The Windows Management Instrumentation (WMI)

... and the technologies it is build on

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Agenda

- WMI required technologies:
  - WBEM
  - COM
  - Distributed COM
- WMI itself and how to use it

WBEM

Web-Based Enterprise Management (WBEM)

- Created by DMTF (Distributed Management Task Force)
- Open Source implementations: OpenPegasus, OpenWBEM

WBEM - Components

- CIM (Common Information Model) - Standard set of classes / objects
  - Core schema
  - Common schema
  - Win32 Extended schema
- CIM Query language
- CIM URI standard
- CIM-XML (default “transport”)

CIM schemas – MOF notation

Superclass

```
class HardwareDevice {
}
```

Derived class

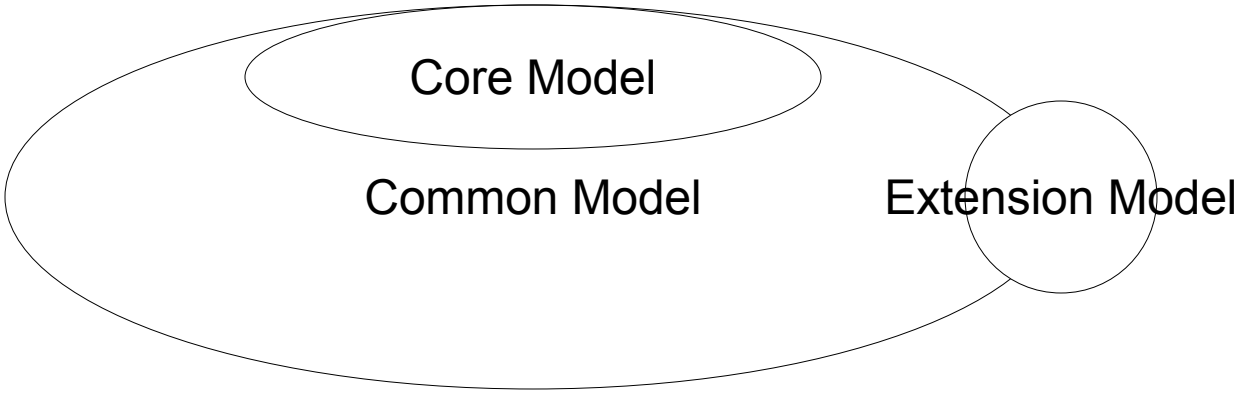
```
class Computer : HardwareDevice {
        string Model;
        uint32 ProcessorClockFrequency;
}
```

Instance

```
instance of Computer {
        ManufacturerName = “ASUS”;
        Model = “M3700N”;
        ProcessorClockFrequency = 1500;
}
```

- Compile and register with mofcomp
- IDL-like

CIM Standard Schemas



WQL

- Subset of SQL92

```
SELECT * FROM Win32_LogicalDisk WHERE FileSystem = “FAT”

ASSOCIATORS OF {Win32_Service = ‘DHCP’}

CALL[\\server\root\cimv2:Win32_Process.Handle="2236"].Terminate(Reason=0)

UPDATE Win32_Environment SET VariableValue = 'bla'  WHERE
__PATH='\\.\root\cimv2:Win32_Environment.Name="Test",UserName="server\\user"'
```

