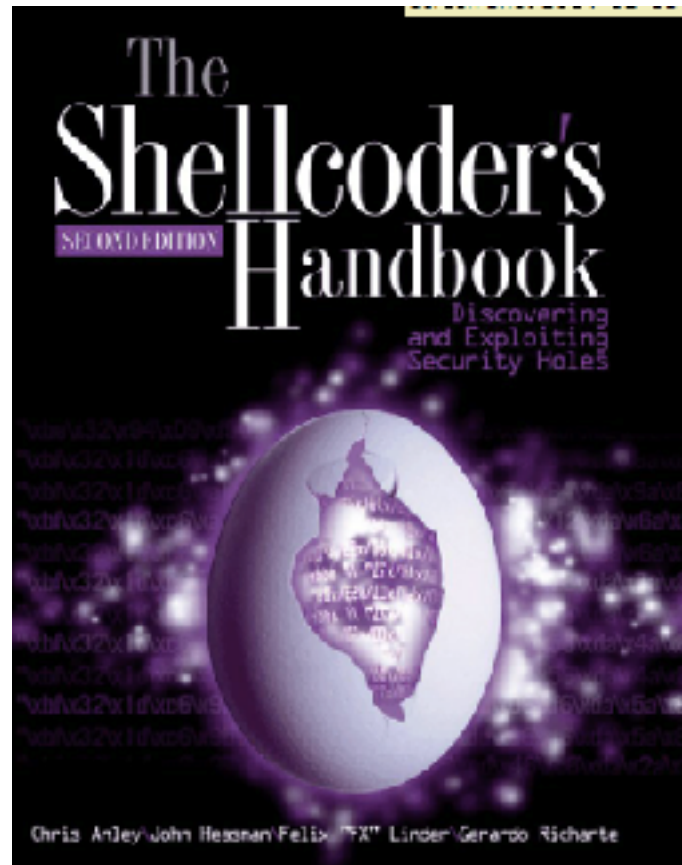


# Exploit Development

## Ch 6: The Wild World of Windows



Revised 8-3-19

# Topics

- Win32 API, DLLs, and PE Files
- Heaps
- Threading
- DCOM
- Exception Handling
- Debuggers

# Win32 API, DLLs, and PE Files

# Windows API

(Application Programming Interface)

- In Linux, a programmer can talk directly to the kernel with syscalls (INT 0x80)
- But in Windows the kernel is only accessible through the Windows API
- Implemented as a set of DLLs
- Changes with each Windows version and Service Pack

# Windows API

## (Application Programming Interface)

- Every process using the Windows API must use dynamic linking to the DLLs
- The Windows API changes more often than Linux Syscalls do
- Here's an API call to make a window

```
hwnd = CreateWindowEx(  
    WS_EX_CLIENTEDGE,  
    g_szClassName,  
    "The title of my window",  
    WS_OVERLAPPEDWINDOW,  
    CW_USEDEFAULT, CW_USEDEFAULT, 240, 120,  
    NULL, NULL, hInstance, NULL);
```

# DLLs

## (Dynamic Link Libraries)

- Pre-compiled library code
- Loaded as needed when executable files run
- You can see loaded DLLs with Process Explorer
  - View, Lower Pane View, DLLs
  - Link Ch 6b

Process Explorer - Sysinternals: www.sysinternals.com [WIN-8LDVLI8QDEN\sam]						
Process	CPU	Private bytes	Working Set	PID	Description	Company Name
System Idle Process	92.37	0 K	8 K	0		
System	0.31	44 K	560 K	4		
smss.exe	0.85	0 K	0 K	n/a	Hardware Interrupts and DPCs	
csrss.exe		196 K	204 K	500		
csrss.exe		736 K	1,436 K	592		
lsass.exe	0.02	976 K	3,116 K	656		
wininit.exe		688 K	384 K	668		
csrss.exe	< 0.01	1,316 K	3,044 K	764		
svchost.exe	0.02	2,924 K	5,948 K	840	Host Process for Windows S	Microsoft Corporation
VimPrivSE.exe		1,420 K	6,372 K	5048		

Name	Description	Company Name	Path
advapi32.dll	Advanced Windows 32 Base API	Microsoft Corporation	C:\Windows\System32\advapi32.dll
bcryptprimitives.dll	Windows Cryptographic Primitives Library	Microsoft Corporation	C:\Windows\System32\bcryptprimitives.dll
combase.dll	Microsoft COM for Windows	Microsoft Corporation	C:\Windows\System32\combase.dll
comctl32.dll	User Experience Controls Library	Microsoft Corporation	C:\Windows\WinSxS\x86_microsoft.windows.common-int...
comdlg32.dll	Common Dialogs DLL	Microsoft Corporation	C:\Windows\System32\comdlg32.dll
cryptbase.dll	Base cryptographic API DLL	Microsoft Corporation	C:\Windows\System32\cryptbase.dll
dwmapi.dll	Microsoft Desktop Window Manager API	Microsoft Corporation	C:\Windows\System32\dwmsapi.dll
gdi32.dll	GDI Client DLL	Microsoft Corporation	C:\Windows\System32\gdi32.dll
imm32.dll	Multi-User Windows IMM32 API Client DLL	Microsoft Corporation	C:\Windows\System32\imm32.dll
kemal.appcore.dll	AppModel API Host	Microsoft Corporation	C:\Windows\System32\kemal.appcore.dll
kernel32.dll	Windows NT BASE API Client DLL	Microsoft Corporation	C:\Windows\System32\kernel32.dll
KernelBase.dll	Windows NT BASE API Client DLL	Microsoft Corporation	C:\Windows\System32\KernelBase.dll
locale.nls			C:\Windows\System32\locale.nls
mscutil.dll	MSCHF Server DLL	Microsoft Corporation	C:\Windows\System32\mscutil.dll
msvcr.dll	Windows NT CRT DLL	Microsoft Corporation	C:\Windows\System32\msvcr.dll
notepad.exe	Notepad	Microsoft Corporation	C:\Windows\System32\notepad.exe
notepad.exe.mui	Notepad	Microsoft Corporation	C:\Windows\System32\en-US\notepad.exe.mui
ntdll.dll	NT Layer DLL	Microsoft Corporation	C:\Windows\System32\ntdll.dll
ole32.dll	Microsoft OLE for Windows	Microsoft Corporation	C:\Windows\System32\ole32.dll
oleaut32.dll		Microsoft Corporation	C:\Windows\System32\oleaut32.dll

