Macro-Reliability in Win32 Exploits

“A la conquete du monde...”

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Agenda

- Problems with large scale exploitation
- Immunity's Solutions
  - Common Addresses
  - Remote Language Fingerprinting
- The Future

Problems in Large Scale Remote Exploitation

- Targets are not homogeneous
- Targets have host protection layers
- Targets have network protection layers
- Targets vary over time

Windows Machine Types

- Targeting a remote exploit requires:
  - Major/Minor versions
  - Service Packs
  - Patches
  - Configurations
  - Language Packs
  - Software version and configuration
  - Networking conditions between attacker and target
  - Host protections on target

Exploits and Magic Numbers

- Most exploits contain a list of “magic numbers” that help them target remote machines
  - shellcode offsets
  - return addresses
  - writable addresses
  - etc
- Each magic number decreases the reliability of the exploit in the wild

Minimizing Magic Numbers

- Two obvious approaches
  - Find common addresses that are the same across all your target types
  - Find a way to do fine-grained fingerprinting on your targets to accurately determine their magic numbers
- Hardest and best way
  - Rewrite the exploit to not need magic numbers at all

Common Addresses

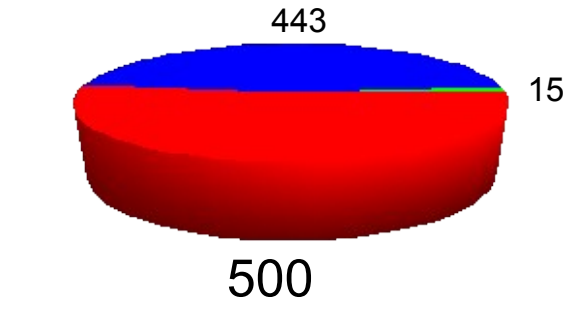
- Avoid fingerprinting as much as possible
  - Fingerprinting is usually noisy
  - SP fingerprinting is not that reliable
    - Usually using MSRPC interfaces
  - AFAIK, localization fingerprinting is pretty nonexistent
- Major Windows version fingerprinting is quite reliable
  - Some work was already done on SP independent return addresses
- “Universal address” often means English only

Naïve Approach

- Try and find addresses as independent as possible of the targets
  - In DLLs: image base address usually changes with language pack
  - In EXEs: image base doesn't change much
  - In EXEs and DLLs: different versions usually means different offsets relatively to image base
- DLLs with same version and same image base might provide common return addresses...
  - Small C program: dllvers.c

Some Results

Windows 2000[1] \system32 DLLs



[1]English, Japanese, Italian, Dutch, German, Spanish, Chinese, Russian, French
SP0 to SP4 up to date

Common accross Language | Common accross SP | Others

- Common DLLs

```
admparse.dll  5.0.2920.0   0x80000000
bootvid.dll   5.0.2172.1   0x80010000
dbmsadsn.dll  1999.10.20.0 0x42bd0000
dbmssocn.dll  1999.10.20.0 0x73330000
dbmsspxn.dll  1999.10.20.0 0x42be0000
gpkcsp.dll    5.0.2134.1   0x8000000
mcdsrv32.dll  5.0.2160.1   0x80010000
msvcirt.dll   6.1.8637.0   0x780a0000
msvcp50.dll   5.0.0.7051   0x780c0000
rtipxmib.dll  5.0.2168.1   0xd0000000
slbcsp.dll    5.0.2134.1   0x8000000
slbkygen.dll  5.0.2144.1   0x8000000
sqlwid.dll    1999.10.20.0 0x412f0000
vcdex.dll     5.0.2134.1   0x0ffb0000
vdmredir.dll  5.0.2134.1   0x0ffa0000
```

Pretty useless!