WBEM URI's

scheme://[user[:pass]@]host/namespace/model

e.g.
https://foo:bar@bla/interop/cim_namespace.name=unknown

for CIM-XML over HTTPS

not used in WMI

SNIA and WBEM

- Worked on CIM as part of the SMI workgroup

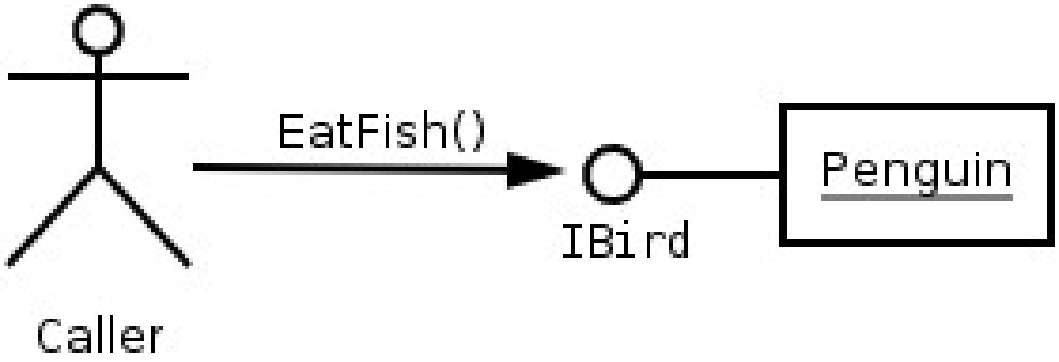
COM

Introduction to COM (1)

- Key part of Windows
- Around since ~1993, actively used since ~1997
- Used as the basis for various other technologies:
  - DCOM
  - OLE2/ActiveX
- Several enhancements in Windows 2000: COM+

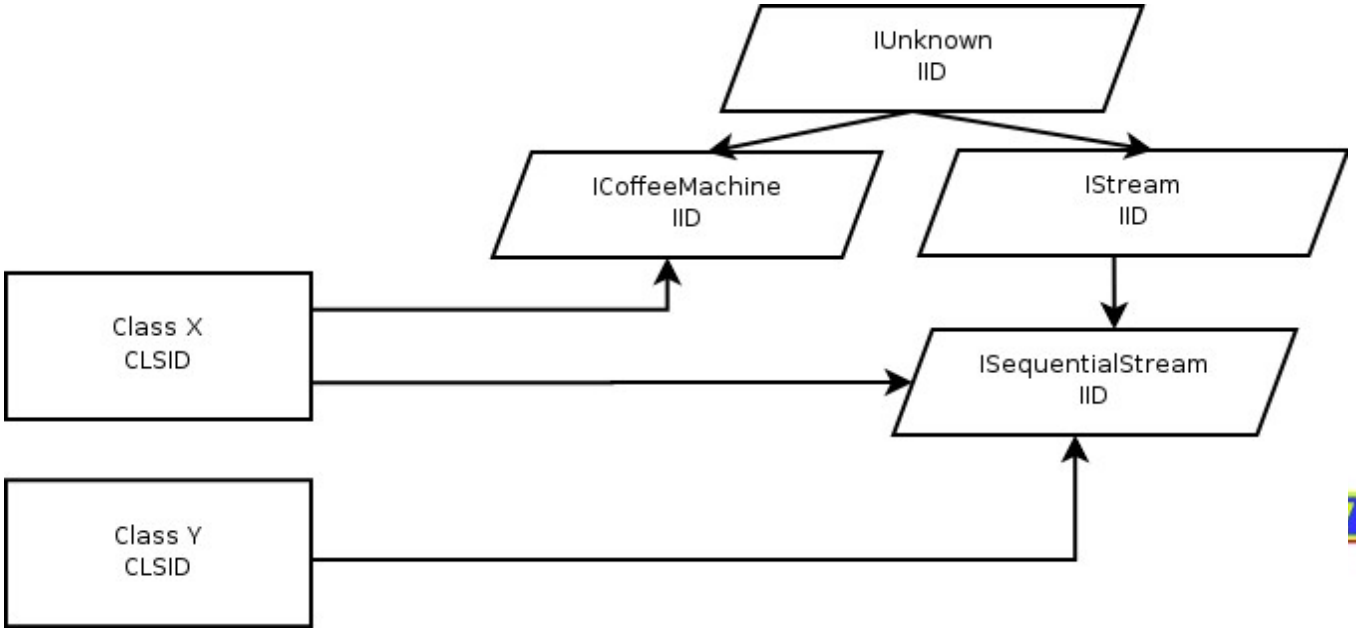
Introduction to COM (2)

- Object-oriented language-independant framework
- Implementation and interface clearly seperated
- Implementation only specified at activation time



IUnknown

- All interface in OO style based upon the *IUnknown* interface
- *IUnknown* contains *GetInterface()*, *AddRef()* and *Release()*