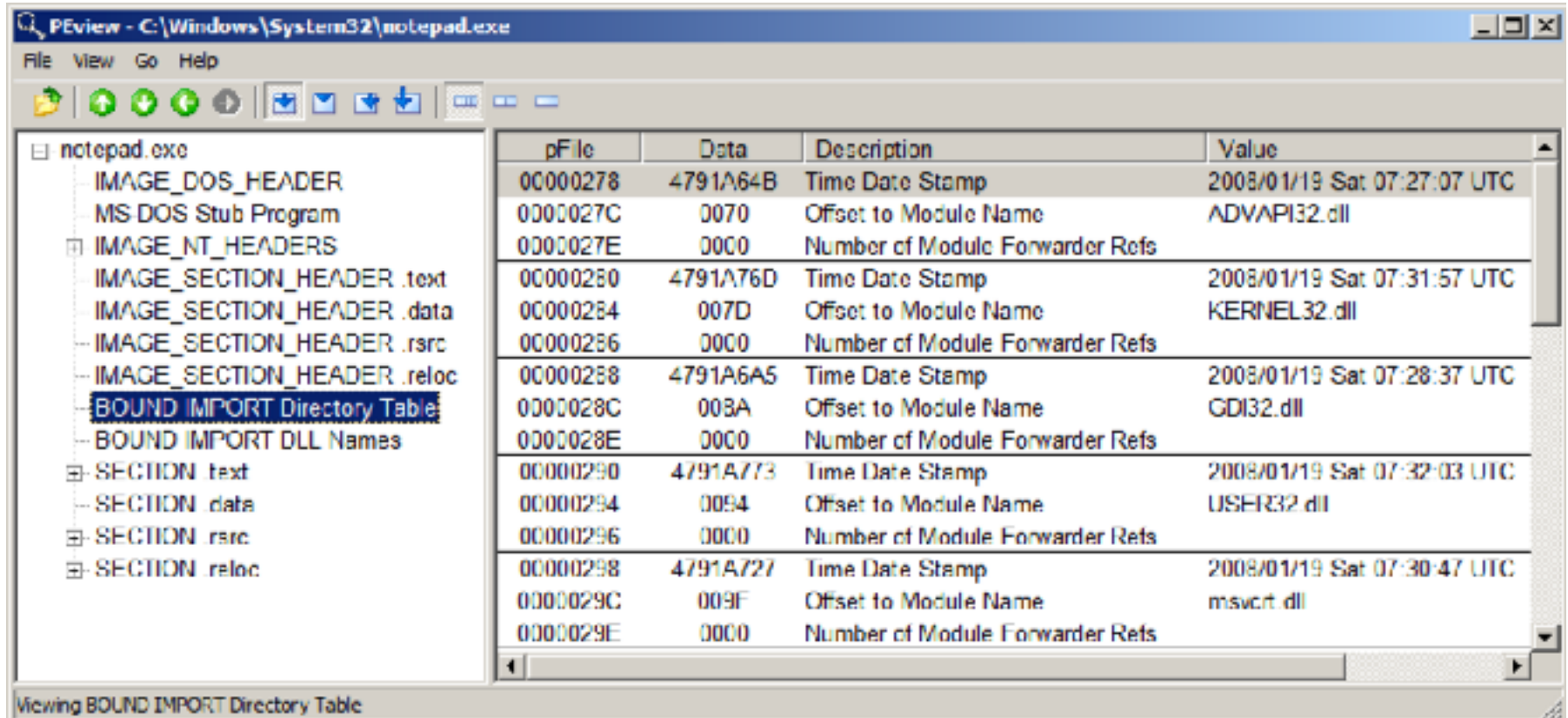
CPU Usage: 7.65%    Commit Charge: 35.79%    Processes: 42    Physical Usage: 68.88%

# PE (Portable Executable) Files

- Format used for .EXE and .DLL files
  - And some other extensions (link Ch 6c)
- Can be loaded on every 32-bit (or 64-bit) Windows version
- Contains information about all required DLLs
- Easy to see with PEView (link Ch 6d)



# Import Table for Notepad



PEView - C:\Windows\System32\notepad.exe

File View Go Help

notepad.exe

- IMAGE\_DOS\_HEADER
- MS-DOS Stub Program
- IMAGE\_NT\_HEADERS
  - IMAGE\_SECTION\_HEADER .text
  - IMAGE\_SECTION\_HEADER .data
  - IMAGE\_SECTION\_HEADER .rsrc
  - IMAGE\_SECTION\_HEADER .reloc
  - BOUND\_IMPORT Directory Table**
  - BOUND\_IMPORT DLL Names
- SECTION text
- SECTION data
- SECTION rsrc
- SECTION reloc

pFile	Data	Description	Value
00000278	4791A64B	Time Date Stamp	2008/01/19 Sat 07:27:07 UTC
0000027C	0070	Offset to Module Name	ADVAPI32.dll
0000027E	0000	Number of Module Forwarder Refs	
00000280	4791A76D	Time Date Stamp	2008/01/19 Sat 07:31:57 UTC
00000284	007D	Offset to Module Name	KERNEL32.dll
00000286	0000	Number of Module Forwarder Refs	
00000288	4791A6A5	Time Date Stamp	2008/01/19 Sat 07:28:37 UTC
0000028C	008A	Offset to Module Name	GDI32.dll
0000028E	0000	Number of Module Forwarder Refs	
00000290	4791A773	Time Date Stamp	2008/01/19 Sat 07:32:03 UTC
00000294	0094	Offset to Module Name	USER32.dll
00000296	0000	Number of Module Forwarder Refs	
00000298	4791A727	Time Date Stamp	2008/01/19 Sat 07:30:47 UTC
0000029C	009F	Offset to Module Name	msvcrt.dll
0000029E	0000	Number of Module Forwarder Refs	

Viewing BOUND\_IMPORT Directory Table

- Windows Server 2008 Version

# Sections of a PE File

- .text - instructions to execute
- .data - global variables
- .idata - Import descriptors
- .rsrc - Resources (icons, etc.)
- .reloc - Relocation data

# Relocating PE Files

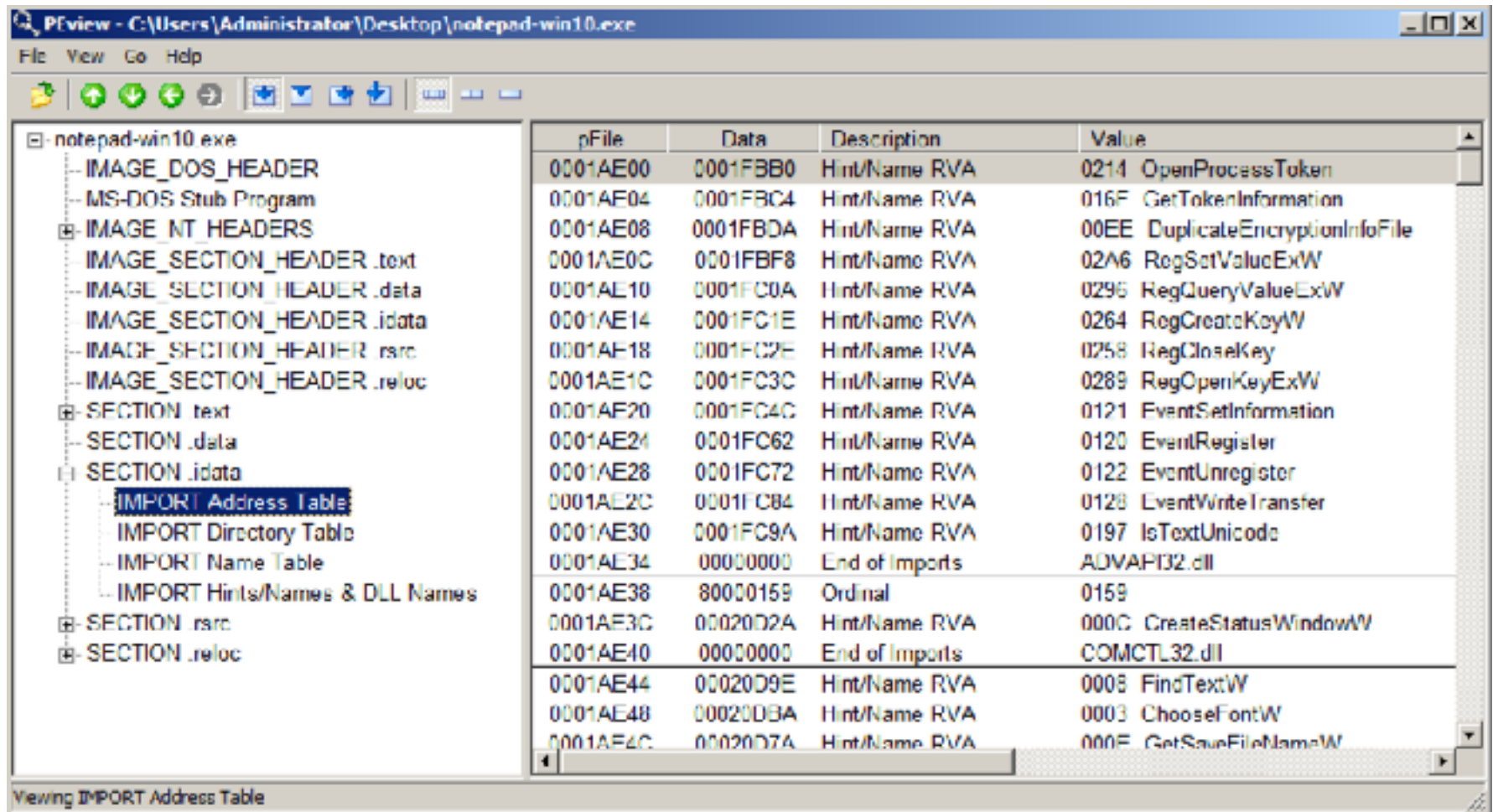
- DLLs have a Base Address
  - This is where they are designed to load
- But two DLLs might have the same Base Address
  - And both be used by the same EXE
- One of them must be moved--"Rebased"
- This process uses the .reloc section