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In Memory

- Not only DLLs and EXEs and memory
  - Stacks
  - Heaps
  - File mappings
  - PEB, TEBs
  - Various different kinds of sections...
- Do not only stick to EXEs or DLLs to search for opcodes, look into the whole memory space
  - Small C program: dumpop.c

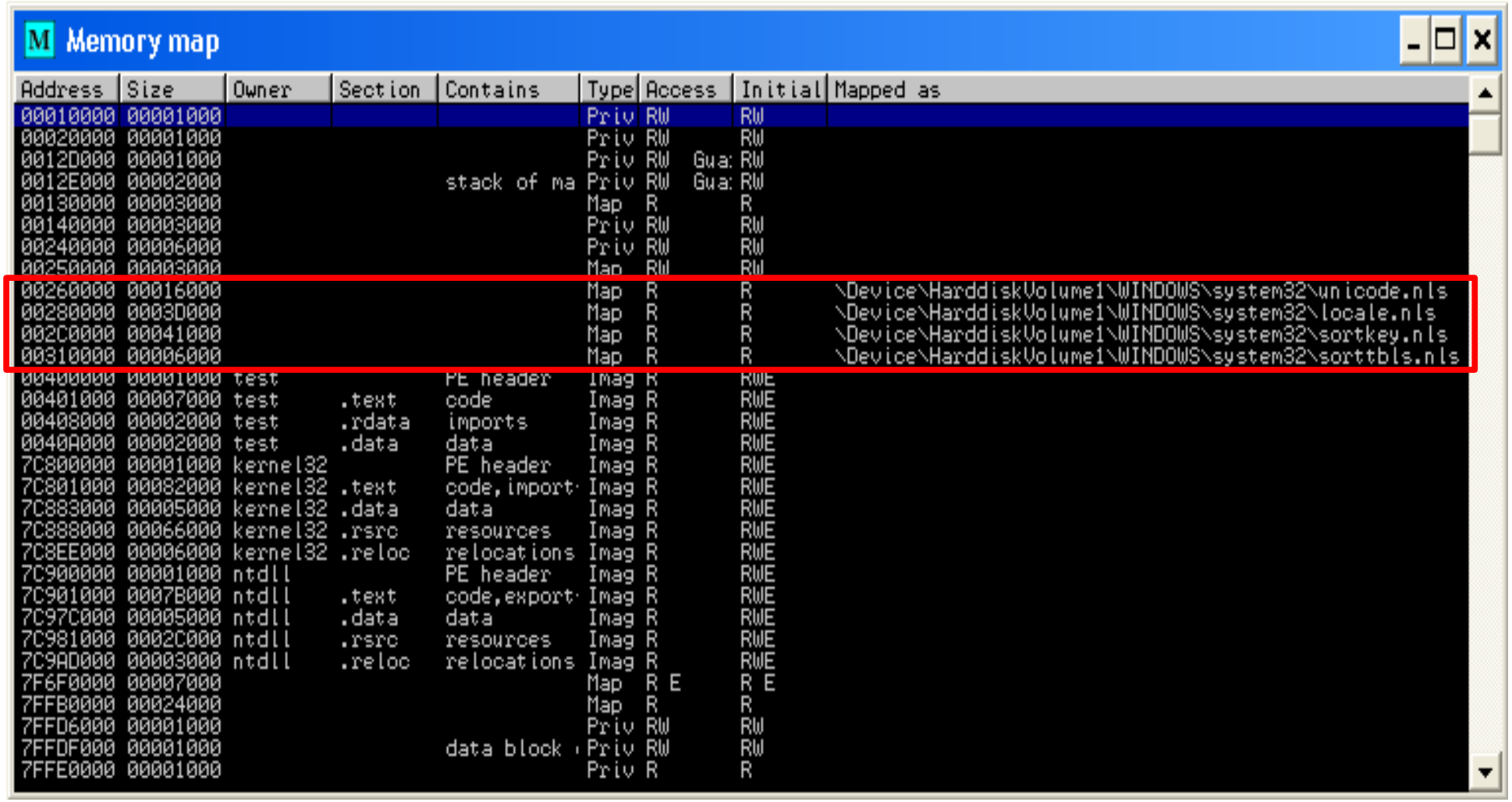
NLS File Mappings

- Several NLS files are mapped by default by Windows before the process even starts
  - unicode.nls
    locale.nls
    sortkey.nls
    sorttbls.nls
- Others can be loaded at runtime depending on the locale used
  - ctype.nls for example
- Mapping base address is (almost) fixed for a given binary on the same major version of Windows

NLS File Mappings (cont.)

