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COMPREHENSIVE COMPUTER SECURITY SERVICES

So You Want To Analyze Malware?

Tools, Techniques, and Mindset

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Introduction

Who, What, Why?

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Introduction

- Me – Wes Brown
  - Software and Systems Hacker
    - Fond of Lisp-based and Functional Languages
    - Developed Lisp dialect with Scott Dunlop
      - Mosquito Lisp
      - Evolved into Wasp Lisp
  - Security Researcher and Malware Analyst
    - MOSREF – uses Mosquito Lisp for a remote command and execution framework
    - Malware Analyst – analyzed thousands of samples
  - Security Consultant
    - Penetration Testing
    - Code Review
    - SDL
  - IOActive

Agenda

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- Motivations behind Malware Analysis
- Mindset behind Malware and Analysis
- Trends in Malware
- Building a Malware Lab
- Tools for Malware Analysis
- Analysis Walkthrough

Motivations behind Malware and Analysis

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- Why Analyze Malware?
  - Better understanding of threats to protect network
    - Defender
  - To write software that detects malware
    - Tools for Defender
  - Aesthetic admiration
    - Admiration of Techniques
  - Writing a better mousetrap
    - Financial Gain
- Why Malware?
  - Financial gain
    - Follow the money
  - Political agenda
  - Used to be for the challenge and pranks

What Makes A Good Malware Analyst?

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- Mindset
  - Meticulous data collection
  - Logical processes
  - Thinks outside the box
  - Tenacious
- Technical
  - Good systems understanding
  - Good understanding of programming
  - Some reverse engineering skills
- Attitude
  - Ties into motivations discussed earlier

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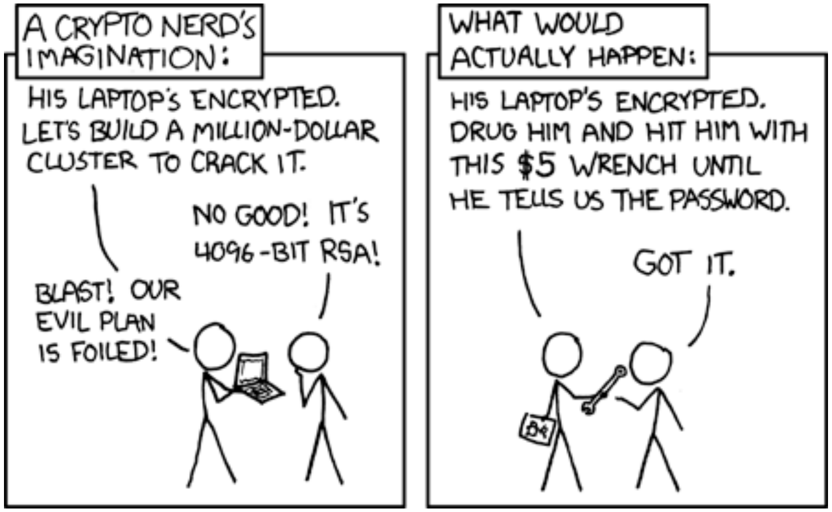
Trends in Malware

Past, Present, and Future

Attack Vectors

- In the Ancient Past
  - Viruses via floppy disks
  - Downloaded via FTP or BBS'es
- Past
  - Systems level
  - Exploitation of remote services, worms
  - System protections an NAT/Firewalls made this difficult
- Now
  - System is only as strong as its weakest link


A CRYPTO NERD'S IMAGINATION:
HIS LAPTOP'S ENCRYPTED. LET'S BUILD A MILLION-DOLLAR CLUSTER TO CRACK IT.
NO GOOD! IT'S 4096-BIT RSA!
BLAST! OUR EVIL PLAN IS FOILED!
WHAT WOULD ACTUALLY HAPPEN:
HIS LAPTOP'S ENCRYPTED. DRUG HIM AND HIT HIM WITH THIS $5 WRENCH UNTIL HE TELLS US THE PASSWORD.
GOT IT.

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Human Factor

- In the past, attacks were mainly technical.
  - Attackers searched for network or systems level vulnerabilities.
  - Automatic exploitation and spread.
  - Humans not involved in the attack cycle.
- In the present, exploit the human.
  - Spam email
  - Compromise a legitimate site.
    - "Drive by" site
    - Human visits compromised site, is compromised.
  - Advertising attacks
    - Especially at shadier sites such as P2P trackers.
  - Goal is to get the initial injection vector in.
    - Once vector is in, payload can be sent, and network is compromised.

Attacking through Social Networks

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- Social Networks
  - Flickr
  - Facebook
  - Twitter
  - Myspace
  - Etc
- File sharing
  - Torrents
  - Warez
  - P2P
- Highly connected network
- Massive information sharing
- Rich media content

Internationalization of Malware

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- Formerly, English-targeted samples.
  - Easy to conduct a strings search on.
- Cultural assumptions of what Malware is.
  - Varies from region to region.
  - One man’s anti-cheating toolkit is another man’s rootkit.
    - Punkbuster
    - Korean and Chinese games
- What should it be flagged at?
  - Suspicious?
  - White list?
  - Malware?

Current Attack Lifecycle

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- Initial payload is small
- Initial checks
  - Mutex, OS Version, Keyboard, location
  - Conficker A didn't infect systems with Ukrainian Keyboard
- Payload is downloaded
- Backdoor/trojan/infect
- Contacts command and control server for tasks
- May fall back to secondary C&C
- Dynamically generate rendezvous point

- Conficker quietly spreads internally and waits before phoning home

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Current Obfuscation Techniques

Staying on the System

Obfuscation

- Obfuscation used to confuse analysis
  - Antivirus signatures
  - Static analysis – decompilers
  - Dynamic analysis – tracing, debugging, inspection
- Obfuscation used legitimately for DRM systems
  - Hide important logic to *slow* reverse engineering
- Race to Zero Competition
  - Highlighted ineffectiveness of AV

Basic Techniques

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- Polymorphism and Packers
  - UPX, Armadillo or custom packer
- Simple Debugger checks
  - IsDebuggerPresent()
- Jumping into data/ middle of instructions
- Encoding strings/values
- Manipulating imports
- Corrupting PE Header
  - Bad LoaderFlags
  - Bad NumberOfRvaAndSizes
- Section Header Stuff
  - Enormous bogus sections
  - Overlapping sections

Basic Techniques (cont.)