**Kahoot!**

# Imports and Exports

- Imports
  - Functions the program needs to use from other code
  - Both EXE and DLL files have imports
  - The imports generally point to DLL's
- Exports
  - Functions this program offers for others to use
  - DLL's have many exports, EXE's don't

# Notepad.exe Imports



PEView - C:\Users\Administrator\Desktop\notepad-win10.exe

File View Go Help

notepad-win10.exe

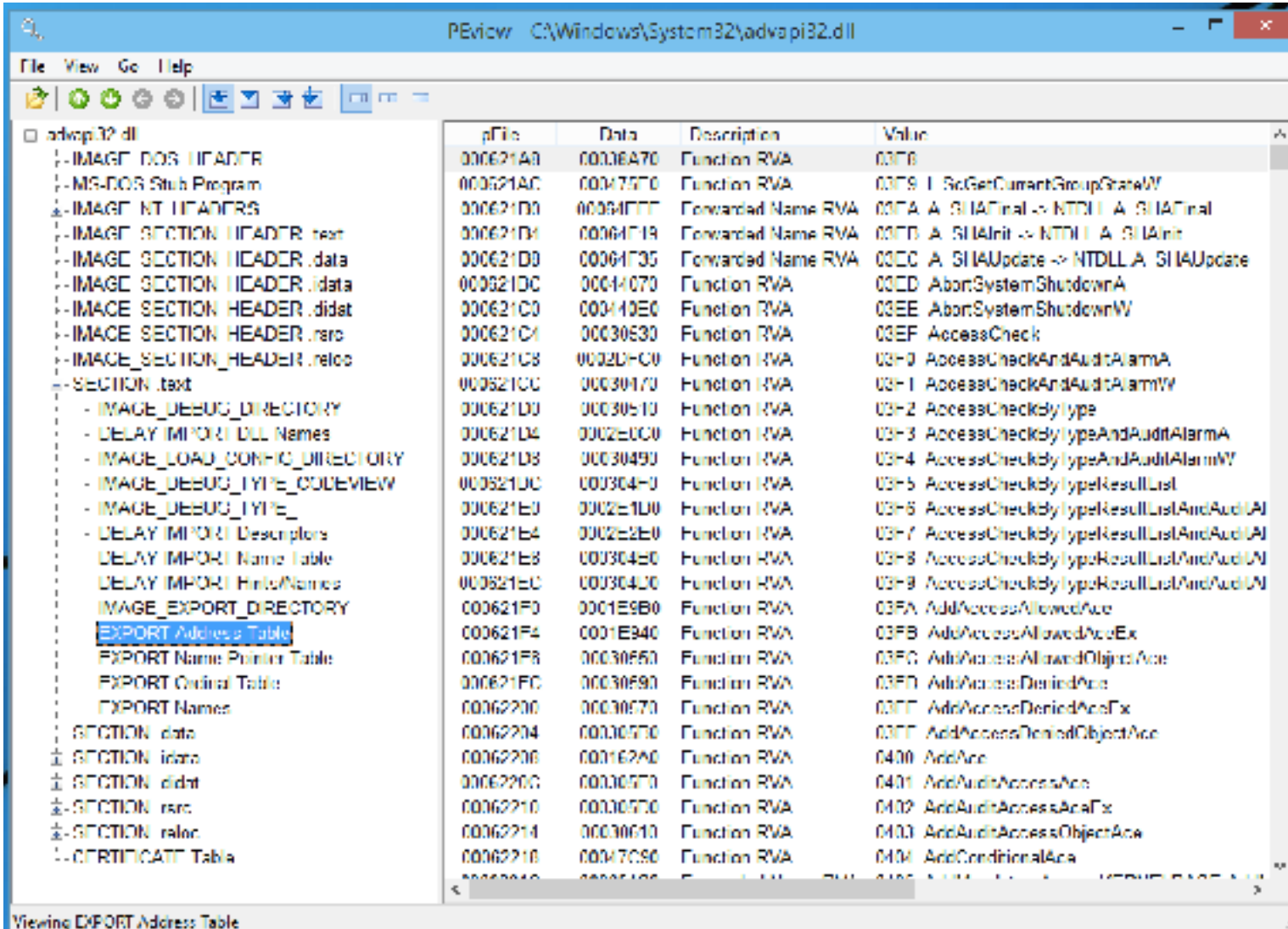
- IMAGE\_DOS\_HEADER
- MS-DOS Stub Program
- IMAGE\_NT\_HEADERS
  - IMAGE\_SECTION\_HEADER .text
  - IMAGE\_SECTION\_HEADER .data
  - IMAGE\_SECTION\_HEADER .idata
    - IMPORT Address Table**
    - IMPORT Directory Table
    - IMPORT Name Table
    - IMPORT Hints/Names & DLL Names
  - SECTION .rsrc
  - SECTION .reloc

pFile	Data	Description	Value
0001AE00	0001FBB0	Hint/Name RVA	0214 OpenProcessToken
0001AE04	0001FBC4	Hint/Name RVA	016F GetTokenInformation
0001AE08	0001FBDA	Hint/Name RVA	00EE DuplicateEncryptionInfoFile
0001AE0C	0001FBF8	Hint/Name RVA	02A6 RegSetValueExW
0001AE10	0001FC0A	Hint/Name RVA	0296 RegQueryValueExW
0001AE14	0001FC1E	Hint/Name RVA	0264 RegCreateKeyW
0001AE18	0001FC2E	Hint/Name RVA	0258 RegCloseKey
0001AE1C	0001FC3C	Hint/Name RVA	0289 RegOpenKeyExW
0001AE20	0001FC4C	Hint/Name RVA	0121 EventSetInformation
0001AE24	0001FC62	Hint/Name RVA	0120 EventRegister
0001AE28	0001FC72	Hint/Name RVA	0122 EventUnregister
0001AE2C	0001FC84	Hint/Name RVA	0128 EventWriteTransfer
0001AE30	0001FC9A	Hint/Name RVA	0197 IsTextUnicode
0001AE34	00000000	End of Imports	ADVAPI32.dll
0001AE38	80000159	Ordinal	0159
0001AE3C	00020D2A	Hint/Name RVA	000C CreateStatusWindowW
0001AE40	00000000	End of Imports	COMCTL32.dll
0001AE44	00020D9E	Hint/Name RVA	0008 FindTextW
0001AE48	00020DBA	Hint/Name RVA	0003 ChooseFontW
0001AE4C	00020D7A	Hint/Name RVA	000F GetSaveFileNameW