- Mapping base address will depend on previously allocated pages:
  - Stack of main thread
    - Based on SizeOfStackReserve parameter in PE header
  - Imported DLLs
    - Based on their image base address
- Include a lot of jmp reg, call reg, push reg & ret
- Haven't changed since Windows NT 4.0
- Contain 1 NULL byte, not executable
  - Still can be used quite efficiently

Memory Mapping Example



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Remote options

- Passive
  - SIGINT can tell you a lot of things about a machine, including language strings
    - This is mostly useful for client-side attacks
- Active
  - Scanning may correlate your SIGINT data with a particular machine after it moves IP addresses
  - Various services on the remote machine may offer “localized” strings which can be used for language detection

Determining Language Pack Remotely

- Microsoft Windows does not offer a remote and anonymous way to correctly determine the language pack of a Windows install
- The applied language pack changes offsets and base addresses within DLLs which affect our exploits
- Some vulnerabilities and/or exploits are only effective on certain languages
  - MS06-009: Korean Input Method Editor
  - MS07-001: Brazilian Portuguese Grammar Checker

Why care so much about language pack?

- Most research on exploit reliability assumes English Windows
- But any large company has branches in places where the native language is not English
- Consultants come from all countries and place their non-English Windows laptops onto corporate networks

The Same Path Principle

- When exploiting a vulnerability we want to reduce the number of services and ports used
  - All services might not be running
  - All ports might not be opened
- Try and find as many ways as possible to remotely fingerprint a Windows language
  - MSRPC
  - SNMP
  - Web browsers
  - ...

MSRPC Localization using Shares

- Works by matching “remark” unicode field of a SHARE_INFO_1 structure returned by the NetShareEnum() API
  - Interface 4b324fc8-1670-01d3-1278-5a47bf6ee188 v3.0, opnum 15 in services.exe (2000)
  - Endpoints on ncacn_np, ncadg_ip_udp (old SP)
- Needs IPC$ and/or C$ share to exist
  - Usually better be if exploiting a RPC bug
- Will work anonymously against NT 4.0, 2000, XP < SP2 and 2003 SP0

Shares Results

- Uniquely matched
  - French
    Spanish
    Russian
    German
    Dutch
    Polish
    Simplified Chinese
    Traditional Chinese
    Turkish
    Hungarian
    Czech
    Norwegian
    Swedish
    Greek
    Danish
    Finnish
- “Collisions”
  - Common (no translation)
    - English
      Arabic
      Hebrew
      Japanese
      Korean
  - On IPC$ share
    - Italian
      Portuguese
      Brazilian
  - On C$ share (or any disk)
    - Portuguese
      Brazilian

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MSRPC Localization using Users

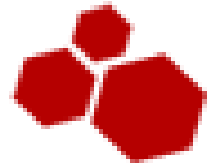
- List users on a system using LsaLookupSids() API by bruteforcing SIDs, match the default ones that are localization dependent
  - Interface 12345778-1234-abcd-ef00-0123456789ab v0.0, opnum 57
  - Endpoints on ncacn_np
- Will work anonymously against NT 4.0 and 2000
  - Useful in some case to refine previous technique results
- Works against XP SP1a with fake credentials if a Share has been setup

MSRPC Localization using Print Providers

- Best of the RPC methods, unique to CANVAS
- Works by matching the “comment” unicode field of a PRINTER_INFO_1 structure returned by the EnumPrinters() API
  - API itself doesn't support remote listing of Print Providers
- Needs access to the `spoolsv.exe` service
  - Interface 12345678-1234-abcd-ef00-0123456789ab v1.0, opnum 0
  - Usually through ncacn_np:\PIPE\spoolss
- Works anonymously against up to and including XP SP2!
  - No access on 2003 unless configured as a Printer Server

Print Providers

- Windows based clients and servers have 3 print providers by default
  - `win32spl.dll` comment string is localized
- 3rd party software can install their own print provider
- Side note: multiple vulnerabilities in the recent past, PP enumeration is interesting for that too
  - MS05-043: Heap overflow in `win32spl.dll`
  - Novell TID #3125538: Stack overflow in `nwspool.dll`
  - CTX111686: Stack overflow in `cpprov.dll`
  - And more...