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- Junk code
  - Spaghetti assembly
- SEH
  - Exception handler patches memory
  - Access to application context structure -> Erase Hardware debug Registers

Advanced Techniques

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- Metamorphic malware
- Custom virtual machines
  - Polymorphic instruction sets
- Encryption
  - Corrupting PE Header, use corrupt data as key
- Instruction Timing
  - Model Specific Register (MSR), counts clock cycles
  - RDTSC instruction, moves timestamp to EDX and EAX

Advanced Techniques (cont.)

- Debugging register tricks
  - Trampolines pass shared stack via debug registers
- Breakpoint detection
  - Before calling API, check first few instructions breakpoints
- VMWare detection
  - VMWare Tools, Network card, hidden APIs
- Random note: Malicious JavaScript can only be fetched once

Custom Virtual Machines

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- Purpose is to complicate static analysis by adding additional layer of translation
- P-Code machine (Pseudo-code)
- Create a software CPU
- Soft registers and pseudo language
- Mapping between pseudo language and real instructions
  - Mapping happens at runtime
- Makes static analysis very difficult
- Must run the system and step through things
- Make your Vmcode self modifying
- Really evil = Instruction set mapping changes after each instruction

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Building a Malware Lab

Tools for Analysis

Malware Lab

- Virtualization Platform
  - Multi-core CPUs are cheap
  - Windows images can be reverted in seconds.
  - Can run dozens of Windows images.
  - Easy to audit
    - Use Copy on Write disk images
- Must not be on any network but its own.
  - Airgapped.
  - Prevents inadverent contamination and information leakage.
- Dynamic Internet Connection
  - Preferrably a consumer-level connection.
  - Reissue new IP addresses via DHCP lease.
  - Prevents blacklists against

Virtualization Platform

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- VMware
  - Why Vmware?
    - Stable.
    - Well-known.
    - Tools to analyze Vmware suspend images
    - Vmware ESXi is free, bare metal virtualization.
  - Fatal Flaw
    - Lowest common denominator.
    - Malware actively detects Vmware.
      - Virtualization drivers detectable.
      - Easy to detect.
        - Put value 10 (0x0a) in the ECX register, and put 0x564D5868 in the EAX register. Read a dword from 0x5658.
      - Exploits to break out of Vmware sandbox now.
  - Recommend strongly against using Vmware for a Malware Lab

Virtualization Platform (cont'd)

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- Xensource
  - Payware
    - Now has a free product to compete with Vmware ESXi
    - Yay competition!
  - Nicely packaged bare-metal virtualizer.
  - Good performance.
  - Excellent Copy-on-Write support
- Qemu
  - Roll your own virtualization platform
  - OpenSource
  - Slower than the others.

Neat Virtualization Tricks

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- Serial Debugging
  - Debugger and Debugee VMs with virtual serial connection.
  - Very handy for kernel debugging with tools such as WinDBG.
- Copy on Write
  - Original VM disk image is unmodified.
  - All changes are made to a separate file.
  - Can mount delta images and examine differences to see what malware changed.
- Memory Image
  - State of memory can be snapshotted while malware is run, and then disassembled and debugged.
- Fast reversion of images
  - Useful for analyzing thousands of samples in a day.

Database (aka, store everything!)

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- Database
  - Needed to store data from automatic and manual analysis.
  - Malware analysis is far more useful with a corpus to compare against.
  - The more data we have on characteristics, the more we are able to do a determination of whether it is malware.
  - Reverse engineering is expensive in terms of man-power to do.
  - Identify characteristics and understand malware to allocate reverse engineering where it is worthwhile to.
- Corpus
  - Store actual malware sample.
  - Store all known characteristics.
  - Store network traces.
  - Store static forensics.

Obtaining Malware to Analyze

- Be an anti-virus or anti-malware software vendor.
  - Set up your software agent to automatically send back unknown samples.
  - Thousands of samples a day!
- Join an existing antimalware intelligence group.
  - Honeynet Project
  - Sandnet
- Build your own honeynet.
  - Collect malware samples from exploits.
- Beg, borrow, steal.
  - Obtain a feed from someone.
  - Offer a feed in return.

Additional Tools

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- Debuggers
  - WinDBG
  - IDA
  - Ollydbg
- Tracers
  - Process Monitor (regmon, filemon)
  - Detours
  - Third party: apimonitor, strace
- Unpackers
  - PeID
  - Import rebuilders

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Analysis Walkthrough

Dynamic and Static

Analysis Walkthrough

- Version of Sality family
- From the network logs we know some behavior
  - Slowly spreads internally
  - Outbound connections on high number ports
  - HTTP requests
  - Not detected by antivirus
- Initial samples
  - Four executables
  - Random filenames starting with “win”
  - Same size, different checksums

Process Monitor

- External behavior highlights what to look for during static analysis
  - Ex: strings of URLs, registry keys, file names
- A lot of what you'll see is general noise as application loads libraries,reads registry keys, starts threads, accesses files
- Focus on RegSetValue for fast info

