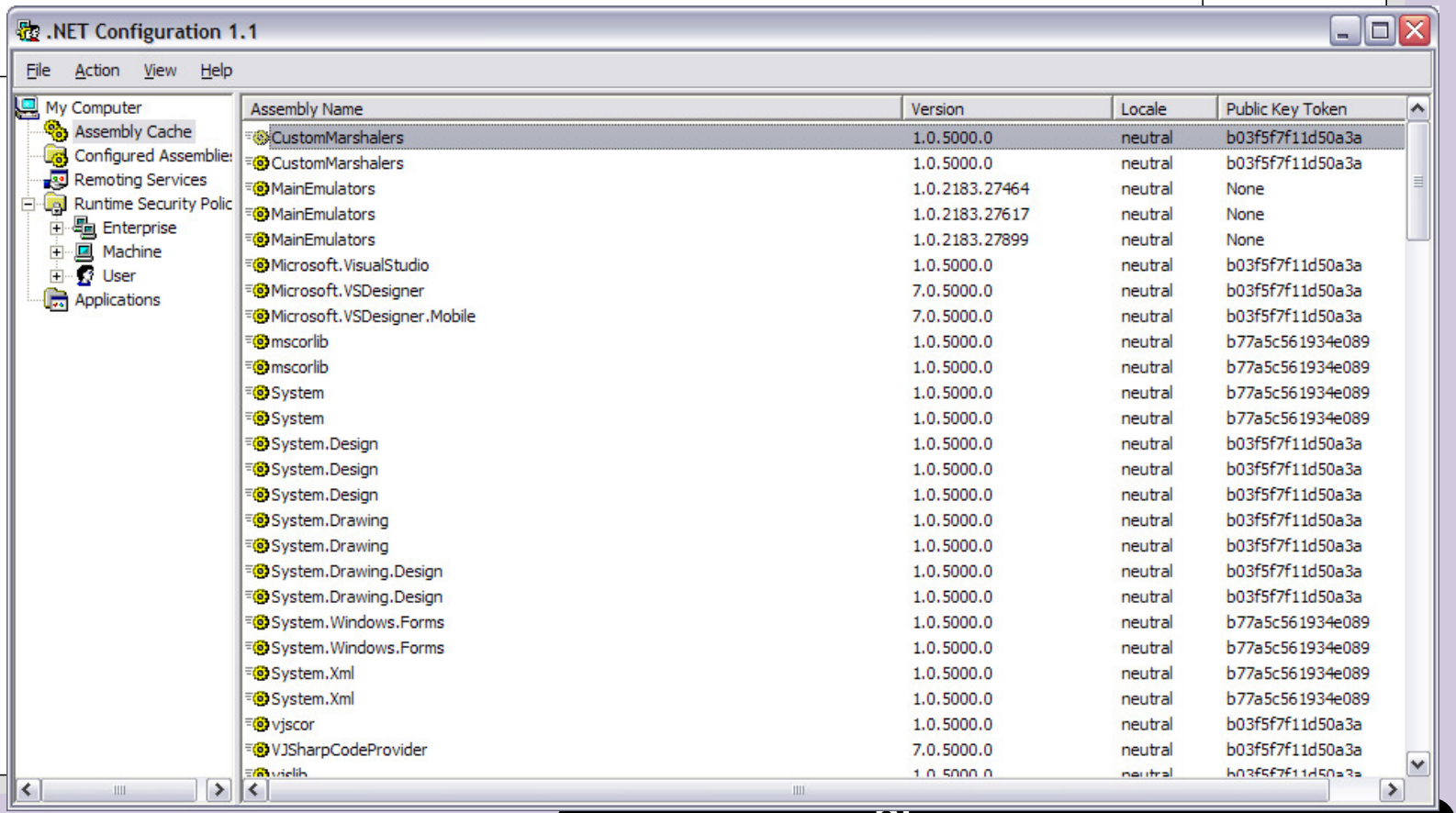


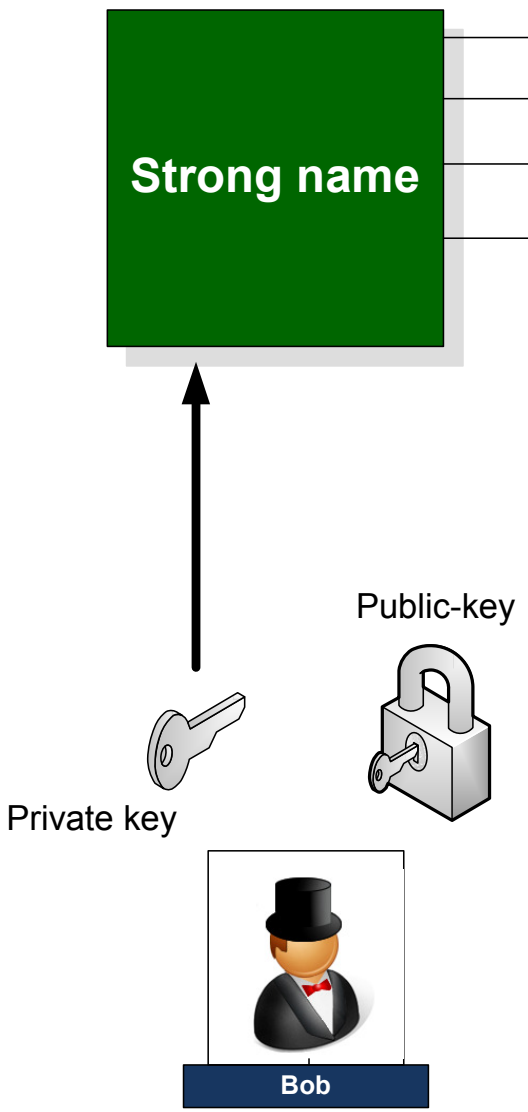
Software Security

.NET Security

Author: Prof Bill Buchanan

- Strong Name uses cryptography and digital signatures. It uses a digital signatures with asymmetric cryptography (RSA, EL Gamal), and a hash signature (MD5, SHA).
- Overcomes DLL hell and are used for versioning and authentication.
- In order to enhance security, an assembly uses an assembly strong name which normally has a text name, a public key and a digital signature. The digital signature is used to validate the assembly, and the system can thus check to see if the code has be modified in any way. If the code has been tampered with, the assembly will not load.