Print Providers Results

- Uniquely matched
  - French
    Spanish
    Russian
    German
    Dutch
    Polish
    Simplified Chinese
    Traditional Chinese
    Turkish
    Hungarian
    Czech
    Norwegian
    Swedish
    Greek
    Danish
    Finnish
    Japanese
    Korean
    Protuguese
    Italian
    Brazilian
- “Collisions”
  - English
    Arabic
    Hebrew
  - Probably due to lazy translators

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SNMP Localization

- No such thing as a Windows Language OID :-(
  - Well at least I haven't found one
  - SNMPv2-MIB::sysLocation.0 is pretty useless
- Hopefully, Windows provides a list of installed software accessible from the public community
  - HOST-RESOURCES-MIB::hrSWInstalledName.*
  - Hopefully the term “Hotfix” is localized
    - “Correctif” in French, “Revisión” in Spanish
- Needs at least some hotfixes installed
  - No hotfix usually means no trouble for us though :>

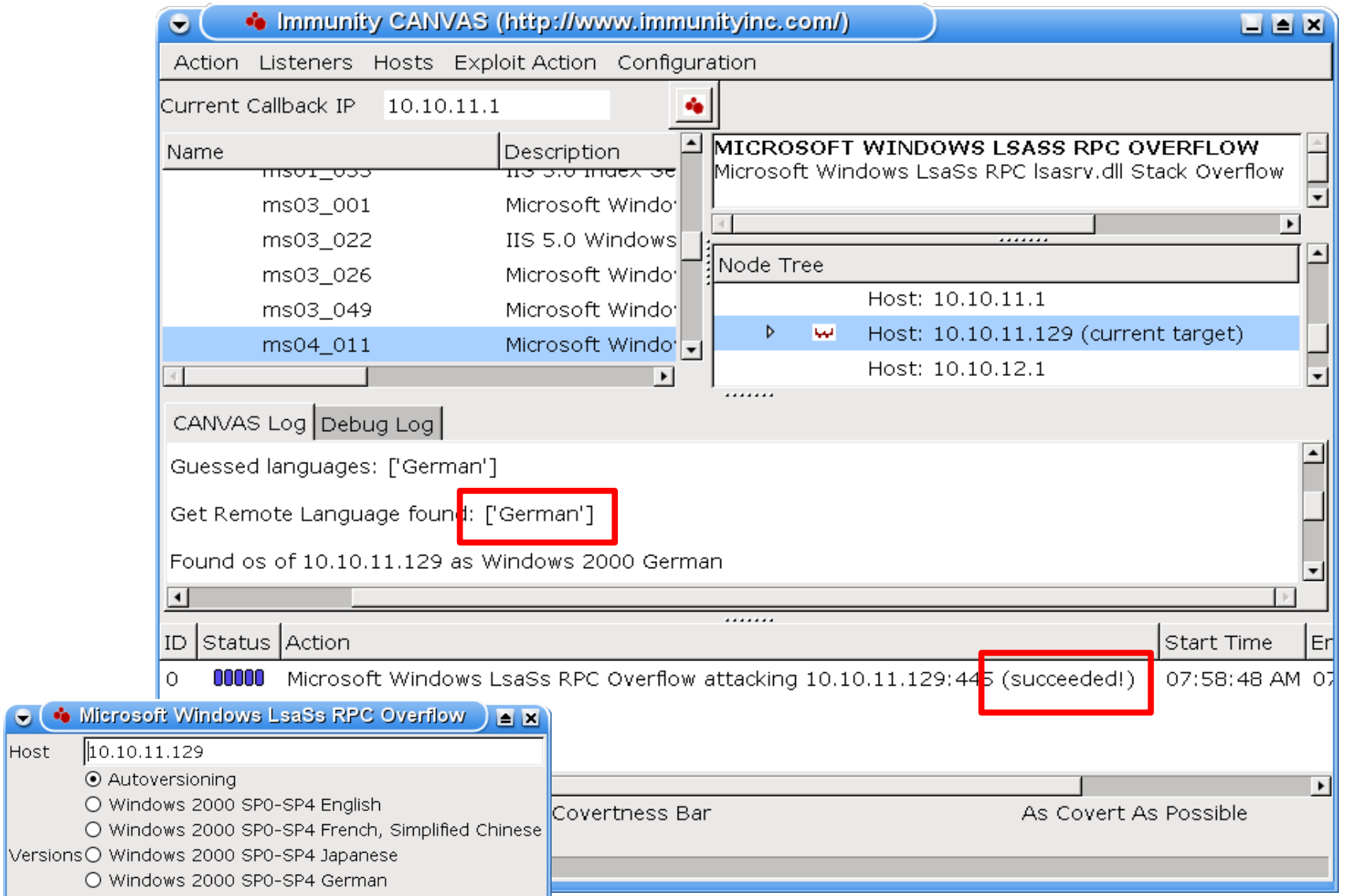
IIS & IE Localization

- IIS is not very talkative about its localization
- 40x errors are localized
  - 404 error string
  - 404 pages
    - If customized, several other 40x pages to try
- Localization through IE might be useful for client-side exploits
  - Accept-Language header can give an hint
  - Nowadays heap-spray provides a mean to disregard this

Configuration Options

- Of we can't get the localization of the remote target:
  - Assume it is English or another particular localization
  - Don't run the exploit
  - Assume the target has the same localization of the nearest neighbor

CANVAS Example



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Some CANVAS Exploits

Exploit	Vulnerability	Method	Target
ms01_023	IPP ISAPI Overflow	NLS mapping	2000 SP0-SP1
ms01_033	Index Server ISAPI Overflow	NLS mapping	2000 SP0-SP1
ms03_001	RPC Locator Overflow	NLS mapping	NT 4.0 SP6a, 2000 SP0-SP3
ms03_022	Media Services ISAPI Overflow	NLS mapping	2000 SP0-SP4
ms03_026	RPC Interface Overflow	NLS mapping	NT 4.0 SP6a, 2000 SP0-SP4, XP SP0-SP1a, 2003 SP0
ms03_049	WksSvc Overflow	`ws2help.dll` address based on localization	2000 SP0-SP4, XP SP0-SP1a
ms04_011	LsaSs Overflow	`ws2help.dll` address based on localization	2000 SP0-SP4, XP SP0-SP1a
ms04_031	NetDDE RPC Overflow	NLS mapping	2000 SP0-SP4, XP SP0-SP1a
ms05_039	UPNP RPC Overflow	NLS mapping	NT 4.0 SP6a, 2000 SP0-SP4, XP SP0-SP1a
ms06_066	Netware Service Overflow	NLS mapping	2000 SP0-SP4, XP SP0-SP1a
ms06_070	WksSvc Overflow	NLS mapping	2000 SP0-SP4

Heap Overflows

- Usually needs a function pointer overwritten
  - UEF should be considered last resort since depending on SP and language
  - PEB lock functions are at a fixed location but might not be triggered when we want
  - To avoid an exception, we might want to find a writable location
    - Might be in .data section of a binary
- Memory leaks will help a lot