Introduction to COM (3)

- ODL (extended IDL)
  - **coclass** data type
  - inheritance for **interface**s
  - Identification by UUID's
- Activated using *GetObject()*
- "Activation" information all stored in the registry (*HKEY_CLASSES_ROOT*)

```
IBird *pBird = CoCreateInstance(CLSID_Penguin, IID_IBird, ...)
pBird->EatFish()
```

DCOM

DCE/RPC

- Traditional *OpenGroup DCE/RPC*
- NDR encoding version 1 defined
- Should be well known to most CIFS vendors

Introduction to DCOM

- Distributed version of *COM*
- Documented in an internet draft
- Microsofts' answer to CORBA
- “hidden” from the application programmer
- Once “hyped” as *the* way of providing services over the internet

DCOM – RPC extensions

- ORPC (NDR revision 2)
  - uses extra field in dcerpc bind with object GUID
  - new primitive data type: **MInterfacePointer** (i.e. pointing)
  - additional **this** and **that** arguments
  - uses alternate binding contexts **a lot**

```
▷ Frame 74 (198 bytes on wire, 198 bytes captured)
▷ Ethernet II, Src: 192.168.1.8 (00:06:5b:de:85:e5), Dst: 192.168.1.3 (00:08:74:93:31:a6)
▷ Internet Protocol, Src: 192.168.1.8 (192.168.1.8), Dst: 192.168.1.3 (192.168.1.3)
▷ Transmission Control Protocol, Src Port: 1035 (1035), Dst Port: 2467 (2467), Seq: 276, Ack: 415, Len: 144
▽ DCE RPC Request, Fragment: Single, FragLen: 144, Call: 1 Ctx: 0, [Resp: #78]
    Version: 5
    Version (minor): 0
    Packet type: Request (0)
  ▷ Packet Flags: 0x83
  ▷ Data Representation: 10000000
    Frag Length: 144
    Auth Length: 16
    Call ID: 1
    Alloc hint: 68
    Context ID: 0
    Opnum: 5
    Object UUID: 00007c00-051c-0000-ba02-42e0ad315410
    Auth type: NTLMSSP (10)
    Auth level: Connect (2)
    Auth pad len: 12
    Auth Rsrvd: 0
    Auth Context ID: 4360412
    [Response in frame: 78]
  ▽ NTLMSSP Verifier
      Version Number: 1
      Verifier Body: 000000000000000000000000
▽ IRemUnknown, RemRelease
    Operation: RemRelease (5)
  ▷ DCOM, ORPCThis, V5.4, Causality ID: 00000003-e7ab-0000-cd1d-f9ff951ff9ff
    InterfaceRefs: 1
  ▷ RemInterfaceRef[1]: IPID=00008402-051c-0000-b666-3e015606be8f, PublicRefs=5, PrivateRefs=0
    Auth Padding (12 bytes)
```