- No other name can ever exist.
- Supports different versions.
- Verifies the assembly.

```
C:\bill>sn -k bill.snk

Microsoft (R) .NET Framework Strong Name Utility
Version 1.1.4322.573
Copyright (C) Microsoft Corporation 1998-2002. All
rights reserved.

Key pair written to bill.snk

C:\bill>dir
 Volume in drive C has no label.
 Volume Serial Number is A873-2C50

 Directory of C:\bill

08/03/2007  21:15    <DIR>          .
08/03/2007  21:15    <DIR>          ..
08/03/2007  21:15               596 bill.snk
               1 File(s)            596 bytes
               2 Dir(s)   2,058,932,224 bytes free
```

.NET Security

Software Security

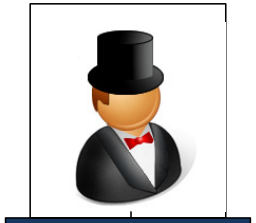
.NET Configuration 1.1

File Action View Help

My Computer
- Assembly Cache
- Configured Assemblies
- Remoting Services
- Runtime Security Policy
- Applications

Assembly Name	Version	Locale	Public Key Token
CustomMarshalers	1.0.5000.0	neutral	b03f5f7f11d50a3a
CustomMarshalers	1.0.5000.0	neutral	b03f5f7f11d50a3a
Microsoft.VisualStudio	1.0.5000.0	neutral	b03f5f7f11d50a3a
Microsoft.VisualStudio	1.0.5000.0	neutral	b03f5f7f11d50a3a
Microsoft.VSDesigner	7.0.5000.0	neutral	b03f5f7f11d50a3a
Microsoft.VSDesigner	7.0.5000.0	neutral	b03f5f7f11d50a3a
Microsoft.VSDesigner.Mobile	7.0.5000.0	neutral	b03f5f7f11d50a3a
mscorlib	1.0.5000.0	neutral	b77a5c561934e089
mscorlib	1.0.5000.0	neutral	b77a5c561934e089
System	1.0.5000.0	neutral	b77a5c561934e089
System	1.0.5000.0	neutral	b77a5c561934e089
System.Design	1.0.5000.0	neutral	b03f5f7f11d50a3a
System.Design	1.0.5000.0	neutral	b03f5f7f11d50a3a
System.Drawing	1.0.5000.0	neutral	
System.Drawing	1.0.5000.0	neutral	
System.Drawing.Design	1.0.5000.0	neutral	
System.Drawing.Design	1.0.5000.0	neutral	
System.Windows.Forms	1.0.5000.0	neutral	
System.Windows.Forms	1.0.5000.0	neutral	
System.Xml	1.0.5000.0	neutral	
System.Xml	1.0.5000.0	neutral	
vjscor	1.0.5000.0	neutral	
vjscor	1.0.5000.0	neutral	
VJSharpCodeProvider	7.0.5000.0	neutral	
VJSharpCodeProvider	7.0.5000.0	neutral	
vjslib	1.0.5000.0	neutral	
vjslib	1.0.5000.0	neutral	

Private key



Bob

Directory of C:

08/03/2007 21
08/03/2007 21
08/03/2007 21
1 File
2 Dir(

office Properties

General

Assembly name:	office
Modified:	
Culture:	neutral
Version:	11.0.0.0
Public key token:	71e9bce111e9429c
Codebase:	
Cache type:	Gac

OK Cancel Apply

ne can

erent

ssembly.

Strong name

```
using System.EnterpriseServices;
using System.Runtime.CompilerServices;
using System.Reflection;
// Specify a name for the COM+ application.
[assembly: ApplicationName("MyMathService")]
// Specify a strong name for the assembly.
[assembly: AssemblyKeyFile("MyMathService.snk")]
namespace MyMathService
{
    [Transaction(TransactionOption.Required)]
    public class Maths: ServicedComponent
    {
        [AutoComplete]
        public int add(int a, int b)
        {
        return(a+b);
        }
    }
}
```

3rd generation: Code-behind

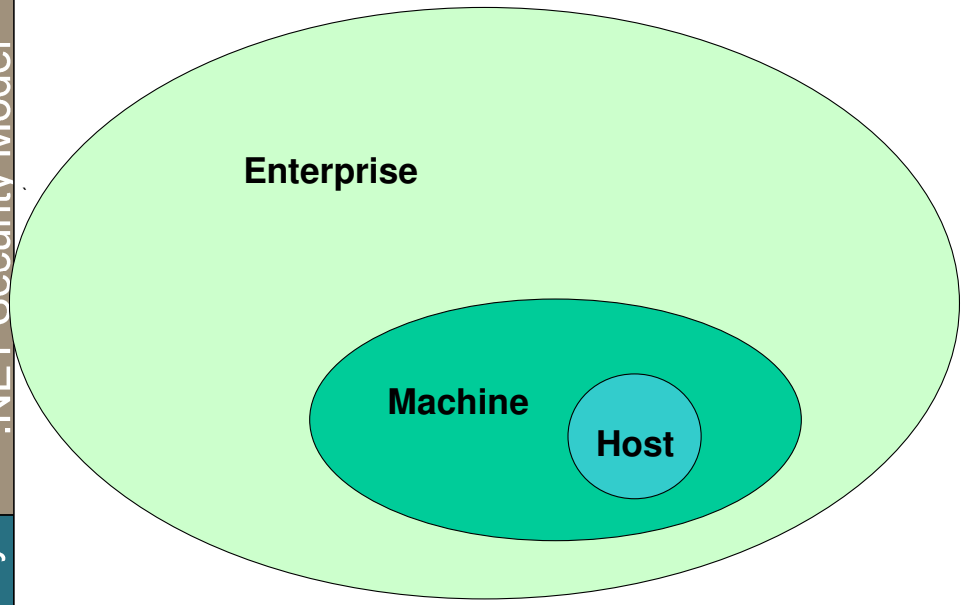
Software Security

.NET Security Model

Author: Prof Bill Buchanan

The .NET Framework enhances this by supporting role based security, where users have defined roles, where a role is assigned to a group of users, and permissions are granted to them.