MSRPC Pointer Leak

- MIDL [unique] attribute leaks a pointer in the target process memory space on the wire if combined with [out]
  - http://msdn2.microsoft.com/en-us/library/aa367294.a
- Example
  - ```
    long  _RpcEnumPrinters (
     [in] long arg_1,
     [in][unique][string] wchar_t * arg_2,
     [in] long arg_3,
     [in, out][unique][size_is(arg_5)] char * arg_4,
     [in] long arg_5,
     [out] long * arg_6,
     [out] long * arg_7
    );
    ```

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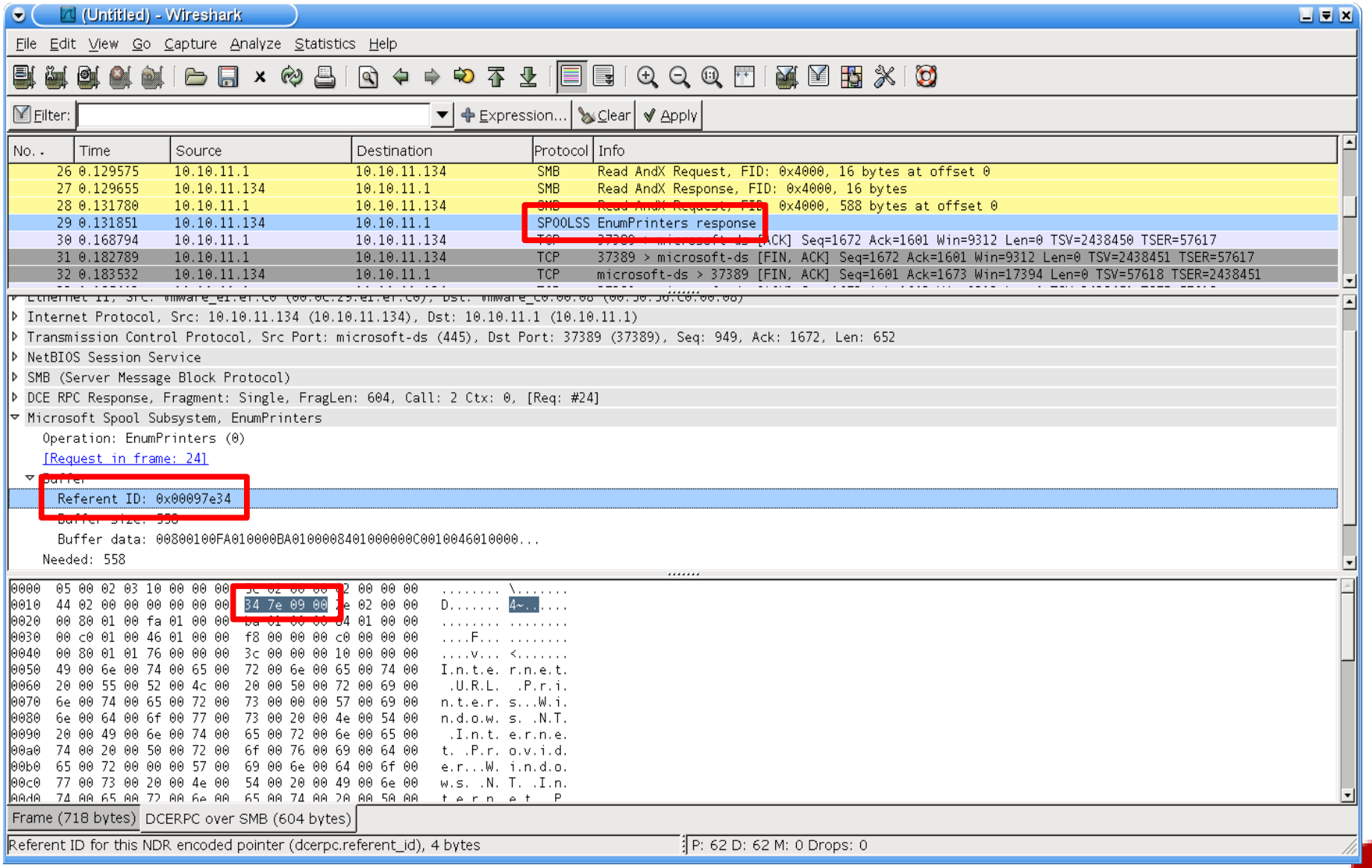
    ```

Wireshark Capture



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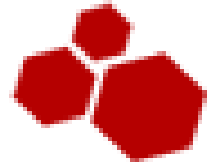
MSRPC Pointer Leak (cont.)

- Ideal use:
  - Populate target memory with an entry of your own using a 1st RPC function
  - Retrieve the entry using a 2nd RPC function with the MSRPC Pointer Leak
    - You have the pointer to your entry!
- Doesn't happen that often:
  - MS05-010: License Logging Service overflow
- Will give a good idea of the base address of the heap anyway



HEROES: MS06-070

- Description of Vulnerability
  - Pseudo-code