Process Monitor Video

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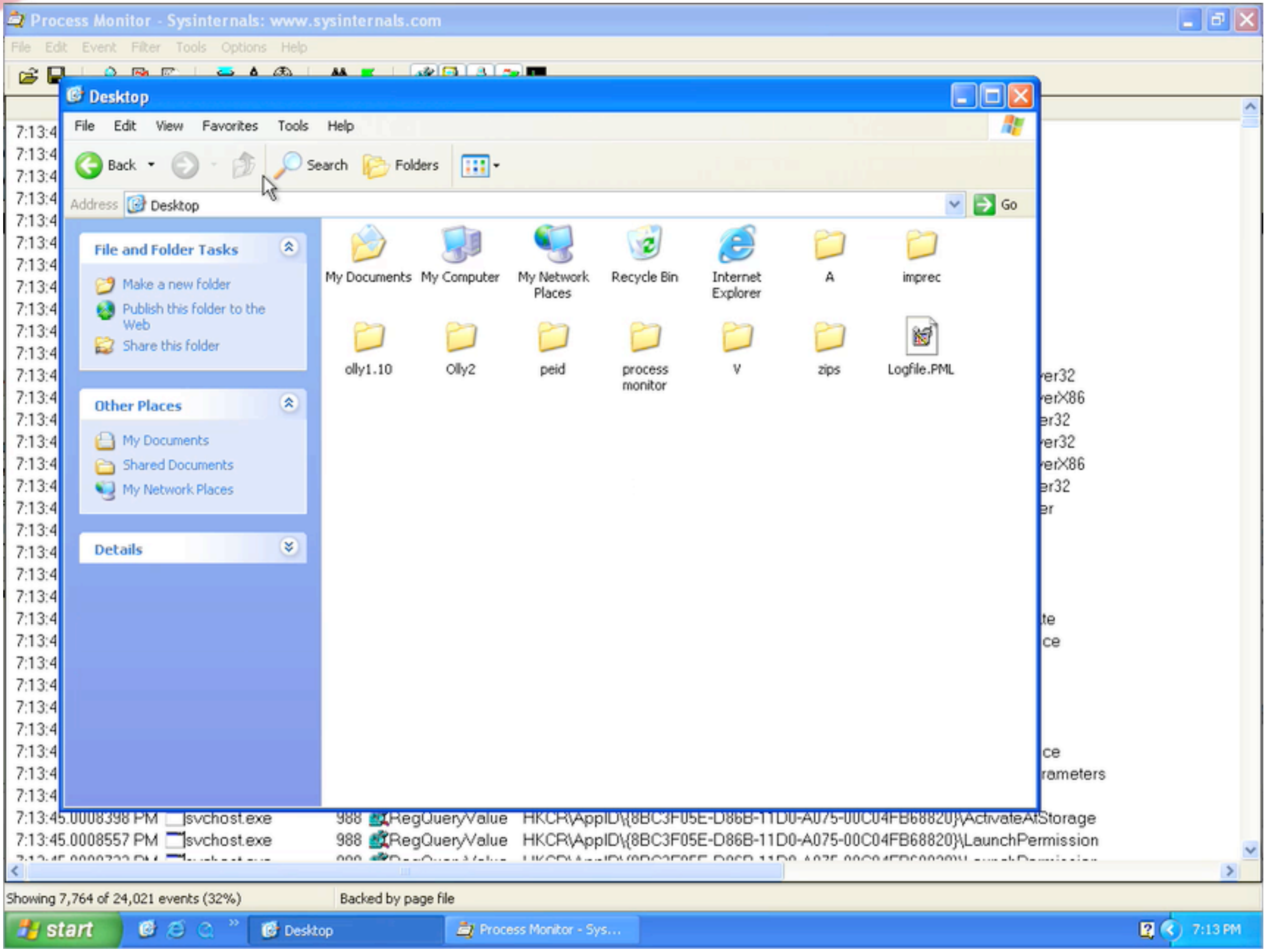

```
7:13:45.0008398 PM   svchost.exe   988  RegQueryValue  HKCR\AppID\{8BC3F05E-D86B-11D0-A075-00C04FB68820}\ActivateAtStorage
7:13:45.0008557 PM   svchost.exe   988  RegQueryValue  HKCR\AppID\{8BC3F05E-D86B-11D0-A075-00C04FB68820}\LaunchPermission
```

Showing 7,764 of 24,021 events (32%)   Backed by page file

RegSetValue Standard Stuff

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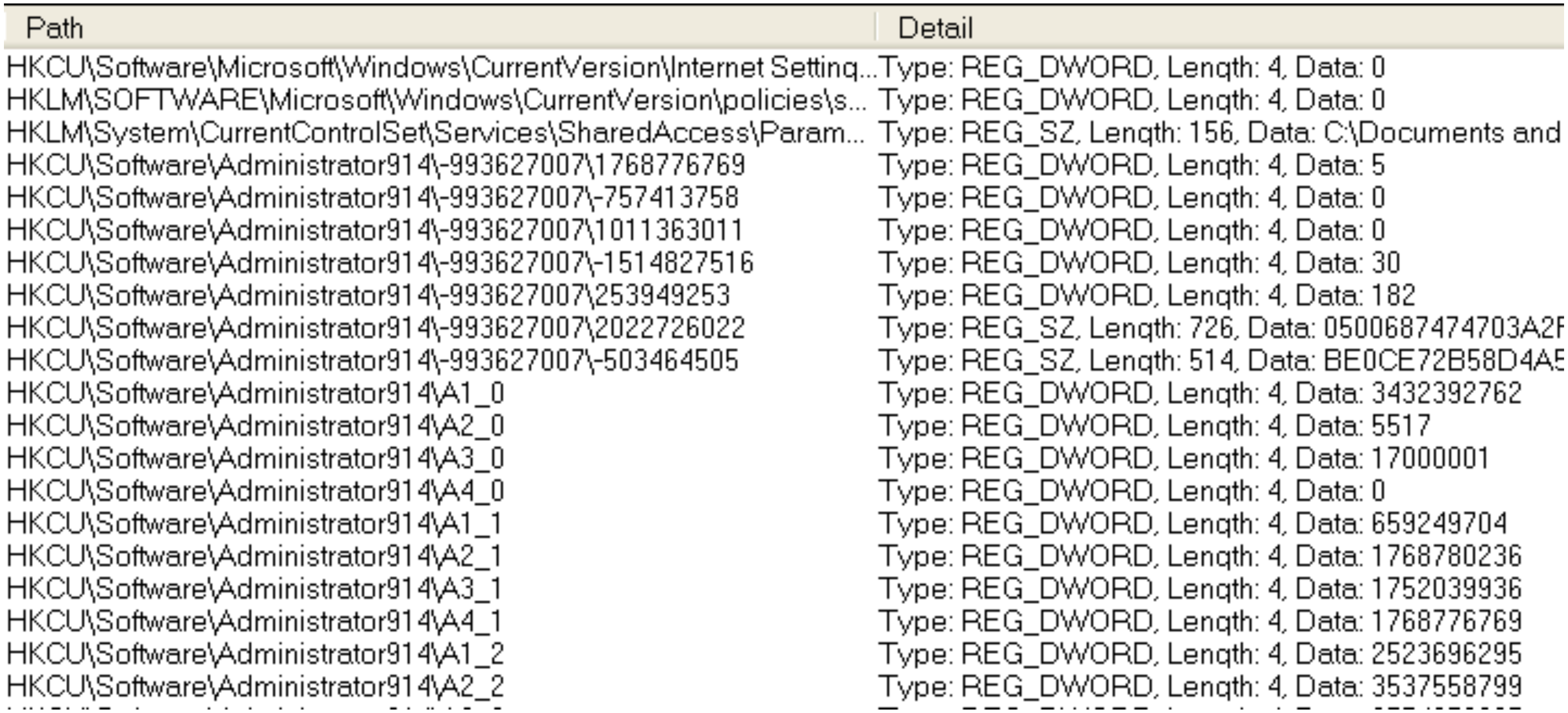