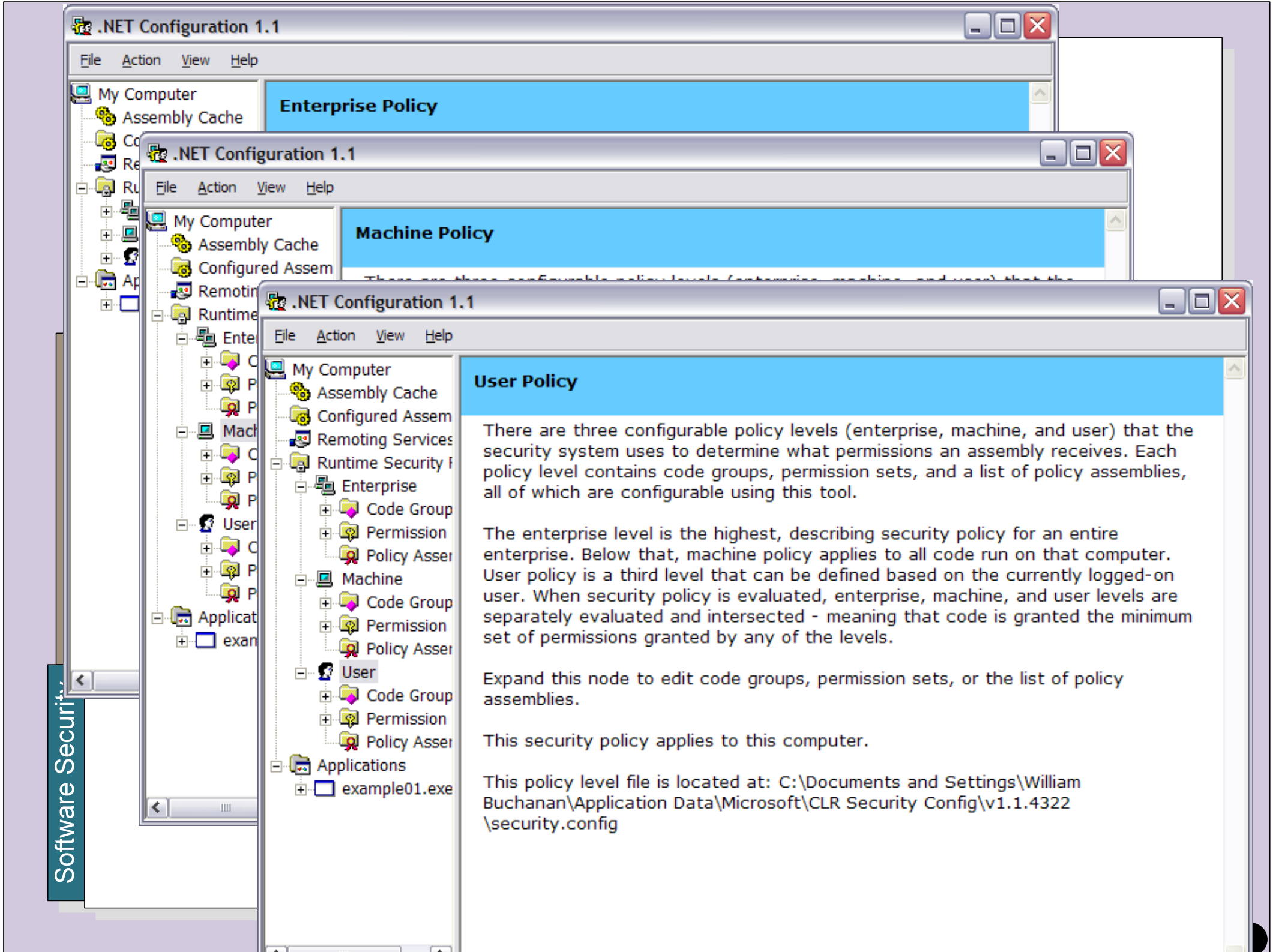
Two important applications which must be protected are in the provision of **Web services**, and in **.NET remoting**, as these run on a service, where the service must be kept secure, especially as it hosts privileged information.