Viewing IMPORT Address Table

- Windows 10 Version

# Advapi32.dll Exports



PEView C:\Windows\System32\advapi32.dll

File View Go Help

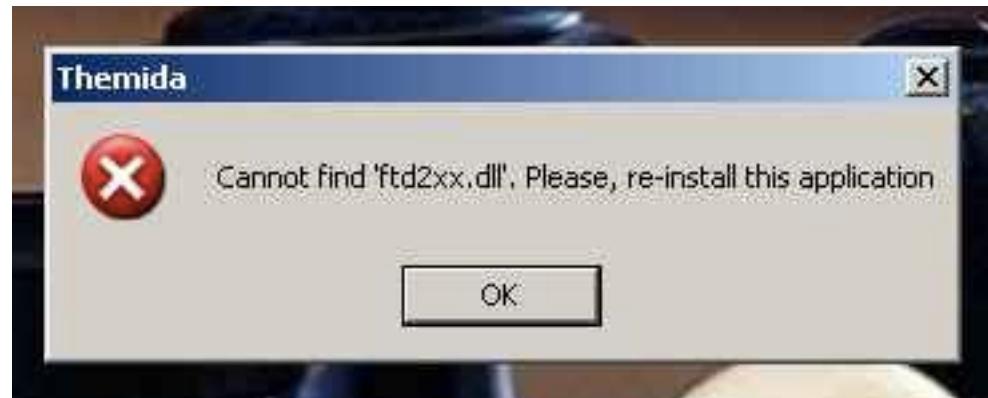
advapi32.dll

- IMAGE\_DOS\_HEADER
- MS-DOS Stub Program
- IMAGE\_NT\_HEADERS
- IMAGE\_SECTION\_HEADER .text
- IMAGE\_SECTION\_HEADER .data
- IMAGE\_SECTION\_HEADER .idata
- IMAGE\_SECTION\_HEADER .didst
- IMAGE\_SECTION\_HEADER .rsrc
- IMAGE\_SECTION\_HEADER .reloc
- SECTION .text
  - IMAGE\_DEBUG\_DIRECTORY
  - DELAY\_IMPORT\_DLL Names
  - IMAGE\_LOAD\_CONFIG\_DIRECTORY
  - IMAGE\_DEBUG\_TYPE\_CODEVIEW
  - IMAGE\_DEBUG\_TYPE\_\*
  - DELAY\_IMPORT\_Descriptors
  - DELAY\_IMPORT Name Table
  - DELAY\_IMPORT Hint/Names
  - IMAGE\_EXPORT\_DIRECTORY
  - EXPORT Address Table**
  - EXPORT Name Pointer Table
  - EXPORT Ordinal Table
  - EXPORT Names
- SECTION .data
- SECTION .idata
- SECTION .didst
- SECTION .rsrc
- SECTION .reloc
- CERTIFICATE Table

pFile	Data	Description	Value
000621A0	0003EA70	Function RVA	0376
000621A0	00047570	Function RVA	0379   SoGetCurrentGroupGrateW
000621D0	00064F77	Forwarded Name RVA	03FA A_SHIAFinal -> NTDLL.A_SHIAFinal
000621D1	00064F19	Forwarded Name RVA	03FD A_SHIAInit -> NTDLL.A_SHIAInit
000621D0	00064F35	Forwarded Name RVA	03EC A_SHIAUpdate -> NTDLL.A_SHIAUpdate
000621D0	00044070	Function RVA	03ED AbortSystemShutdownA
000621D0	000440E0	Function RVA	03EE AbortSystemShutdownW
000621C1	00030630	Function RVA	03EF AccessCheck
000621C8	0002D7C0	Function RVA	03F0 AccessCheckAndAuditAlarmA
000621C0	00030170	Function RVA	03F1 AccessCheckAndAuditAlarmW
000621D0	00030510	Function RVA	03F2 AccessCheckByType
000621D4	0002E0C0	Function RVA	03F3 AccessCheckByTypeAndAuditAlarmA
000621D8	00030490	Function RVA	03F4 AccessCheckByTypeAndAuditAlarmW
000621D0	00030470	Function RVA	03F5 AccessCheckByTypeResultList
000621E0	0002E1D0	Function RVA	03F6 AccessCheckByTypeResultListAndAuditA
000621E4	0002E2E0	Function RVA	03F7 AccessCheckByTypeResultListAndAuditA
000621E8	000304E0	Function RVA	03F8 AccessCheckByTypeResultListAndAuditA
000621E0	000304D0	Function RVA	03F9 AccessCheckByTypeResultListAndAuditA
000621F0	0001E9B0	Function RVA	03FA AddAccessAllowedAce
000621F4	0001E940	Function RVA	03FB AddAccessAllowedAceEx
000621F8	00030650	Function RVA	03FC AddAccessAllowedObjectAce
000621FC	00030690	Function RVA	03FD AddAccessDeniedAce
00062200	00030670	Function RVA	03FE AddAccessDeniedAceEx
00062204	00030670	Function RVA	03FF AddAccessDeniedObjectAce
00062200	0001E2A0	Function RVA	0400 AddAce
00062200	00030670	Function RVA	0401 AddAuditAccessAce
00062210	00030670	Function RVA	0402 AddAuditAccessAceEx
00062214	00030610	Function RVA	0403 AddAuditAccessObjectAce
00062218	00047C90	Function RVA	0404 AddConditionalAce

Viewing EXPORT Address Table

# DLL Loading

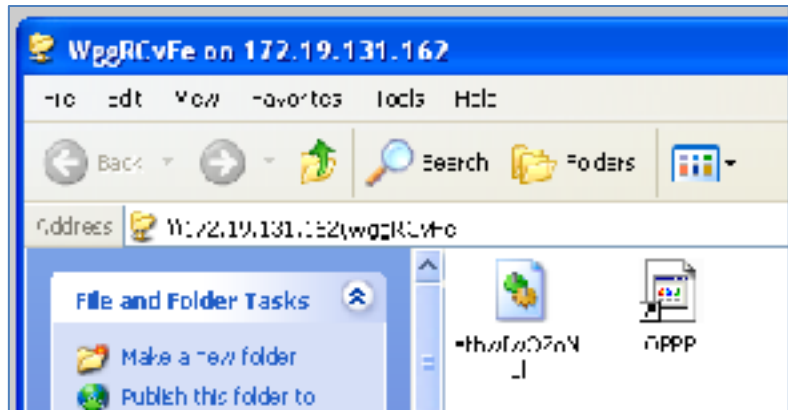


- When an EXE launches, Windows hunts for the required DLLs
  - Looking first in the current working directory
- This allows a developer to include a DLL version other than the one in C:\Windows\System32
  - Leads to DLL Hell; users may need to adjust PATH to resolve DLL version conflicts



# Stuxnet: LNK 0day

- Loaded a DLL from a USB thumbdrive
- Took over the machine as soon as the icons appear
  - Link Ch 6h



# Relative Virtual Address (RVA)

- Windows EXE processes are loaded into 0x00400000 by default
  - This is a Virtual Address, only visible to each process
  - Error on page 113 of textbook, too many zeroes in 0x00400000
- RVA is used to aid in rebasing DLLs
  - Loading them in non-preferred locations

# Example of VA (Virtual Address)

For example, a possible physical memory address (visible by the CPU):

```
0x00300000 on physical memory has process A's main  
0x00500000 on physical memory has process B's main
```

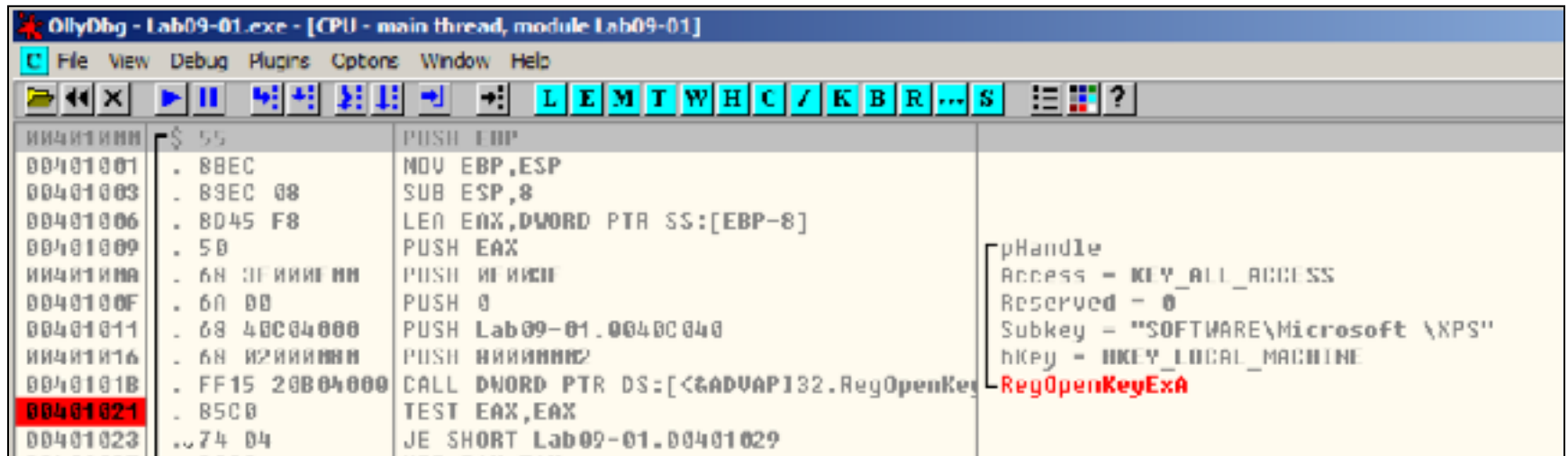
And the OS may have a mapping table:

```
process A's 0x00400000 (VA) = physical address 0x00300000  
process B's 0x00400000 (VA) = physical address 0x00500000
```

Then when you try to read 0x00400000 in process A, you'll get the content which is located on 0x00300000 of physical memory.