Path	Detail
HKCU\Software\Microsoft\Windows\CurrentVersion\Internet Setting...	Type: REG_DWORD, Length: 4, Data: 0
HKLM\SOFTWARE\Microsoft\Windows\CurrentVersion\policies\s...	Type: REG_DWORD, Length: 4, Data: 0
HKLM\System\CurrentControlSet\Services\SharedAccess\Param...	Type: REG_SZ, Length: 156, Data: C:\Documents and
HKCU\Software\Administrator914\-993627007\1768776769	Type: REG_DWORD, Length: 4, Data: 5
HKCU\Software\Administrator914\-993627007\-757413758	Type: REG_DWORD, Length: 4, Data: 0
HKCU\Software\Administrator914\-993627007\1011363011	Type: REG_DWORD, Length: 4, Data: 0
HKCU\Software\Administrator914\-993627007\-1514827516	Type: REG_DWORD, Length: 4, Data: 30
HKCU\Software\Administrator914\-993627007\253949253	Type: REG_DWORD, Length: 4, Data: 182
HKCU\Software\Administrator914\-993627007\2022726022	Type: REG_SZ, Length: 726, Data: 0500687474703A2F
HKCU\Software\Administrator914\-993627007\-503464505	Type: REG_SZ, Length: 514, Data: BE0CE72B58D4A5
HKCU\Software\Administrator914\A1_0	Type: REG_DWORD, Length: 4, Data: 3432392762
HKCU\Software\Administrator914\A2_0	Type: REG_DWORD, Length: 4, Data: 5517
HKCU\Software\Administrator914\A3_0	Type: REG_DWORD, Length: 4, Data: 17000001
HKCU\Software\Administrator914\A4_0	Type: REG_DWORD, Length: 4, Data: 0
HKCU\Software\Administrator914\A1_1	Type: REG_DWORD, Length: 4, Data: 659249704
HKCU\Software\Administrator914\A2_1	Type: REG_DWORD, Length: 4, Data: 1768780236
HKCU\Software\Administrator914\A3_1	Type: REG_DWORD, Length: 4, Data: 1752039936
HKCU\Software\Administrator914\A4_1	Type: REG_DWORD, Length: 4, Data: 1768776769
HKCU\Software\Administrator914\A1_2	Type: REG_DWORD, Length: 4, Data: 2523696295
HKCU\Software\Administrator914\A2_2	Type: REG_DWORD, Length: 4, Data: 3537558799

RegSetValue Standard Stuff

- Adds self to Firewall Policy Authorized Applications List
- GlobalUserOffline -> 0
  - Switches to online if was “Work Offline” mode
- EnableLUA -> 0
  - Turn off User Access Control for Administrator

RegSetValue Interesting Stuff

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- HKCU\Software\Administrator914\-993627007\2022726022
- Size 726
- Value:

```
0500687474703A2F2F61736A6469776575723837777364636
E622E696E666F2F74616E67612E67696600687474703A2F2
F7065646D656F3232326E622E696E666F2F74616E67612E6
7696600687474703A2F2F676F6E646F6C697A6F313834383
32E696E666F2F74616E67612E67696600687474703A2F2F7
46563686E6963616E2E772E696E74657269612E706C2F746
16E67612E67696600687474703A2F2F707A726B2E72752F6
96D672F6C6F676F342E676966
```

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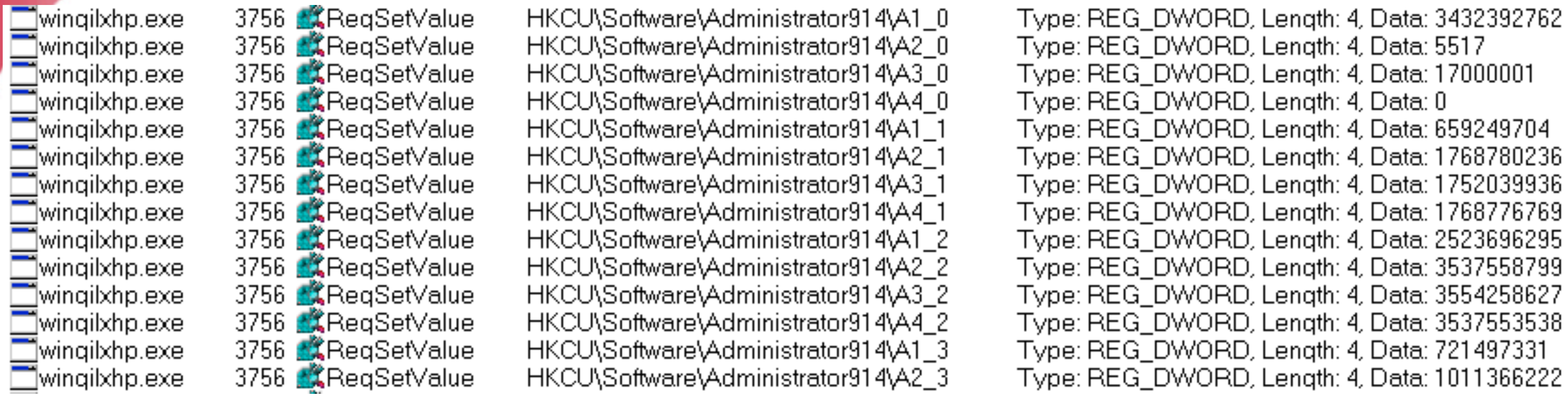
RegSetValue Interesting Stuff