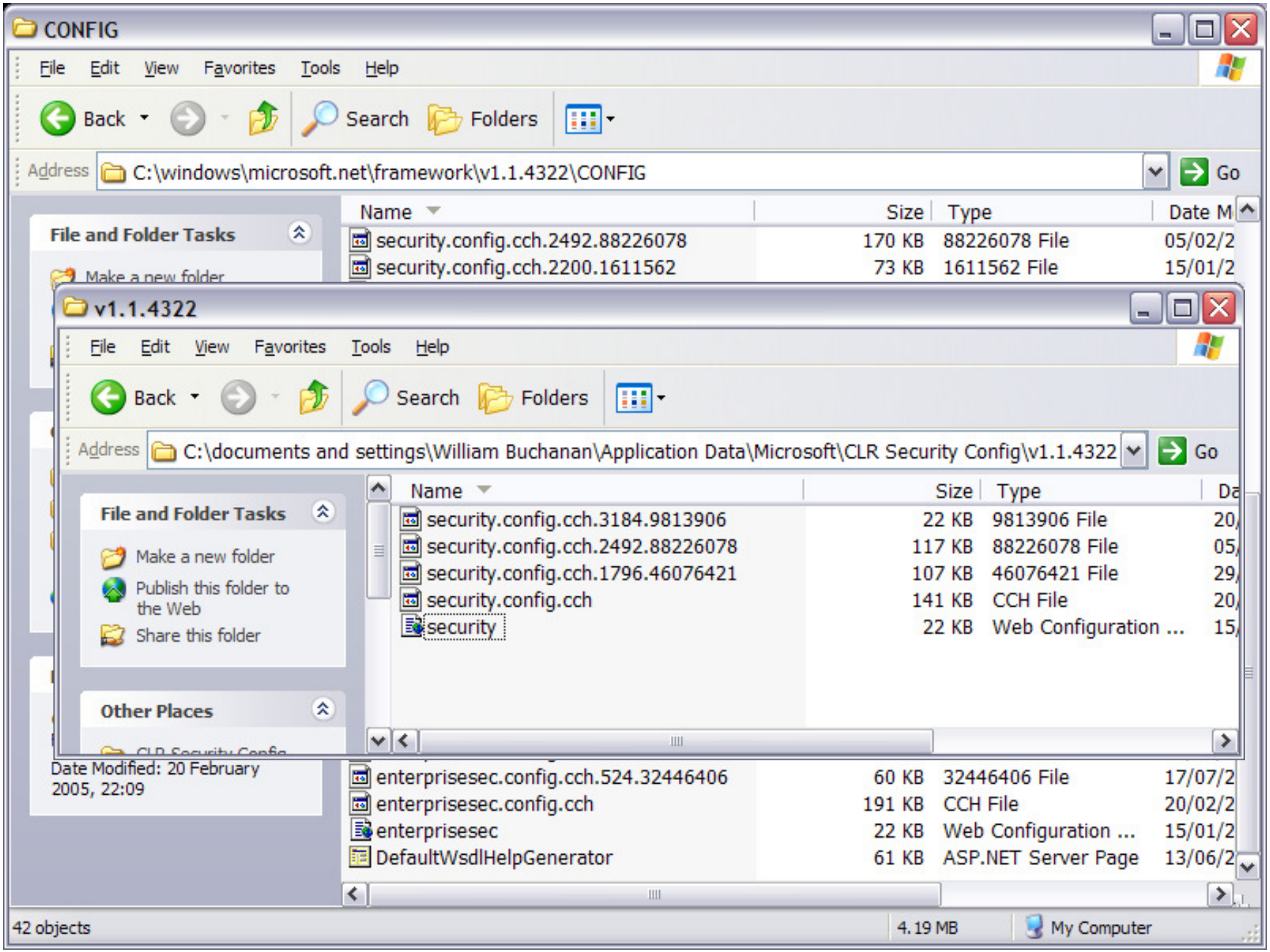


Machine configuration file. The machine configuration file is stored in the Config directory of the default .NET Framework installation. It contains settings that are applied to all the applications which run on the host.

Application configuration file. The application configuration file contains settings which relate to a specific application. These are named are Web.config (for Web applications) and App.config (for Windows applications).

Security configuration file. The security configuration files defines the security policy for a hierarchy of groups. It defines enterprise-level (Enterprisesec.config), machine-level (Security.config), and user-level (Security.config) security policies. The user level security policy is stored in user profile of the user.


.NET Configuration 1.1
File Action View Help
My Computer
Assembly Cache
Enterprise Policy
.NET Configuration 1.1
File Action View Help
My Computer
Assembly Cache
Configured Assem
Machine Policy
.NET Configuration 1.1
File Action View Help
My Computer
Assembly Cache
Configured Assem
Remoting Services
Runtime Security
Enterprise
Code Group
Permission
Machine
Code Group
Permission
User
Code Group
Permission
Applications
example01.exe
User Policy
There are three configurable policy levels (enterprise, machine, and user) that the security system uses to determine what permissions an assembly receives. Each policy level contains code groups, permission sets, and a list of policy assemblies, all of which are configurable using this tool.
The enterprise level is the highest, describing security policy for an entire enterprise. Below that, machine policy applies to all code run on that computer. User policy is a third level that can be defined based on the currently logged-on user. When security policy is evaluated, enterprise, machine, and user levels are separately evaluated and intersected - meaning that code is granted the minimum set of permissions granted by any of the levels.
Expand this node to edit code groups, permission sets, or the list of policy assemblies.
This security policy applies to this computer.
This policy level file is located at: C:\Documents and Settings\William Buchanan\Application Data\Microsoft\CLR Security Config\v1.1.4322 \security.config
Software Securit


CONFIG
File Edit View Favorites Tools Help
Back Search Folders
Address C:\windows\microsoft.net\framework\v1.1.4322\CONFIG
Go
File and Folder Tasks
Make a new folder
Name Size Type Date M
security.config.cch.2492.88226078 170 KB 88226078 File 05/02/2
security.config.cch.2200.1611562 73 KB 1611562 File 15/01/2
v1.1.4322
File Edit View Favorites Tools Help
Back Search Folders
Address C:\documents and settings\William Buchanan\Application Data\Microsoft\CLR Security Config\v1.1.4322
Go
File and Folder Tasks
Make a new folder
Publish this folder to the Web
Share this folder
Other Places
Name Size Type Da
security.config.cch.3184.9813906 22 KB 9813906 File 20
security.config.cch.2492.88226078 117 KB 88226078 File 05
security.config.cch.1796.46076421 107 KB 46076421 File 29
security.config.cch 141 KB CCH File 20
security 22 KB Web Configuration ... 15
Date Modified: 20 February 2005, 22:09
enterprisesec.config.cch.524.32446406 60 KB 32446406 File 17/07/2
enterprisesec.config.cch 191 KB CCH File 20/02/2
enterprisesec 22 KB Web Configuration ... 15/01/2
DefaultWsdlHelpGenerator 61 KB ASP.NET Server Page 13/06/2
42 objects
4.19 MB
My Computer