- Link Ch 6g

# OllyDbg: Code Starts Near 0x400000



The screenshot shows the OllyDbg interface for a process named 'Lab09-01.exe'. The assembly window displays the following code:

Address	Disassembly
00401001	MOV EBP,ESP
00401003	SUB ESP,8
00401006	LEA EAX,DWORD PTR SS:[EBP-8]
00401009	PUSH EAX
0040100A	PUSH 0
0040100F	PUSH 0
00401011	PUSH Lab09-01.0040C040
00401016	PUSH 0
0040101B	CALL DWORD PTR DS:[<&ADVAPI32.RegOpenKeyExA
00401021	TEST EAX,EAX
00401023	JE SHORT Lab09-01.00401029

The register window on the right shows the following values:

- pHandle
- Access = KEY\_ALL\_ACCESS
- Reserved = 0
- Subkey = "SOFTWARE\Microsoft\XPS"
- hKey = HKEY\_LOCAL\_MACHINE

The instruction at address 00401021 is highlighted in red in the assembly window, and the 'RegOpenKeyExA' function name is also highlighted in red in the register window.

# Heaps

# Many Heaps

- Heap is used for temporary storage of data
  - Via `malloc()` and `free()`
- Linux uses one heap, but Windows uses many heaps
- Each DLL that loads can set up its own heap
- Heap corruption attacks are very confusing

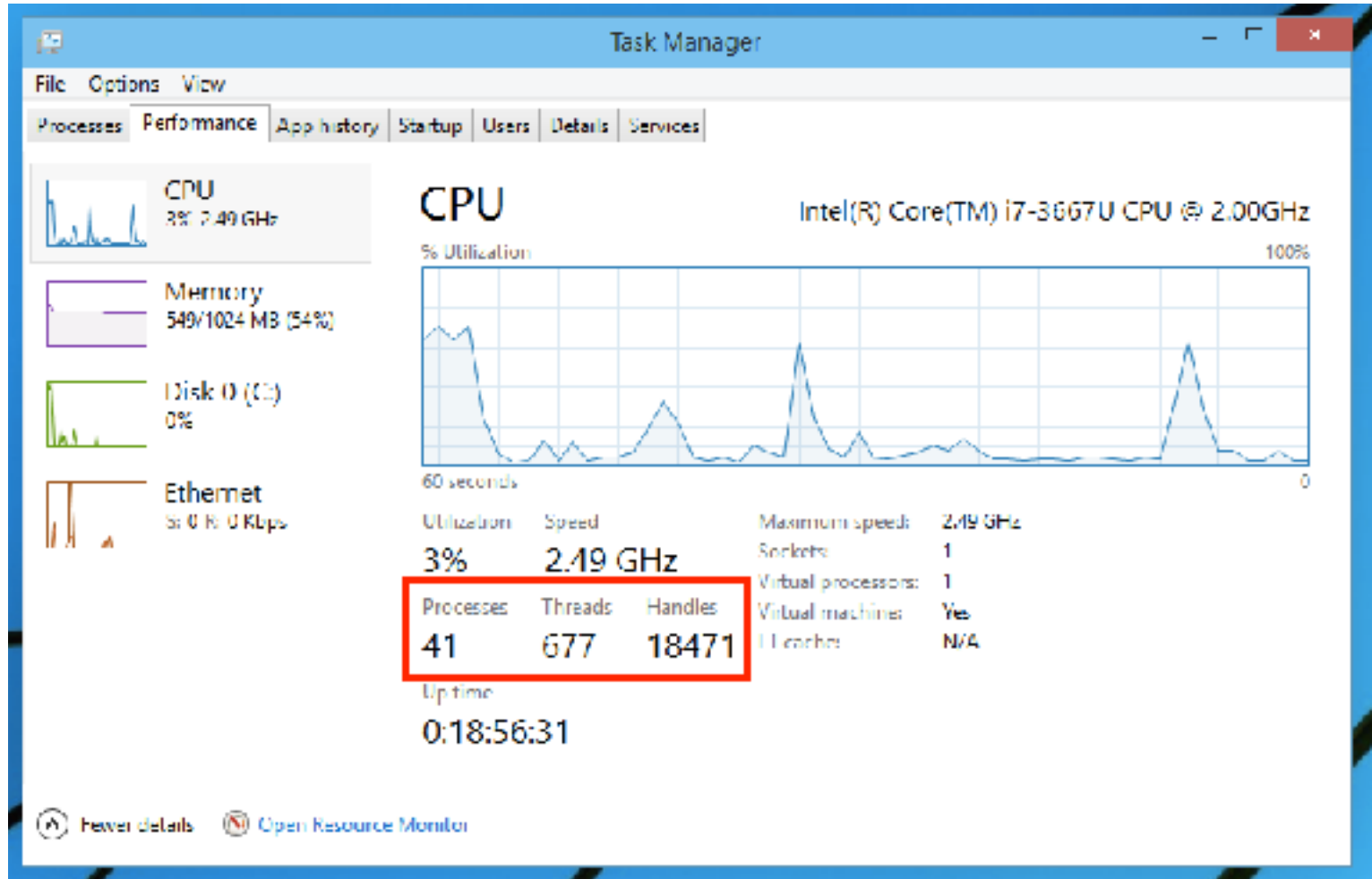
# Threading

# One Process, Many Threads

- Each process is subdivided into **threads**
- Processor time slices are allocated to threads, not processes
- This allows a single process to operate more efficiently
  - If one thread is waiting for something, other threads can keep moving



# Threads in Task Manager



# Handles

- Handles are pointers to objects like open files
- Each thread has many handles
- You can view details about every thread with Process Explorer

Process Explorer - Sysinternals - www.sysinternals.com [WIN-8LDVLI8ODEN\sam]

explorer.exe(3128) Properties

Image Performance Performance Graph GPU Graph **Threads** TCP/IP Security Environment Strings

Count: 56

TID	CPU	Cycles Delta	Start Address
3218	0.08	1,289,600	SHI32H-dllK0x1a129111bae40
3292	< 0.01	62,130	twinkl.apocore.dllDdGetClassObject+0x4b3e0
2116			rdll.dllHISvcHeap+1b1640
3252			SHI32H-dllK0x1a129111bae40
3264			windows.imm32.dllserviceprovider.dllHIDandInputNew+1b1640
3230			twinkl.apocore.dll+0x24e70
3264			SHI32H-dllK0x1a129111bae40
3760			SHI32H-dllK0x1a129111bae40
1896			SHI32H-dllK0x1a129111bae40
3190			combase.dllDdGetErrorInfo+0x110
3280			SHI32H-dllK0x1a129111bae40
3524			ntdll.dllRtlSizeTloop+0x1040
2212			rdll.dllHISvcHeap+1b1640
300			ntdll.dllRtlSizeTloop+0x1040
8072			rdll.dllHISvcHeap+1b1640
4204			ntdll.dllRtlSizeTloop+0x1040

Thread ID: 3128  
 Start Time: 12:41:11 PM 12/12/2014  
 State: Wait:Waiter Request Base Priority: 8  
 Kind: Time: 00:00:01.984 Dynamic Priority: 10  
 User Time: 00:00:02.728 I/O Priority: Normal  
 Control Switches: 18,178 Memory Priority: 5  
 Cycles: 9,729,467,628 Total Processes: 3

Stack Monitor

Permissions Kill Suspend

OK Cancel

Process Name	Private Bytes	Working Set	Private Bytes	Private Bytes	Private Bytes	Private Bytes	Private Bytes	Private Bytes	Private Bytes
explorer.exe	6,000 K	2,760 K	2,760 K	2,760 K	2,760 K	2,760 K	2,760 K	2,760 K	2,760 K
vmtoolsd.exe	0:12	14,750 K	10,064 K	3900 VMware Tools Core Service	VMware, Inc.				
SkyDrive.exe	0:00	4,412 K	3,970 K	4000 Microsoft OneDrive	Microsoft Corporation				
procexp.exe	6:30	23,102 K	39,000 K	5780 Sysinternals Process Explorer	Systeminternals - www.sysinter...				