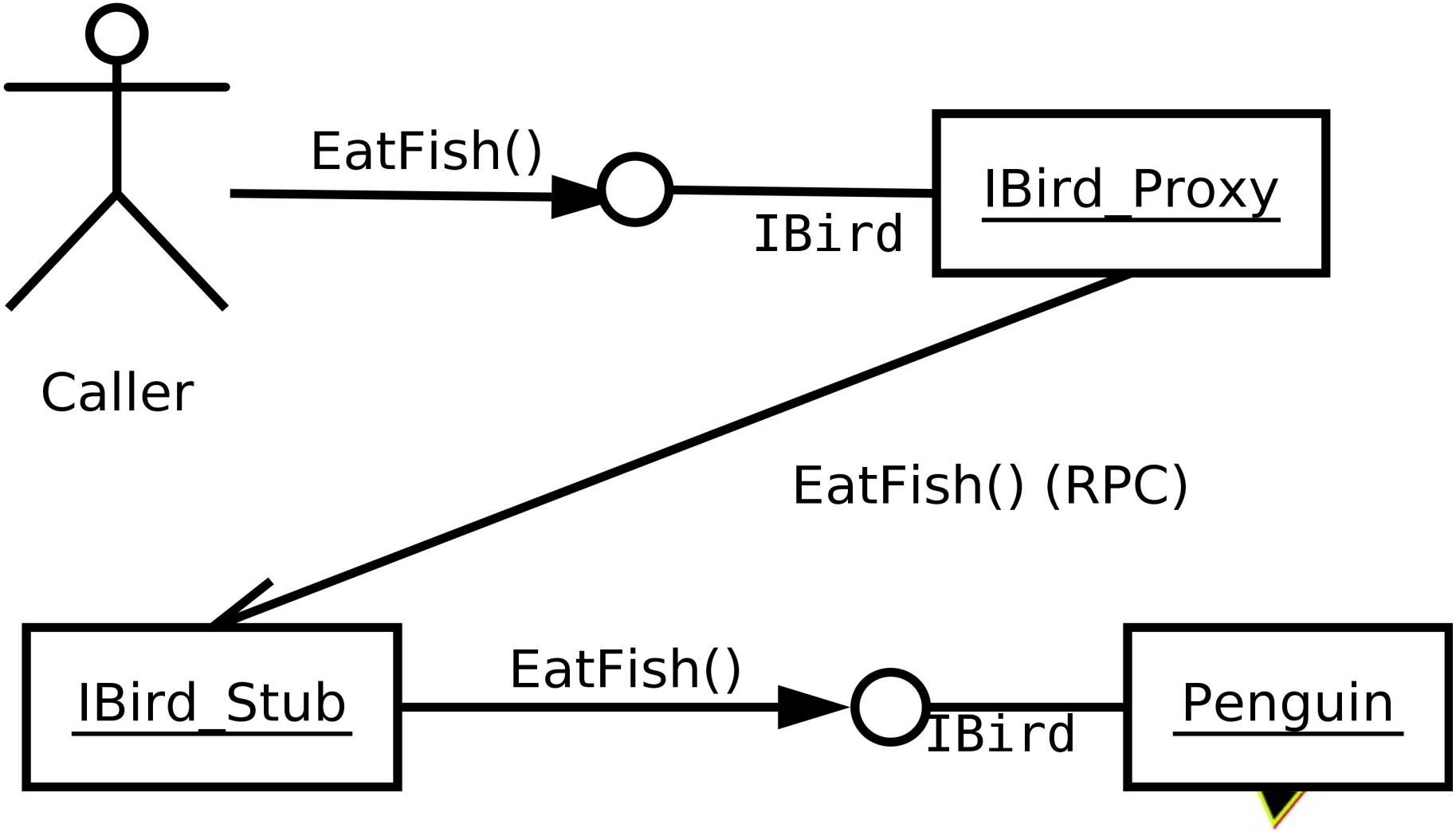
DCOM – RPC interfaces

- Activation
  - IRemoteActivation
  - ISystemActivator (since Win2k)
- Management
  - IOXIDResolver
  - IROT