Software Security

ASP.NET

Author: Prof Bill Buchanan

Web.config file is used to define the security of the Web pages

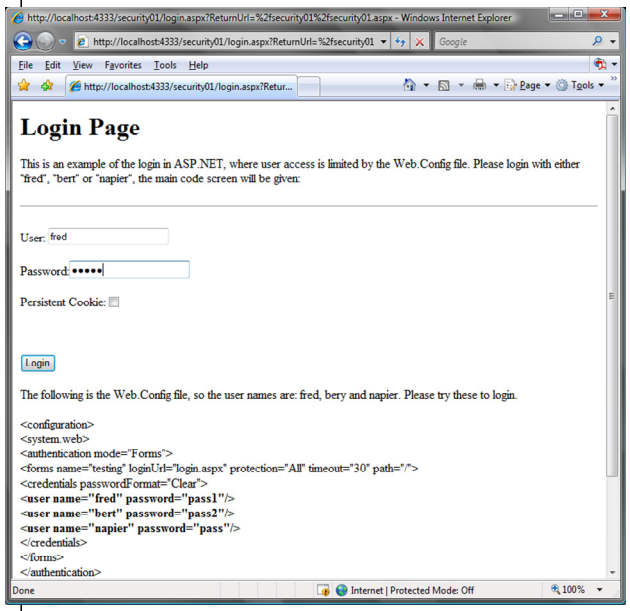
Web.config

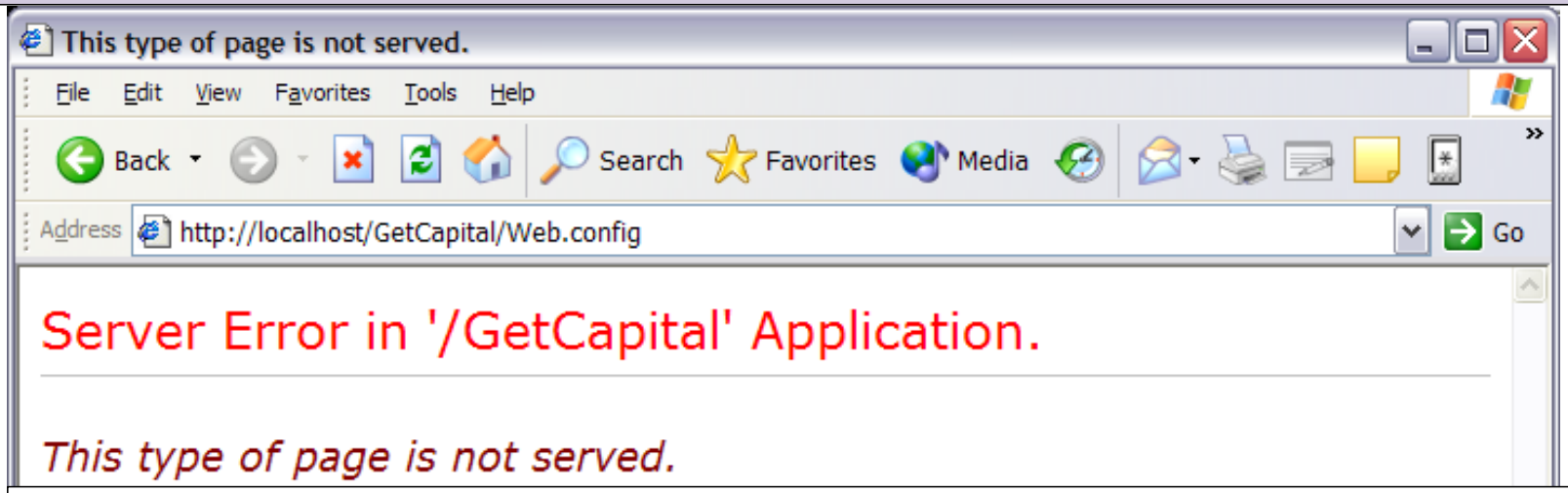
Web pages

Web pages

Web pages

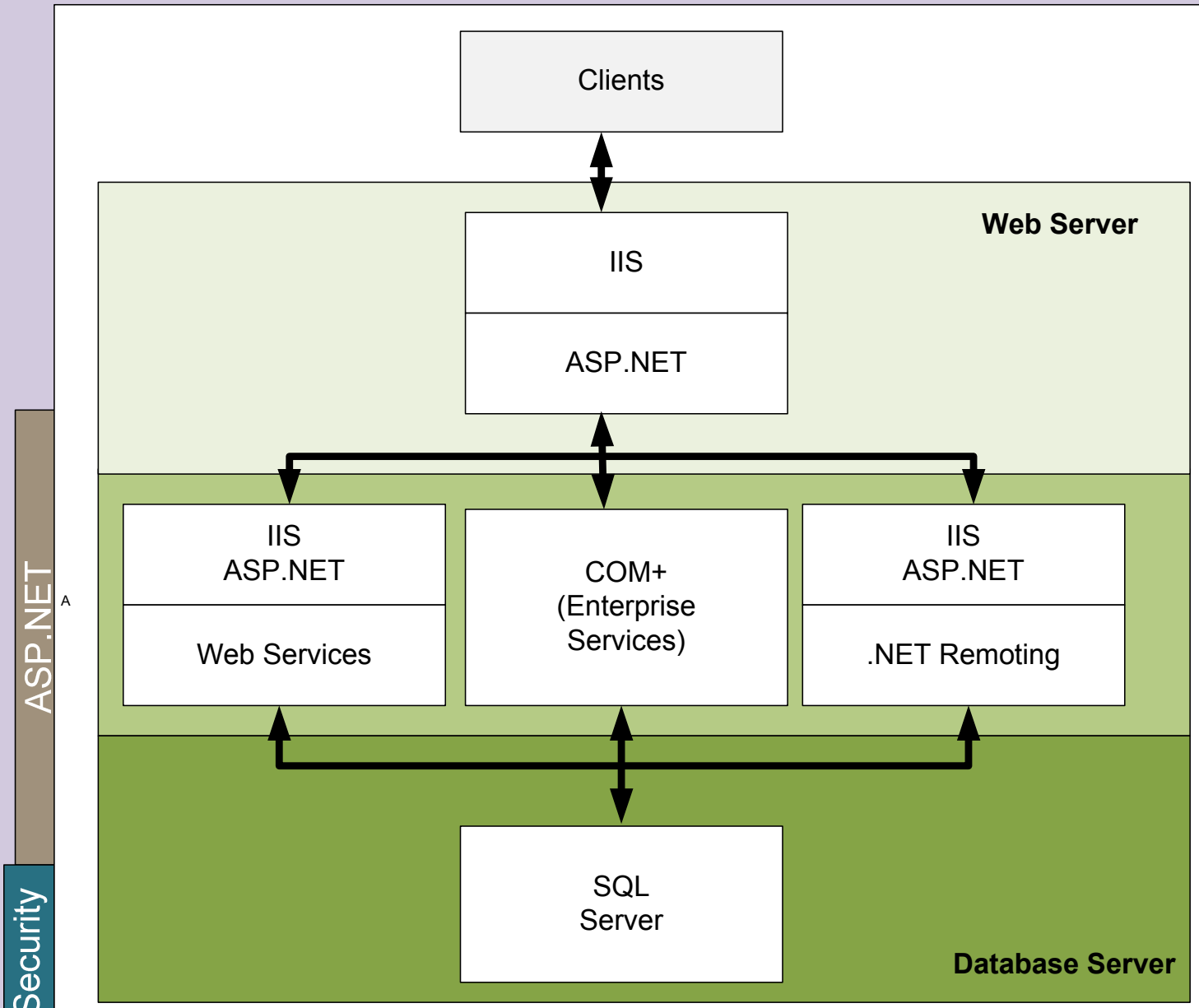
```
<configuration>
  <system.web>

    <authorization>
      <deny users="?"/>
    </authorization>
    <!--
    <authentication mode="Forms">
    </authentication>
    -->

    <authentication mode="Forms">
      <forms name="Test" loginUrl="login.aspx" protection="All"
timeout="30" path="/">
        <credentials passwordFormat="Clear">
          <user name="fred" password="pass1"/>
          <user name="bert" password="pass1"/>
          <user name="napier" password="pass1"/>
        </credentials>
      </forms>
    </authentication>

    <compilation debug="true"/>
  </system.web>
</configuration>
```






```
<?xml version="1.0" encoding="utf-8" ?>
<configuration>
  <system.web>
    <!--  DYNAMIC DEBUG COMPILATION
          Set compilation debug="true" to enable ASPX debugging.
                    Otherwise, setting this value to
          false will improve runtime performance of this application.
    -->
    <compilation
         defaultLanguage="c#"
         debug="true"
    />

    <!--  CUSTOM ERROR MESSAGES
          Set customErrors mode="On" or "RemoteOnly" to enable custom error
                    messages, "Off" to disable.
          Add <error> tags for each of the errors you want to handle.

          "On" Always display custom (friendly) messages.
          "Off" Always display detailed ASP.NET error information.
          "RemoteOnly" Display custom messages only to users not running
    -->
    <customErrors
    mode="RemoteOnly"
    />
```