**Kahoot!**

**The Genius and Idiocy of the DCOM**  
**(Distributed Common Object**  
**Model)**  
**and**  
**DCE-RPC**  
**(Distributed Computing Environment**  
**/ Remote Procedure Calls)**

# Follow the Money

- Microsoft's business model is to distribute binary packages for money
- You can build a complex application by purchasing third-party COM modules from vendors
  - And tying them together with Visual Basic

# COM Objects

- Can be written in any supported language
- Interoperate seamlessly
- BUT a C++ integer is not the same as a Visual Basic integer
- So you need to define the input and outputs with an IDL (Interface Description Language) file

# DCOM Interface Description Language (IDL) File

```
[ uuid(e33c0cc4-0482-101a-bc0c-02608c6ba218),  
  version(1.0),  
  implicit_handle(handle_t rpc_binding)  
] interface ???  
{  
  typedef struct {  
    TYPE_2 element_1;  
    TYPE_3 element_2;  
  } TYPE_1;  
  ...  
  
  short Function_00(  
    [in] long element_9,  
    [in] [unique] [string] wchar_t *element_10,  
    [in] [unique] TYPE_1 *element_11,  
    [in] [unique] TYPE_1 *element_12,  
    [in] [unique] TYPE_2 *element_13,  
    [in] long element_14,  
    [in] long element_15,  
    [out] [context_handle] void *element_16  
  );
```



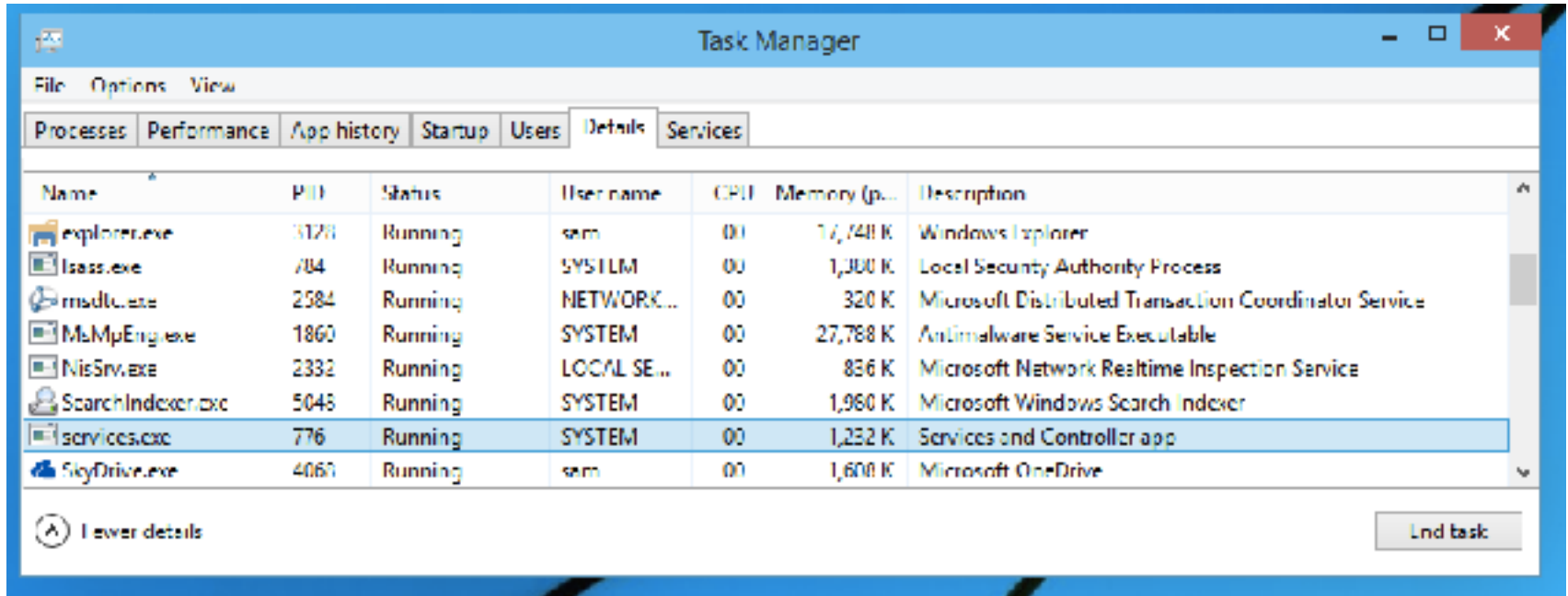
# DCOM IDL File

- Specifies arguments and return values for a particular function
  - In a particular interface defined by UUID, also called a GUID
  - GUID is 128 bits long; 32 hex characters

# Two Ways to Load a COM Object

- Load directly into process space as a DLL
- Launch as a service
  - By the Service Control Manager (services.exe)
- Running as a service is more stable and secure
  - But much slower
- In-process calls are 1000 times faster than calling a COM interface on the same machine but in a different process

# Service Control Manager (SCM)



- Appears in Task Manager as services.exe

# DCOM Calls

- Microsoft's priority: make it easy for developers to write software
- A simple registry or parameter change tells a program to use a different process
  - Or even a different machine
- A process can call a COM interface on a different machine on the LAN
  - 10x slower than calling a COM interface on the same machine

# RPC Endpoint Mapper

- Listening on port TCP 135
  - An RPC request in Wireshark

The image shows a Windows desktop environment. In the background, the 'Computer Management' window is open, displaying the 'Services' console. In the foreground, the Wireshark network traffic analyzer is open, showing a capture on the 'Ethernet' interface. The filter is set to 'tcpport == 135'. The packet list pane shows several packets, with packet 1607 highlighted. The packet details pane shows the structure of an RPC request.

No.	Time	Source	Destination	Protocol	Length	Info
1607	70.467195000	192.168.119.249	192.168.119.137	TCP	68	49377 > 135 [RST] Seq=0 win=0 len=0 MSS=1460
1603	70.467808000	192.168.119.137	192.168.119.249	TCP	68	135 > 49377 [RST] Seq=0 Ack=1 win=0 len=0
1604	70.467881000	192.168.119.249	192.168.119.137	TCP	54	49377 > 135 [ACK] Seq=1 Ack=1 Win=61536 Len=0
1605	70.468740000	192.168.119.249	192.168.119.137	RPC	170	kind: call_id: 2, fragment: single, 2 context fr
1606	70.469020000	192.168.119.137	192.168.119.249	RPC	138	kind: ack: call_id: 2, fragment: single, max_cont
1607	70.469091000	192.168.119.249	192.168.119.137	RPC	210	map request, SWC II, 32bit NW
1608	70.469477000	192.168.119.137	192.168.119.249	RPC	206	map response, SWC II, 32bit NW
1641	70.523813000	192.168.119.249	192.168.119.137	TCP	54	49377 > 135 [ACK] Seq=273 Ack=237 Win=65280 Len=
1694	193.040918000	192.168.119.249	192.168.119.137	TCP	54	49377 > 135 [RST] Seq=273 Ack=237 Win=65280 Len=
1695	193.041416000	192.168.119.137	192.168.119.249	TCP	60	135 > 49377 [ACK] Seq=237 Ack=274 Win=65536 Len=
1696	193.041418000	192.168.119.137	192.168.119.249	TCP	60	135 > 49377 [RST] Seq=237 Ack=274 Win=65536 Len=
1697	193.041451000	192.168.119.249	192.168.119.137	TCP	54	49377 > 135 [ACK] Seq=274 Ack=238 Win=65280 Len=