DCOM – Garbage collection

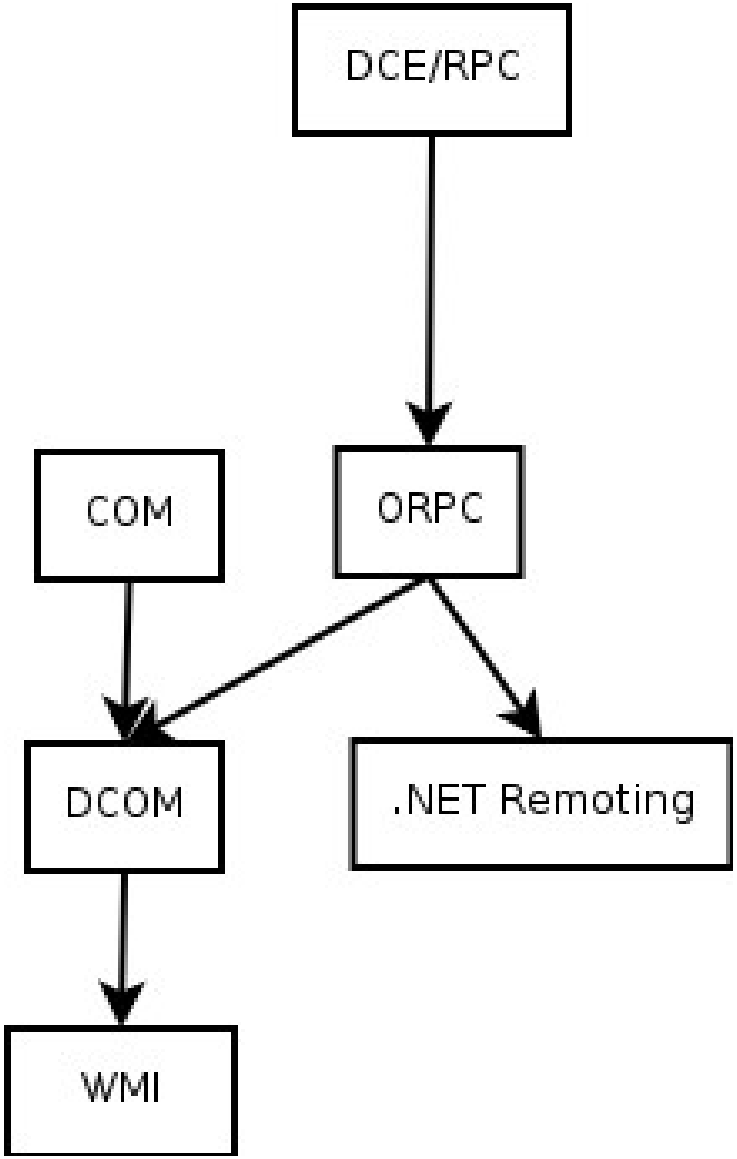
- Destroy objects if
  - Clients don't “ping” an object for 3 minutes
- Mechanism for pinging groups of objects
  - *ComplexPing()* and *SimplePing()* in IOXIDResolver

DCOM – Stubs and proxies



WMI

Mixing it all together...