- Decodes to:

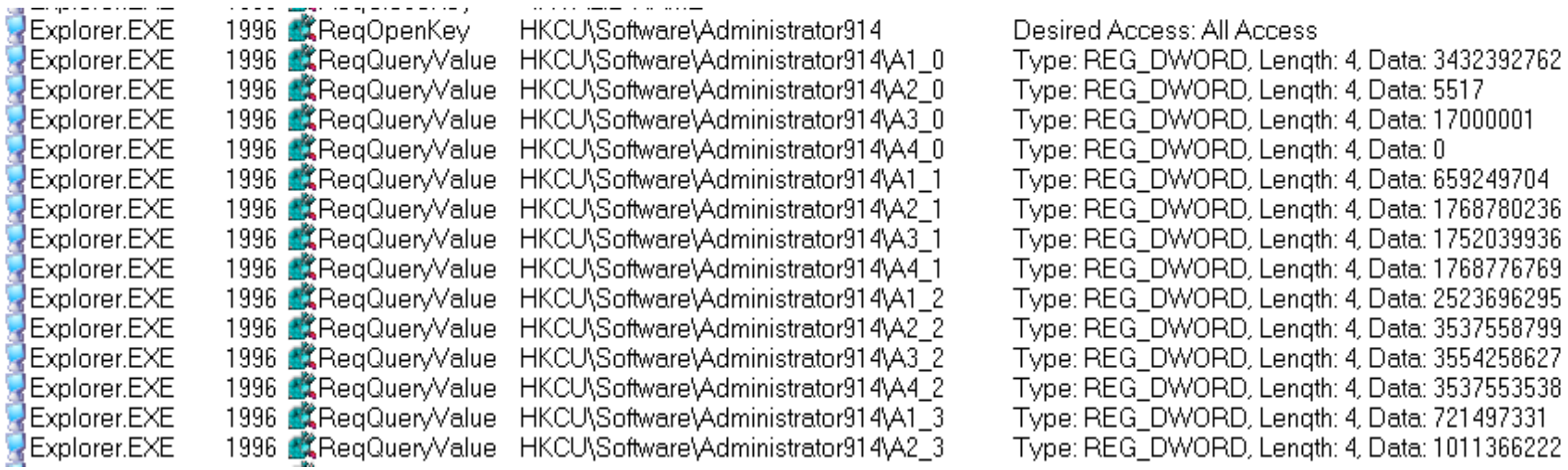
http://asjdiweur87wsdcnb.info/tanga.gif
http://pedmeo222nb.info/tanga.gif
http://gondolizo18483.info/tanga.gif
http://technican.w.interia.pl/tanga.gif
http://pzrk.ru/img/logo4.gif

RegSetValue Interesting Stuff 2



```
wingilxhp.exe    3756  RegSetValue    HKCU\Software\Administrator914\A1_0    Type: REG_DWORD, Length: 4, Data: 3432392762
wingilxhp.exe    3756  RegSetValue    HKCU\Software\Administrator914\A2_0    Type: REG_DWORD, Length: 4, Data: 5517
wingilxhp.exe    3756  RegSetValue    HKCU\Software\Administrator914\A3_0    Type: REG_DWORD, Length: 4, Data: 17000001
wingilxhp.exe    3756  RegSetValue    HKCU\Software\Administrator914\A4_0    Type: REG_DWORD, Length: 4, Data: 0
wingilxhp.exe    3756  RegSetValue    HKCU\Software\Administrator914\A1_1    Type: REG_DWORD, Length: 4, Data: 659249704
wingilxhp.exe    3756  RegSetValue    HKCU\Software\Administrator914\A2_1    Type: REG_DWORD, Length: 4, Data: 1768780236
wingilxhp.exe    3756  RegSetValue    HKCU\Software\Administrator914\A3_1    Type: REG_DWORD, Length: 4, Data: 1752039936
wingilxhp.exe    3756  RegSetValue    HKCU\Software\Administrator914\A4_1    Type: REG_DWORD, Length: 4, Data: 1768776769
wingilxhp.exe    3756  RegSetValue    HKCU\Software\Administrator914\A1_2    Type: REG_DWORD, Length: 4, Data: 2523696295
wingilxhp.exe    3756  RegSetValue    HKCU\Software\Administrator914\A2_2    Type: REG_DWORD, Length: 4, Data: 3537558799
wingilxhp.exe    3756  RegSetValue    HKCU\Software\Administrator914\A3_2    Type: REG_DWORD, Length: 4, Data: 3554258627
wingilxhp.exe    3756  RegSetValue    HKCU\Software\Administrator914\A4_2    Type: REG_DWORD, Length: 4, Data: 3537553538
wingilxhp.exe    3756  RegSetValue    HKCU\Software\Administrator914\A1_3    Type: REG_DWORD, Length: 4, Data: 721497331
wingilxhp.exe    3756  RegSetValue    HKCU\Software\Administrator914\A2_3    Type: REG_DWORD, Length: 4, Data: 1011366222
```