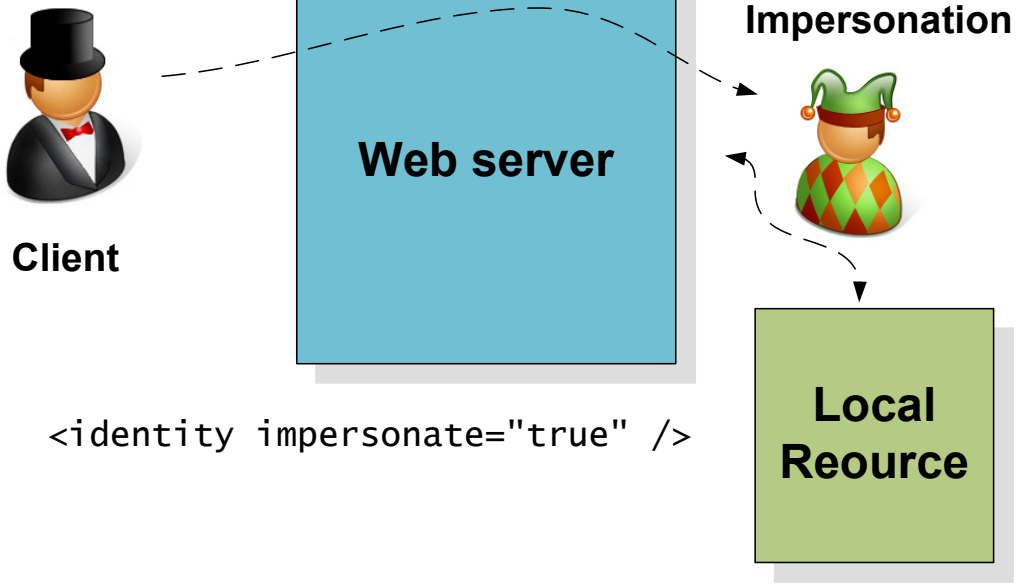

Web.config



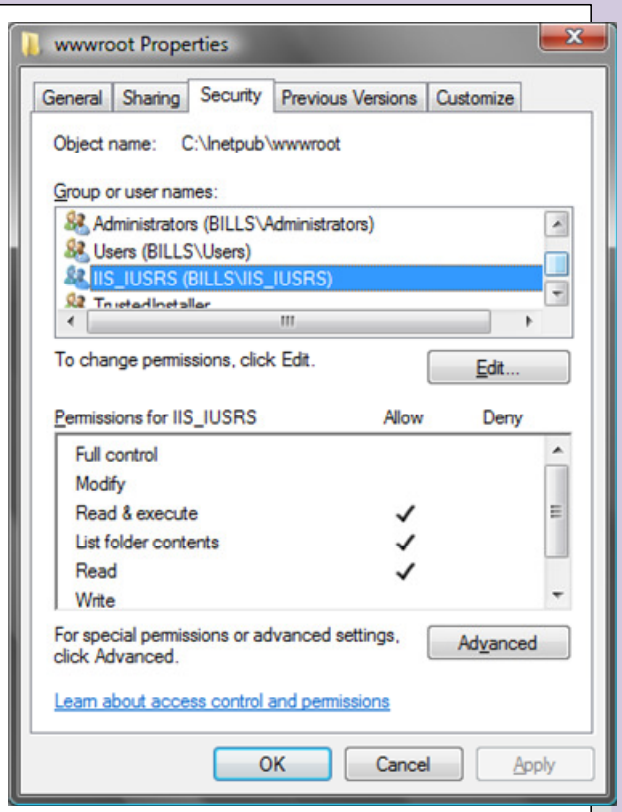
IIS
Authentication:
Anonymous, Basic, Digest, Integrated and Certifications
Authorization:
NTFS Permissions, IP Restrictions