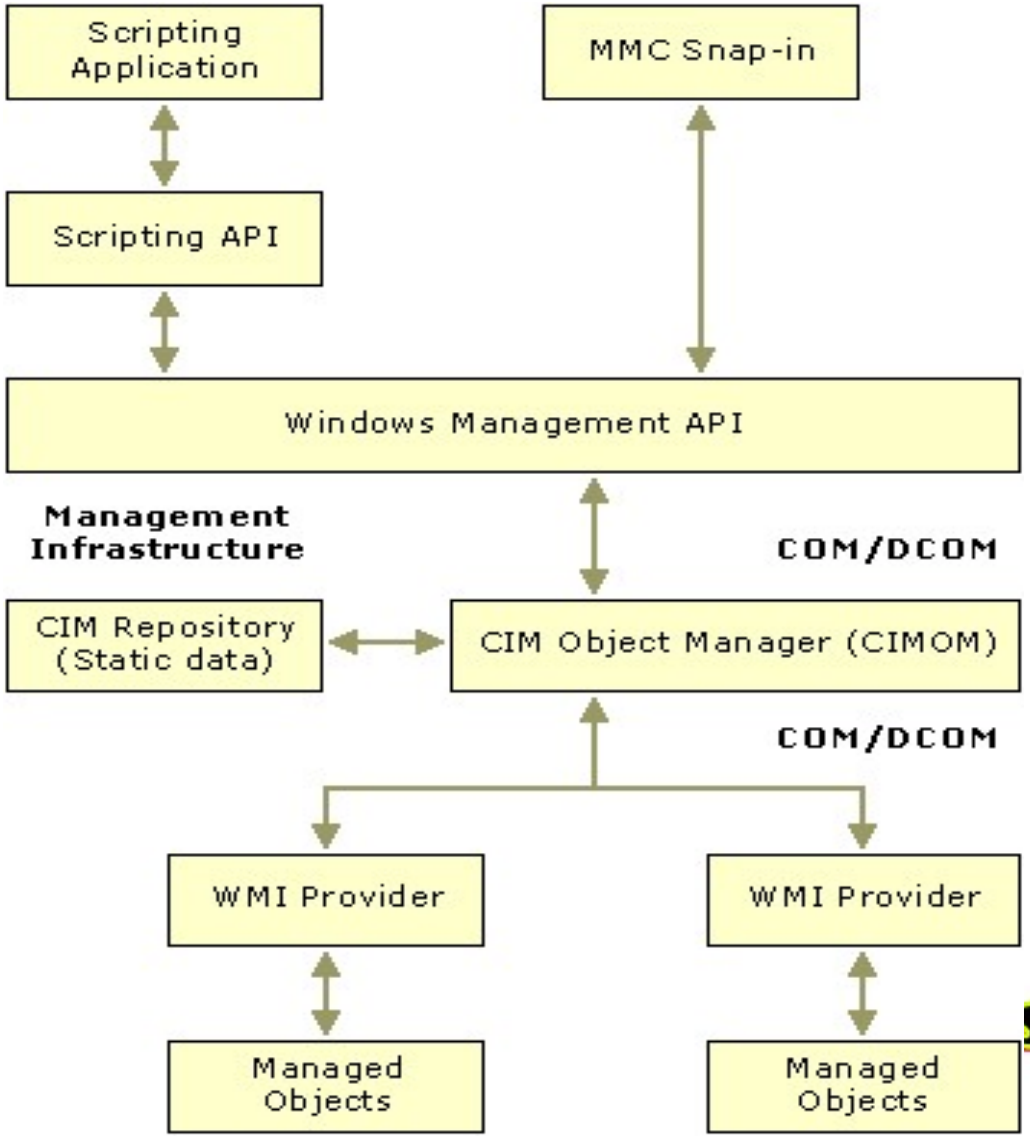


- Windows Management Instrumentation
  - basically WBEM with DCOM as transport
  - Core Model, Common Model, Microsoft-specific model (CIMv2)

WMI

- Runs on Win9x/NT4 and above
  - Included by default since Win2K
- Available thru DCOM using the *IWbemServices* class
- Special Activation mechanism for WMI: the *winmgmts:* namespace
- Can manage pretty much everything:
  - Hardware devices
  - Several applications such as Office
  - .NET Framework
  - AD Related

WMI

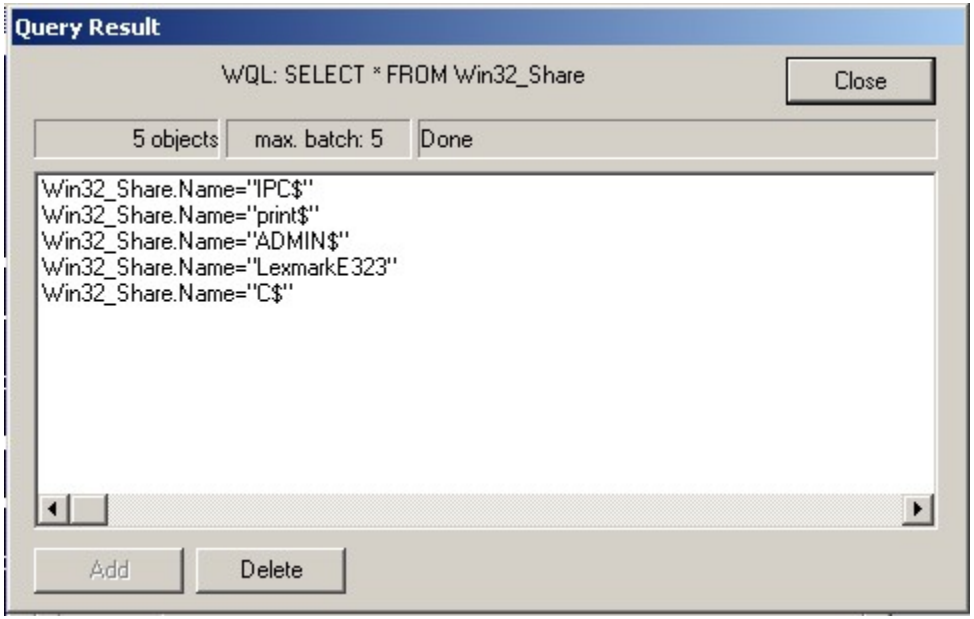

Scripting Application
MMC Snap-in
Scripting API
Windows Management API
Management Infrastructure
COM/DCOM
CIM Repository (Static data)
CIM Object Manager (CIMOM)
COM/DCOM
WMI Provider
WMI Provider
Managed Objects
Managed Objects