Kill off the malware process and a little while later….



```
Explorer.EXE   1996  RegOpenKey     HKCU\Software\Administrator914         Desired Access: All Access
Explorer.EXE   1996  RegQueryValue  HKCU\Software\Administrator914\A1_0    Type: REG_DWORD, Length: 4, Data: 3432392762
Explorer.EXE   1996  RegQueryValue  HKCU\Software\Administrator914\A2_0    Type: REG_DWORD, Length: 4, Data: 5517
Explorer.EXE   1996  RegQueryValue  HKCU\Software\Administrator914\A3_0    Type: REG_DWORD, Length: 4, Data: 17000001
Explorer.EXE   1996  RegQueryValue  HKCU\Software\Administrator914\A4_0    Type: REG_DWORD, Length: 4, Data: 0
Explorer.EXE   1996  RegQueryValue  HKCU\Software\Administrator914\A1_1    Type: REG_DWORD, Length: 4, Data: 659249704
Explorer.EXE   1996  RegQueryValue  HKCU\Software\Administrator914\A2_1    Type: REG_DWORD, Length: 4, Data: 1768780236
Explorer.EXE   1996  RegQueryValue  HKCU\Software\Administrator914\A3_1    Type: REG_DWORD, Length: 4, Data: 1752039936
Explorer.EXE   1996  RegQueryValue  HKCU\Software\Administrator914\A4_1    Type: REG_DWORD, Length: 4, Data: 1768776769
Explorer.EXE   1996  RegQueryValue  HKCU\Software\Administrator914\A1_2    Type: REG_DWORD, Length: 4, Data: 2523696295
Explorer.EXE   1996  RegQueryValue  HKCU\Software\Administrator914\A2_2    Type: REG_DWORD, Length: 4, Data: 3537558799
Explorer.EXE   1996  RegQueryValue  HKCU\Software\Administrator914\A3_2    Type: REG_DWORD, Length: 4, Data: 3554258627
Explorer.EXE   1996  RegQueryValue  HKCU\Software\Administrator914\A4_2    Type: REG_DWORD, Length: 4, Data: 3537553538
Explorer.EXE   1996  RegQueryValue  HKCU\Software\Administrator914\A1_3    Type: REG_DWORD, Length: 4, Data: 721497331
Explorer.EXE   1996  RegQueryValue  HKCU\Software\Administrator914\A2_3    Type: REG_DWORD, Length: 4, Data: 1011366222
```

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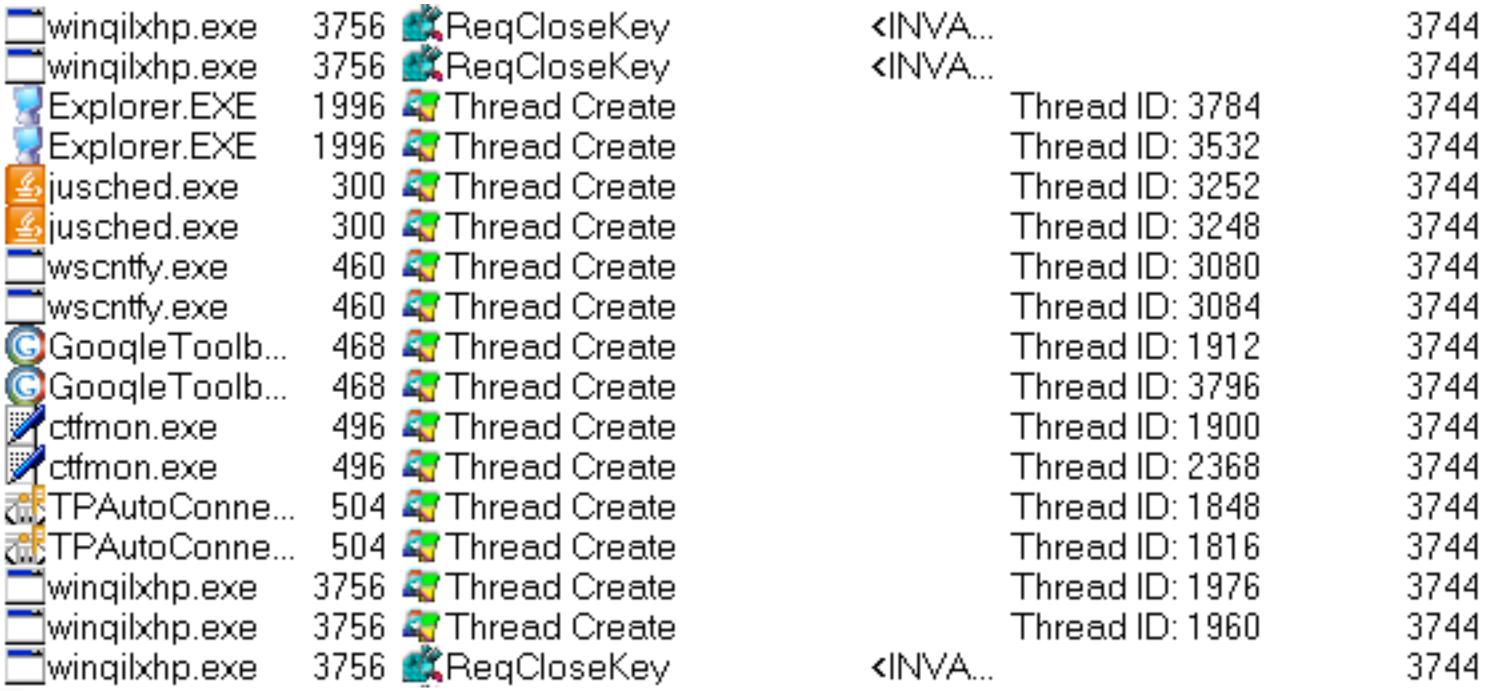
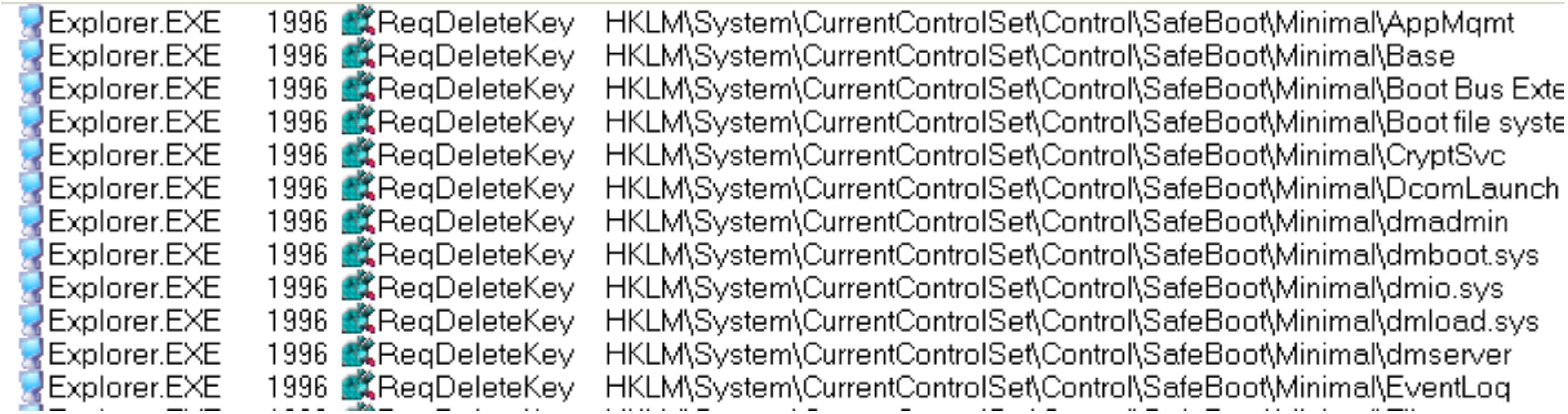
Thread Injection