# Maps to UUID Values

- Map request shows available RPC functions
  - Link Ch 6m for details

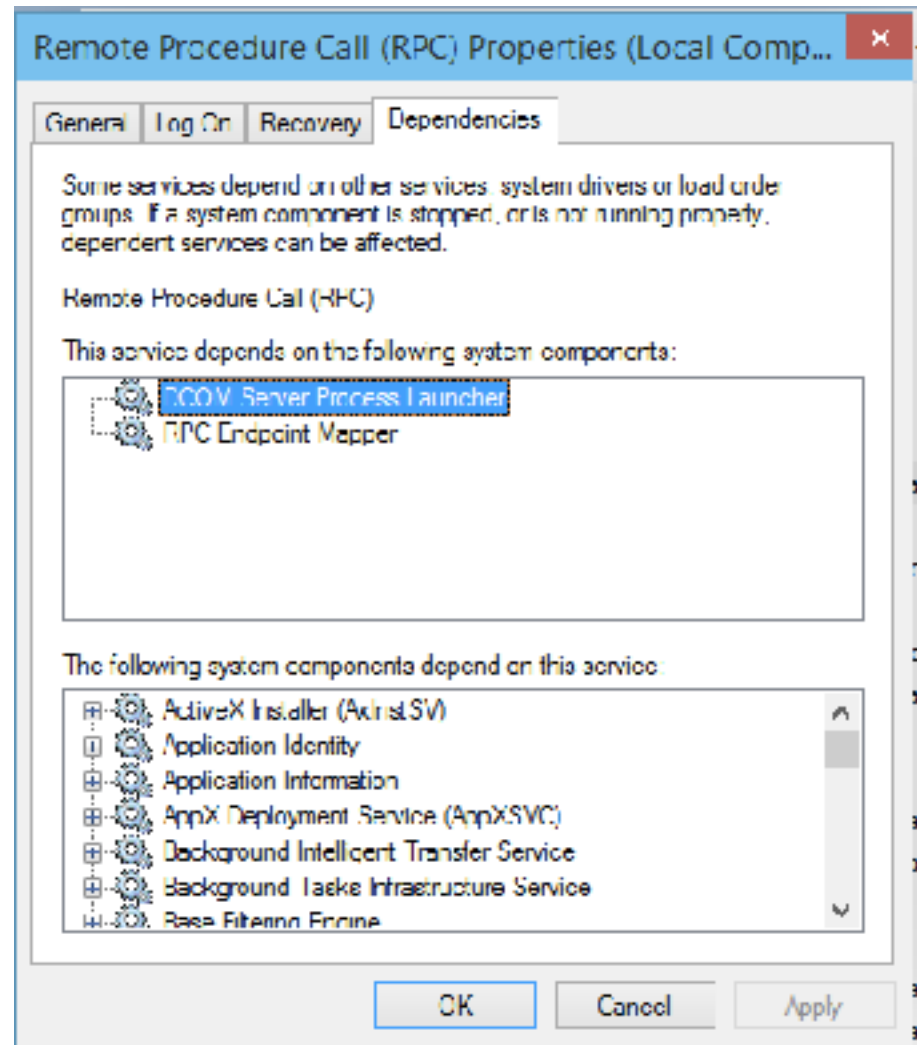
Filter: tcp.port == 135

No.	Time	Source	Destination	Protocol	Length	Info
1605	70.468740000	192.168.119.249	192.168.119.137	DCERPC	170	Bind: call_id: 2, Fragment: Single, 2 context
1606	70.469020000	192.168.119.137	192.168.119.249	DCERPC	138	Bind ack: call_id: 2, Fragment: Single, max_xr
1607	70.469091000	192.168.119.249	192.168.119.137	RPM	210	Map request, SVCCTL, 32bit NDR
1608	70.469177000	192.168.119.137	192.168.119.249	RPM	206	Map response, SVCCTL, 32bit NDR
1641	70.523813000	192.168.119.249	192.168.119.137	TCP	54	49377 > 135 [ACK] Seq=273 Ack=237 Win=65280 Li

```
Number of floors: 5
- Floor 1 UUID: SVCCTL
  LIS Length: 19
  Protocol: UUID (0x0d)
  UUID: SVCCTL (36/abb81-9844-35f1-ad32-98f038001003)
  Version 2.0
  RHS Length: 2
  Version Minor: 0
+ Floor 2 UUID: 32bit NDR
  LIS Length: 19
  Protocol: UUID (0x0d)
  UUID: 32bit NDR (8a885d04-1ceb-11c9-9fe8-08002b104860)
  Version 2.0
  RHS Length: 2
  Version Minor: 0
```

# Components that Depend on RPC

- Open Services
- Double-click "Remote Procedure Call"



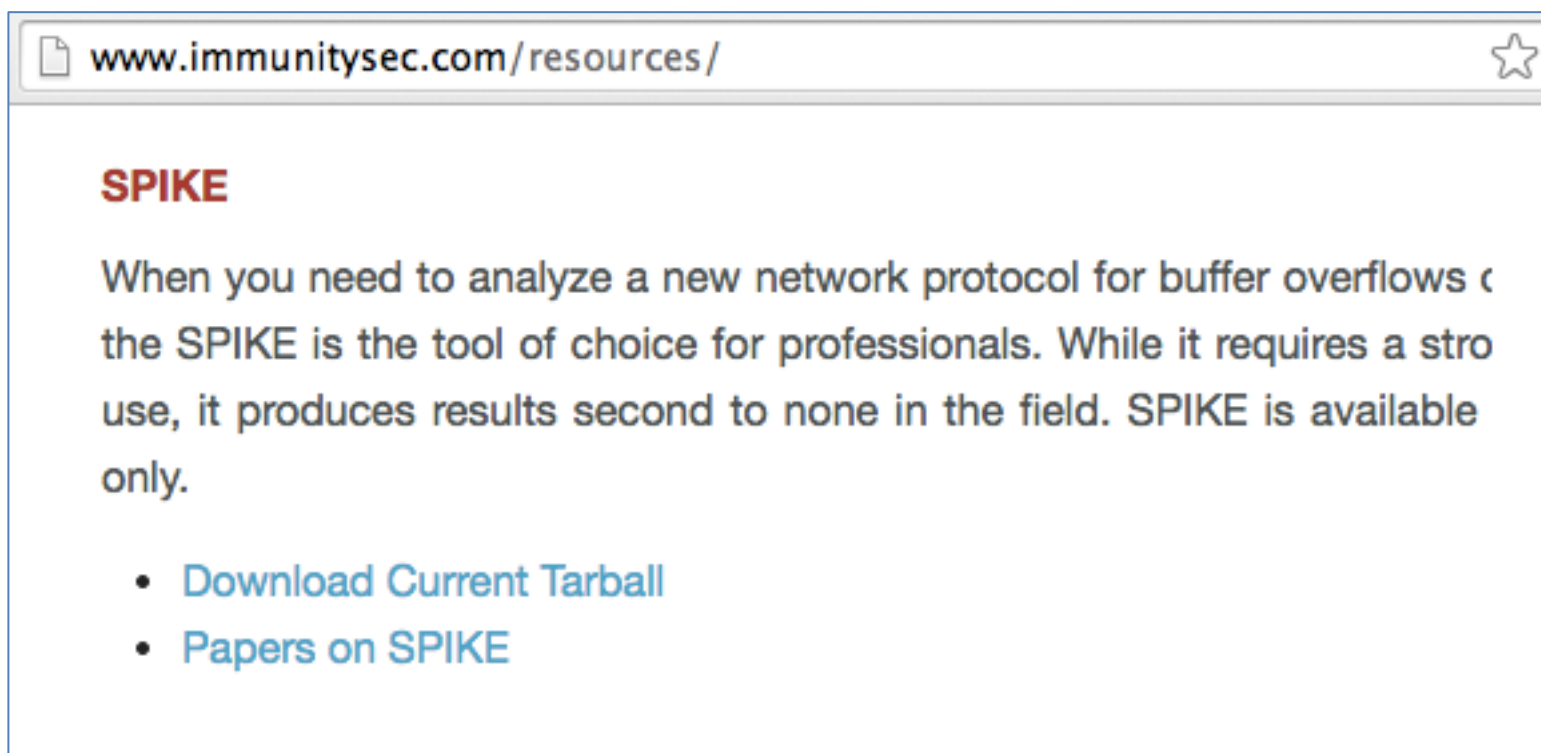
# Security Implications

- Code can be designed to run in a trusted environment
  - Calling DLLs that are included in your application, or Microsoft DLLs
- And easily adapted to run in an untrusted environment
  - Listening on a network port



# DEC-RPC Exploitation

- Recon, fuzz, and exploit with Dave Aitel's SPIKE and other tools



The screenshot shows a web browser window with the address bar containing [www.immunitysec.com/resources/](http://www.immunitysec.com/resources/). The page content includes the title **SPIKE** in red, followed by a paragraph describing the tool as a choice for professionals for analyzing network protocols for buffer overflows. Below the paragraph is a bulleted list of links: [Download Current Tarball](#) and [Papers on SPIKE](#).