WMI – User tools

- WBEMtester
- MMC
- VBScript / API
- Available to all COM-enabled languages (VB/C++/Python/...)
- Part of .NET (System.Management)
- WMIC

WMI - WBEMtester

Windows WBEM test client



WMI – Microsoft Management Console

- WMI used for snap-ins

WMI – VBScript (1)

```
Set WMIService = _
        GetObject("winmgmts:{impersonationLevel=impersonate}!” + _
                                                        “\\.\root\cimv2")

Set users = WMIservice.ExecQuery("SELECT * FROM Win32_UserAccount WHERE Name='" + _
                WScript.Arguments(0) + "'")

For Each User In users
        Wscript.Echo(user.Domain)
        Wscript.Echo(user.SID)
        Wscript.Echo(user.Fullname)
Next
```

WMI – VBScript (2)

```
Set objWMIService = GetObject("winmgmts:{impersonationLevel=impersonate}!\\.\root\cimv2")

Set objRefresher = CreateObject("WbemScripting.SWbemRefresher")

Set colDiskDrives = objRefresher.AddEnum _
   (objWMIService, "Win32_PerfFormattedData_PerfDisk_LogicalDisk").objectSet

objRefresher.Refresh

For i = 1 to 500
   For Each objDiskDrive in colDiskDrives
            Wscript.Echo "Drive name: " & objDiskDrive.Name
            Wscript.Echo "Disk bytes per second: " & objDiskDrive.DiskBytesPerSec
            Wscript.Sleep 2000
            objRefresher.Refresh
   Next
Next
```

WMI – VBScript (3)

```
Set objWMIService = GetObject("winmgmts:{impersonationLevel=impersonate}!\\.\root\cimv2")

Set colComputers = objWMIService.ExecQuery("Select * from Win32_ComputerSystem")

For Each objComputer in colComputers
    errReturn = ObjComputer.Rename("NewName")
    WScript.Echo "Computer name is now " & objComputer.Name
Next
```

WMI – In .NET

```
using System;
using System.Management;

class Class1
{
   static void Main(string[] args)
   {
         ManagementClass mc = new ManagementClass("Win32_Share");

         ManagementObjectCollection mcc = mc.GetInstance();

         foreach(ManagementObject mo in mcc) {
             Console.WriteLine("'{0}' path is '{1}'", mo["__REL_PATH"], mo["Path"]);
         }
   }
}
```

```
Win32_Share.Name='C$' path is 'C:\'
Win32_Share.Name='IPC$' path is '
Win32_Share.Name='ADMIN$' path is 'C:\WINNT'
```

Future

- Replace by a full .NET equivalent (no DCE/RPC)
- Move towards standardised transport CIM-XML (?)

Implementation Considerations

- DCOM or CIM-XML as transport protocol?
  - CIM-XML advantages
    - Simpler to implement
    - Less security
    - Standardised
  - DCOM
    - Natively supported on Windows
    - Superceded by .NET (?)

Further resources

- WMI http://msdn.microsoft.com/library/default.asp?url=/library/e
- DCOM white-paper http://samba.org/~jelmer/dcom.pdf
- WBEM standard http://www.dmtf.org/standards/wbem/
- DCOM standard http://www.ietf.org/internet-drafts/draft-brown-dcom-v1-spe
- DCE/RPC http://www.opengroup.org/onlinepubs/9629399/toc.html
- SNIA CIM/WBEM http://www.snia.org/tech_activities/SMI/cim/