```
array=(unsigned int *)malloc(n*sizeof(unsigned int *))
   //initialization and various operations on array
   ...
   for (i=0;condition==true;i++) {
       free(array[i]);
       //process some more, update condition
       ...
   }
```

  - We can influence condition based on the content of the SNMP request, thus freeing pointers outside of array

HEROES: MS06-070 (cont.)

- Several issues arise when attempting to exploit this vulnerability:
  - How can we control the pointer that will be freed?
  - Given pointer control, what do we actually want to free?
  - Once we get our Write4 primitive, what will we overwrite?
  - How do we leverage our Write4 primitive into full blown code execution?

HEROES: MS06-070 (cont.)

- Exploitation stages
  - Crash
  - Find information leak
  - Get working on a language dependent way
    - Only writable function pointers are in .data section of snmpapi.dll:
      - Image base depends on language
      - Offset relative to image base depends on version
  - Get working with special OID for global lock function pointer
    - Using the PEB lock routines

Other similar vulnerabilities

- VERDE
  - Arbitrary Free in DHCP MSRPC Service on Windows 2000 SP2/SP3
- DTLOGIN
  - Arbitrary Free in XDMCP service of dtlogin on Solaris (or other commercial Unixes)

Networking Issues

- Attacking an entire class-B you will find many networking setups
  - Port forwarding
  - Load balancing
  - NAT (perhaps both the attacker and target are behind different NATs)
  - Firewalls with ex-filtration filters
  - Poorly configured routers
- Each of these setups forces complications on your exploit efforts

Defeating network speed-bumps

- Accurate network reconnaissance is hugely expensive in memory, network traffic, time, and technology
- Ideally the solution is to re-use the socket we came in on
- Alternately, we could use a shellcode that did not require socket connections at all, such as an HTTP downloader shellcode
  - But this does require SOME network connectivity, and our target may be in a strict DMZ

Socket Stealing on Windows

- Windows socket stealing is difficult
  - Common technique is to call getpeername() on all handles and check to see which ones come from our host and/or source port
    - This fails to handle NAT and other networking setups properly
    - Getpeername will freeze when called on named pipes and other handles, causing the shellcode to sometimes fail
  - Immunity's 3rd generation Windows socket stealing shellcode launches one thread per handle and sends a GOOO to the client
  - This handshake ensures proper operation over all network types

Socket Stealing on Windows (cont)

- Sometimes stealing a socket is not possible
  - MSRPC calls typically go through the SMB stack and no socket is available
    - In this case a “bind-to-an-MSRPC function” shellcode is useful
  - Overflows are often in a different process than the socket, for example, ISAPIs

ISAPI stealing

- Immunity's ISAPI-GO-Code will search the stack for the currently used ISAPI structure
- This contains a Read and Write function, which can be used to send and receive data from the Inetinfo.exe process
- Using this code allows exploits to steal SSL sockets, even though the process being exploited is not the Inetinfo process!

The Future

- Windows XP SP2
  - Remote language fingerprinting is – I think – absolutely necessary to work out DEP issues
    - Most addresses are language-dependent
      - Microsoft Netware Service stack overflow
      - Novell Netware Client for Windows PP stack overflow
- Vista
  - Even more languages supported!
- OS X/Linux
  - Getting more important all the time!

Conclusion

- Attacking large scale global networks can be done effectively by spending a fairly reasonable amount of time doing effective fingerprinting
- Questions?

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