- You can actually see the thread injection



```
winqilxhp.exe    3756  ReqCloseKey      <INVA...                        3744
winqilxhp.exe    3756  ReqCloseKey      <INVA...                        3744
Explorer.EXE     1996  Thread Create             Thread ID: 3784        3744
Explorer.EXE     1996  Thread Create             Thread ID: 3532        3744
jusched.exe       300  Thread Create             Thread ID: 3252        3744
jusched.exe       300  Thread Create             Thread ID: 3248        3744
wscntfy.exe       460  Thread Create             Thread ID: 3080        3744
wscntfy.exe       460  Thread Create             Thread ID: 3084        3744
GoogleToolb...    468  Thread Create             Thread ID: 1912        3744
GoogleToolb...    468  Thread Create             Thread ID: 3796        3744
ctfmon.exe        496  Thread Create             Thread ID: 1900        3744
ctfmon.exe        496  Thread Create             Thread ID: 2368        3744
TPAutoConne...    504  Thread Create             Thread ID: 1848        3744
TPAutoConne...    504  Thread Create             Thread ID: 1816        3744
winqilxhp.exe    3756  Thread Create             Thread ID: 1976        3744
winqilxhp.exe    3756  Thread Create             Thread ID: 1960        3744
winqilxhp.exe    3756  ReqCloseKey      <INVA...                        3744
```

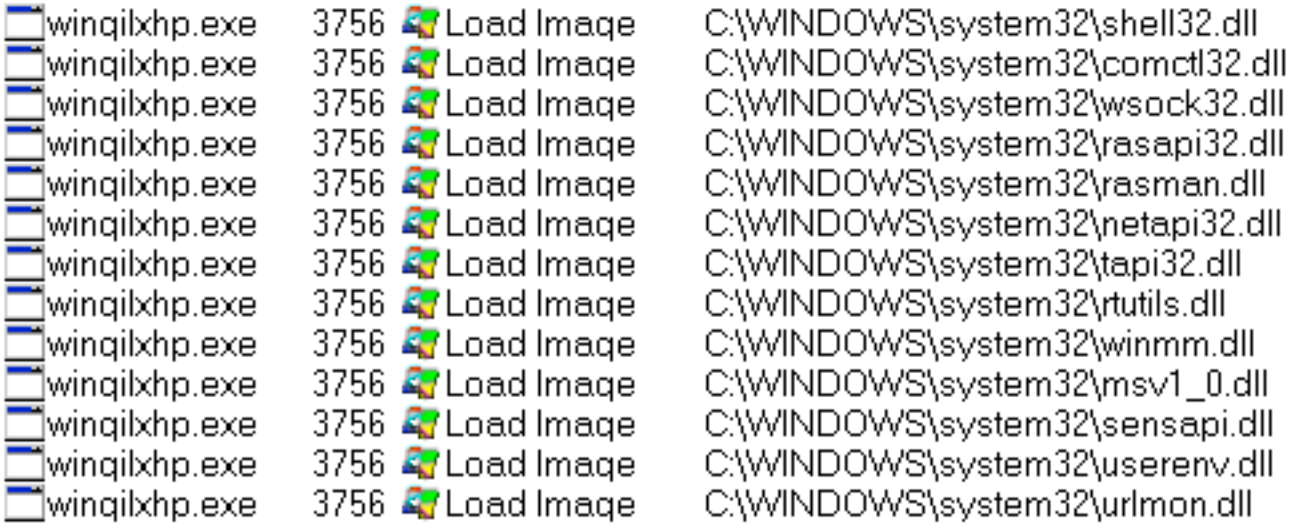
No more safeboot!



```
Explorer.EXE   1996  RegDeleteKey   HKLM\System\CurrentControlSet\Control\SafeBoot\Minimal\AppMgmt
Explorer.EXE   1996  RegDeleteKey   HKLM\System\CurrentControlSet\Control\SafeBoot\Minimal\Base
Explorer.EXE   1996  RegDeleteKey   HKLM\System\CurrentControlSet\Control\SafeBoot\Minimal\Boot Bus Exte
Explorer.EXE   1996  RegDeleteKey   HKLM\System\CurrentControlSet\Control\SafeBoot\Minimal\Boot file syste
Explorer.EXE   1996  RegDeleteKey   HKLM\System\CurrentControlSet\Control\SafeBoot\Minimal\CryptSvc
Explorer.EXE   1996  RegDeleteKey   HKLM\System\CurrentControlSet\Control\SafeBoot\Minimal\DcomLaunch
Explorer.EXE   1996  RegDeleteKey   HKLM\System\CurrentControlSet\Control\SafeBoot\Minimal\dmadmin
Explorer.EXE   1996  RegDeleteKey   HKLM\System\CurrentControlSet\Control\SafeBoot\Minimal\dmboot.sys
Explorer.EXE   1996  RegDeleteKey   HKLM\System\CurrentControlSet\Control\SafeBoot\Minimal\dmio.sys
Explorer.EXE   1996  RegDeleteKey   HKLM\System\CurrentControlSet\Control\SafeBoot\Minimal\dmload.sys
Explorer.EXE   1996  RegDeleteKey   HKLM\System\CurrentControlSet\Control\SafeBoot\Minimal\dmserver
Explorer.EXE   1996  RegDeleteKey   HKLM\System\CurrentControlSet\Control\SafeBoot\Minimal\EventLog
```