# Tokens and Impersonation

# Token

- A token is a 32-bit integer like a file handle
- Defines user rights

The screenshot shows the Process Explorer application window. The title bar reads "Process Explorer - Sysinternals: www.sysinternals.com [WIN-8LDVLI8QDEN]". The menu bar includes "File", "Options", "View", "Process", "Find", "Handle", "Users", and "Help". The toolbar contains various icons for file operations and process management. The main window is divided into two panes. The top pane is a table of running processes, and the bottom pane shows the token information for the selected process, explorer.exe.

Process	CPU	Private Bytes	Working Set	PID	Description	Company Name
wininit.exe		672 K	3,476 K	664	Windows Start-Up Application	Microsoft Corporation
winlogon.exe		1,188 K	5,136 K	700	Windows Logon Application	Microsoft Corporation
explorer.exe	0.08	36,696 K	72,616 K	2032	Windows Explorer	Microsoft Corporation

Type	Name	Object Address
Thread	winlogon.exe(700): 988	0xA00D8040
Token	NT AUTHORITY\SYSTEM:3e7	0xA2AAA030
Token	NT AUTHORITY\SYSTEM:3e7	0xA2AAA840
Token	WIN-8LDVLI8QDEN\sam:14318	0xA555DAE0
Token	WIN-8LDVLI8QDEN\sam:14318	0xA55176E8
Token	WIN-8LDVLI8QDEN\sam:14318	0xA552FC60
Token	WIN-8LDVLI8QDEN\sam:14318	0xA555DAE0
WindowStation	\Sessions\1\Windows\WindowStations\WinSta0	0x803D5E10

# Exploiting Token Handling

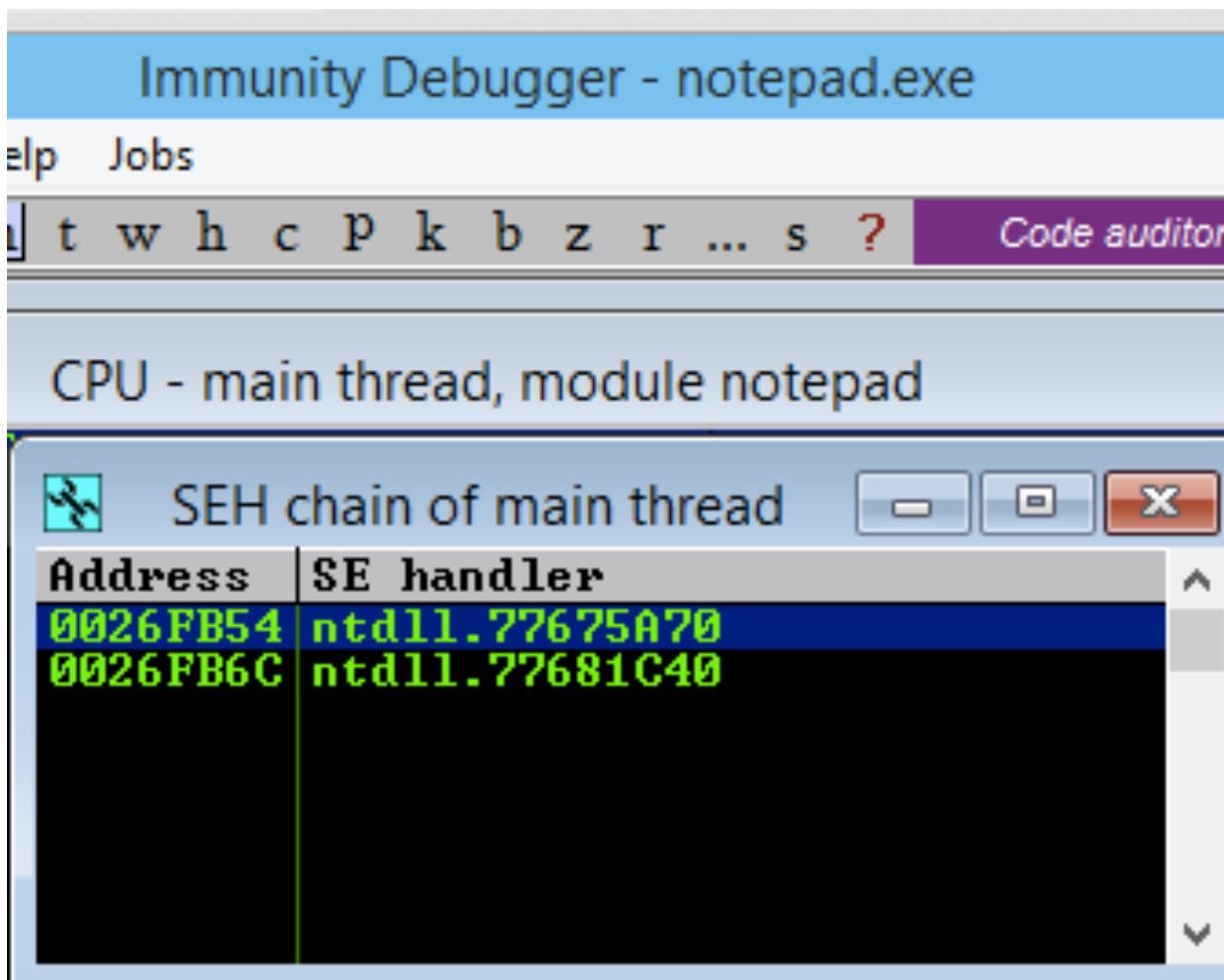
- Attacker can create threads and copy any available token to them
- There are typically tokens available for any user that has recently authenticated

# Exception Handling

# Structured Exception Handler (SEH)

- When an illegal operation occurs, such as
  - Divide by zero
  - Attempt to execute non-executable memory
  - Attempt to use invalid memory location
- The processor sends an **Exception**
- The OS can handle it, with an error message or a Blue Screen of Death
- But the application can specify custom **exception handlers**

# SEH in Immunity Debugger



# Exploiting the SEH

- Overwrite the pointer to the SEH chain
- Overwrite the function pointer for the handler on the stack
- Overwrite the default exception handler



# Debuggers

# Three Options

- SoftICE
  - Old, powerful, difficult to install
- WinDbg
  - Use by Microsoft
  - Can debug the kernel, using a serial cable and two computers
    - Or Ethernet, for Win 8 or later
    - Or LiveKD and one machine
  - UI is terrible
- OllyDbg
  - Very popular but apparently abandoned

# OllyDbg

- OllyDbg version 1.10 is very nice
- OllyDbg 2.x is terrible, giving false results, and useless
- No later version seems to be available

# Immunity Debugger



# Immunity Debugger

- Based on OllyDbg
- Still alive and under development
- Used by many exploit developers

# Immunity Debugger

The screenshot displays the Immunity Debugger interface with the following components:

- Assembly Code:** A list of assembly instructions with their addresses and mnemonics. A white box labeled "Assembly Code" highlights the instruction `OR ECK, ECK` at address `77924129`.
- Registers (FPU):** A window showing the state of various registers. A white box labeled "Registers" highlights the `EIP` register, which contains the address `77924109`.
- Hex Dump:** A window showing the memory dump at the current instruction address. A white box labeled "Hex Dump" highlights the memory address `00403000`.
- Current Instruction:** A window showing the current instruction being executed. A white box labeled "Current Instruction" highlights the instruction `OR ECK, ECK`.
- Stack:** A window showing the stack frame. A white box labeled "Stack" highlights the `RETURN to` field, which contains the address `779537E0`.
- Status:** A window showing the current status of the debugger. A white box labeled "Status" highlights the `Paused` status.

At the bottom of the interface, a status bar indicates: `[E8:47 43] Attached process paused at ntdll.DbgBreakPoint`. A yellow box labeled "Paused" is also visible in the bottom right corner.

**Kahoot!**