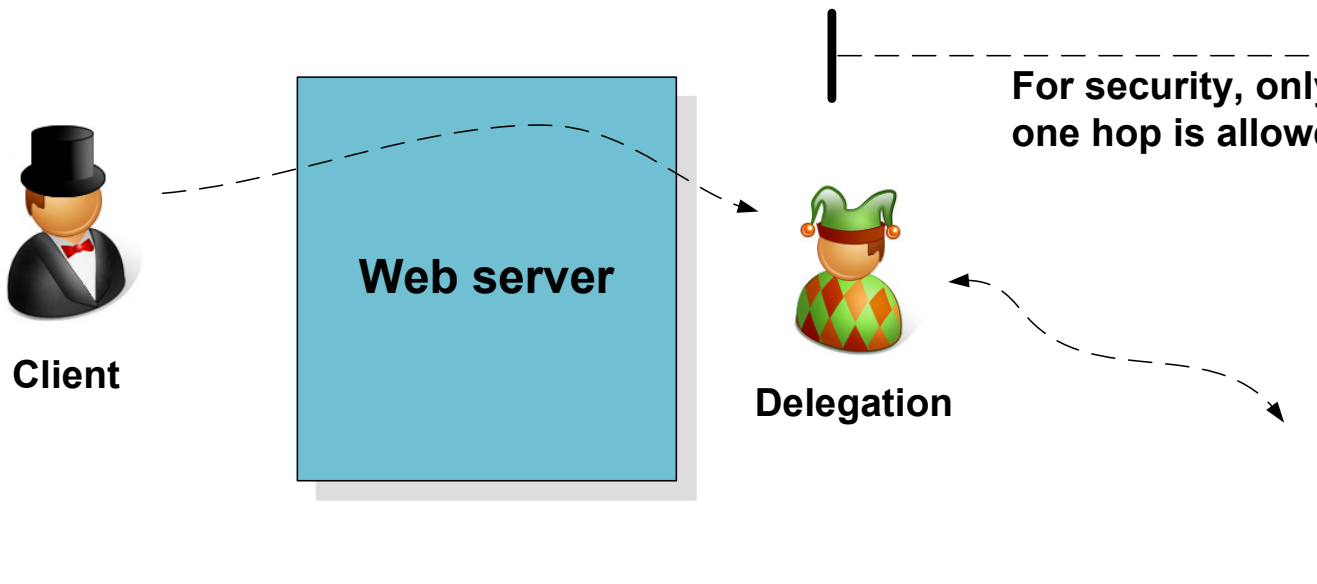
ASP.NET
Authentication:
Windows, Forms, Password, None
Authorization:
URL Authorization, File Authorization and .NET Role

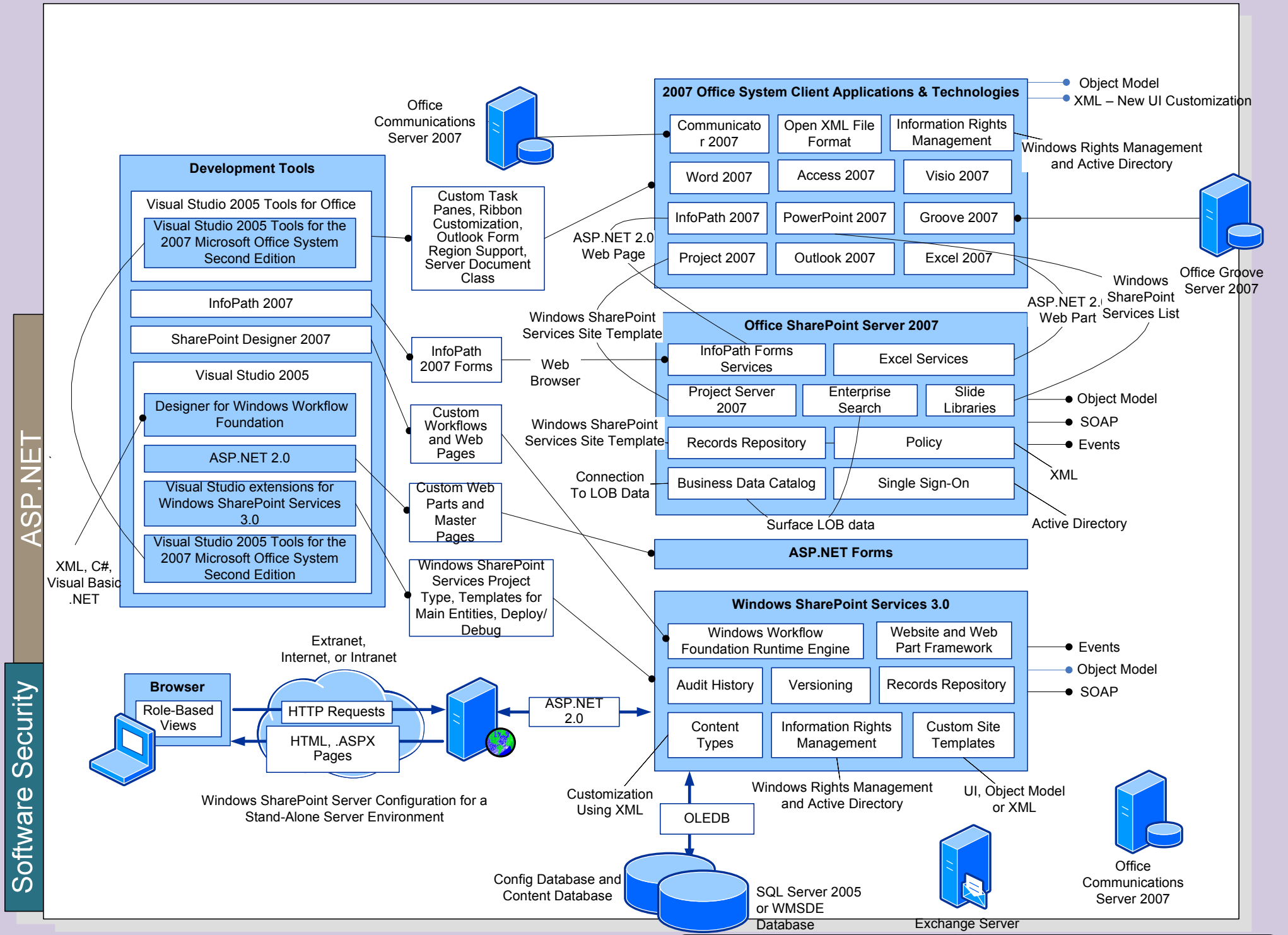
- Authentication (to identify the clients of your application)
- Authorization (to provide access controls for those clients)
- Secure communication (to ensure that messages remain private and are not altered by unauthorized parties)




```
<identity impersonate="true" />
```





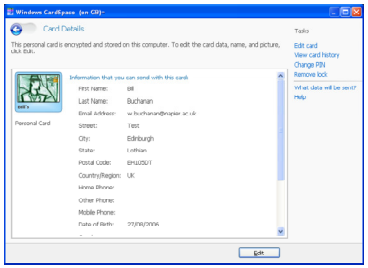


Microsoft Office SharePoint Server (MOSS)

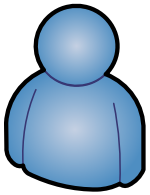
Software Security

Kerberos

Author: Prof Bill Buchanan



Identity



User

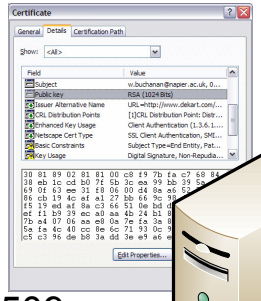
Identity selector

SAML (Security Assertion Markup Language)
Or Custom

WS-Security Policy
WS-Security

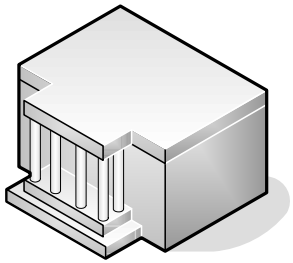
Relying Parity (RP)

Security Token Service (STS)



Identity Provider (IP)

X509 Certificate



Kerberos

PKI Server
Digital Certificate Granter (Verisign)

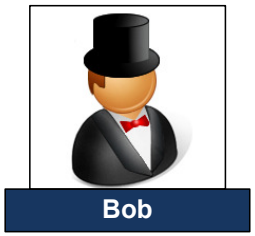
Open XML standards:
WS-*:-
WS-Trust, WS-Metadata Exchange Framework

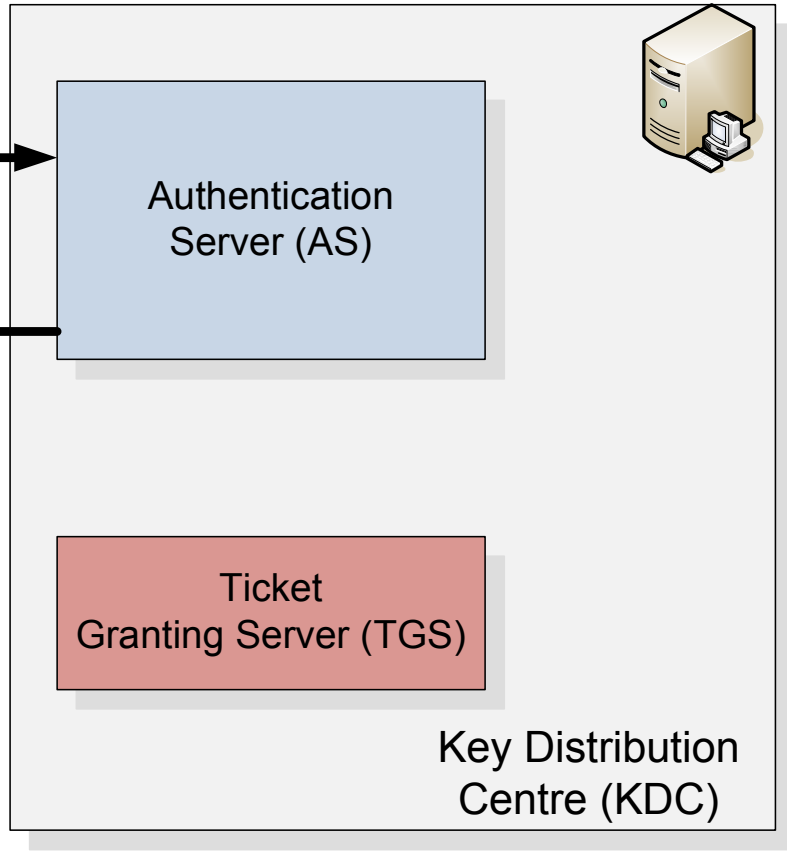
Author: Prof Bill Buchanan

AS_REQ is the initial user authentication request. This message is directed to the KDC component known as Authentication Server (AS).

$AS\_REQ = (Principal_{Client}, Principal_{service}, IP\_list, Lifetime)$

Eg $Principal_{Client}$ = Principal for user (such as fred@home.com), IP_list = all IP address which will use the ticket (may be null if behind NAT), lifetime = require life of the ticket.





AS_REP. Reply for the previous request. It contains the TGT (Ticket Granting Ticket - encrypted using the TGS secret key) and the session key (encrypted using the secret key of the requesting user).

$TGT = (Principal_{Client}, krbtgt/REALM@REALM, P\_list, Timestamp, Lifetime, SK_{TGS})$

$AS\_REP = \{ Principal_{service}, Timestamp, Lifetime, SK_{TGS} \}K_{User} \{ TGT \}K_{TGS}$

SK_{TGS} – Session key of the TGS – randomly created.

K_{TGS} – Key of TGS.

K_{user} – Secret key of Bob.

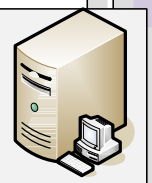
Note:

{ Message } – The curly brackets identify an encrypted message.

(Message) – The round brackets identify an non-encrypted message.

$AS\_REQ = (Principal_{Client}, Principal_{Service}, IP\_list, Lifetime)$

AS_REQ



Authentication Server (AS)

$TGT = (Principal_{Client}, krbtgt/REALM@REALM, P\_list, Timestamp, Lifetime, SK_{TGS})$

$AS\_REP = \{ Principal_{Service}, Timestamp, Lifetime, SK_{TGS} \}K_{User} \{ TGT \}K_{TGS}$

AS_REP

Bob now needs a service ticket

TGS_REQ

Ticket Granting Server (TGS)

$Authenticator = \{ Principal_{Client} , Timestamp \}SK_{TGS}$

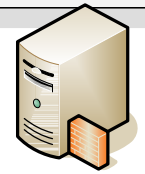
$TGS\_REQ = (Principal_{Service} , Lifetime , Authenticator) \{ TGT \}K_{TGS}$

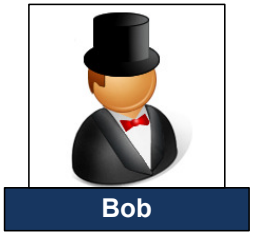
TGS_REP

$T_{Service} = (Principal_{Client}, Principal_{Service}, IP\_list, Timestamp, Lifetime, SK_{Service})$

$TGS\_REP = \{Principal_{Service}, Timestamp, Lifetime, SK_{Service} \}SK_{TGS} \{ T_{Service} \}K_{Service}$

Key Distribution Centre (KDC)





SK_{TGS} – Session key of the TGS – randomly created.

K_{TGS} – Key of TGS.

K_{user} – Secret key of Bob.

$SK_{Service}$ – Secret key of the service

Author: Prof Bill Buchanan

Software Security

Conclusions

Author: Prof Bill Buchanan