Some other Things

- See the Libraries its loading



```
winqilxhp.exe    3756  Load Image    C:\WINDOWS\system32\shell32.dll
winqilxhp.exe    3756  Load Image    C:\WINDOWS\system32\comctl32.dll
winqilxhp.exe    3756  Load Image    C:\WINDOWS\system32\wsock32.dll
winqilxhp.exe    3756  Load Image    C:\WINDOWS\system32\rasapi32.dll
winqilxhp.exe    3756  Load Image    C:\WINDOWS\system32\rasman.dll
winqilxhp.exe    3756  Load Image    C:\WINDOWS\system32\netapi32.dll
winqilxhp.exe    3756  Load Image    C:\WINDOWS\system32\tapi32.dll
winqilxhp.exe    3756  Load Image    C:\WINDOWS\system32\rtutils.dll
winqilxhp.exe    3756  Load Image    C:\WINDOWS\system32\winmm.dll
winqilxhp.exe    3756  Load Image    C:\WINDOWS\system32\msv1_0.dll
winqilxhp.exe    3756  Load Image    C:\WINDOWS\system32\sensapi.dll
winqilxhp.exe    3756  Load Image    C:\WINDOWS\system32\userenv.dll
winqilxhp.exe    3756  Load Image    C:\WINDOWS\system32\urlmon.dll
```

- Writes System.ini
- Thread heavy >100 threads in 1 minute

Static Analysis and Debugging

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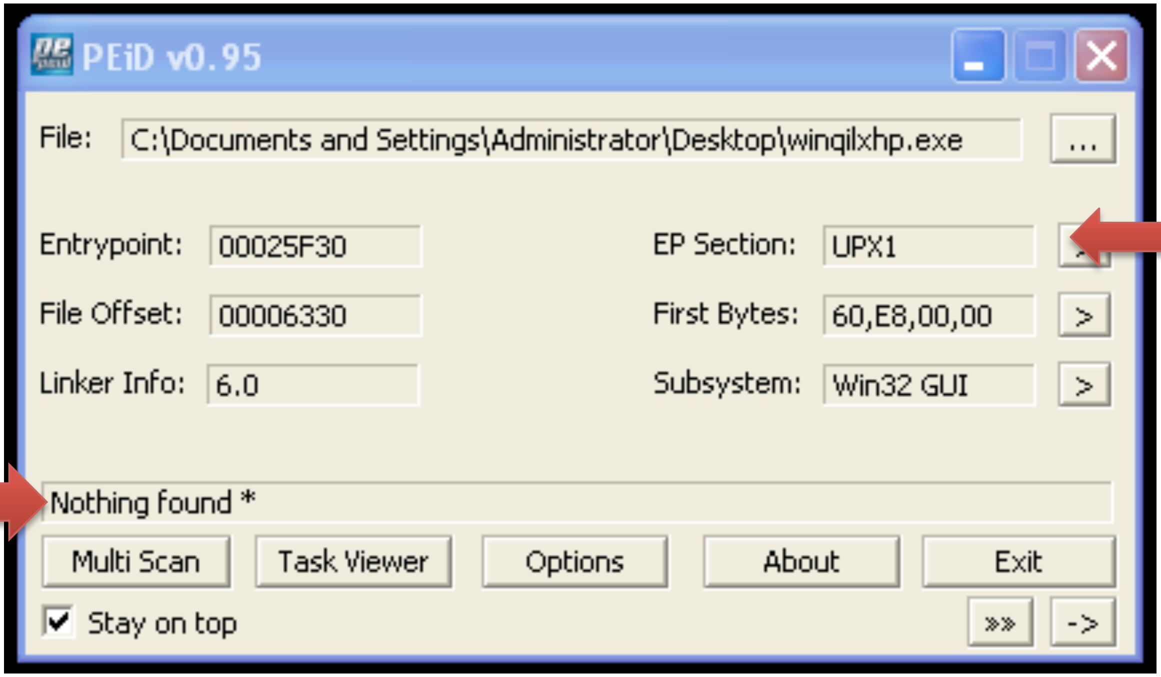
- More difficult than simple runtime trace analysis
- Malware is usually packed
- Uses anti-debugging techniques
  - Debugger checks
  - Import table stuff
  - SEH
  - Timing

- Unpack
  - Automated tools, PeID
  - Manually with memdumper
- Fix Imports
- Use Debugger with anti-anti-debugging features

Unpacking

- PEiD Fails
- At least we know it’s UPX (probably)



PEiD v0.95

File: C:\Documents and Settings\Administrator\Desktop\winqilxhp.exe

Entrypoint: 00025F30

EP Section: UPX1

File Offset: 00006330

First Bytes: 60,E8,00,00

Linker Info: 6.0

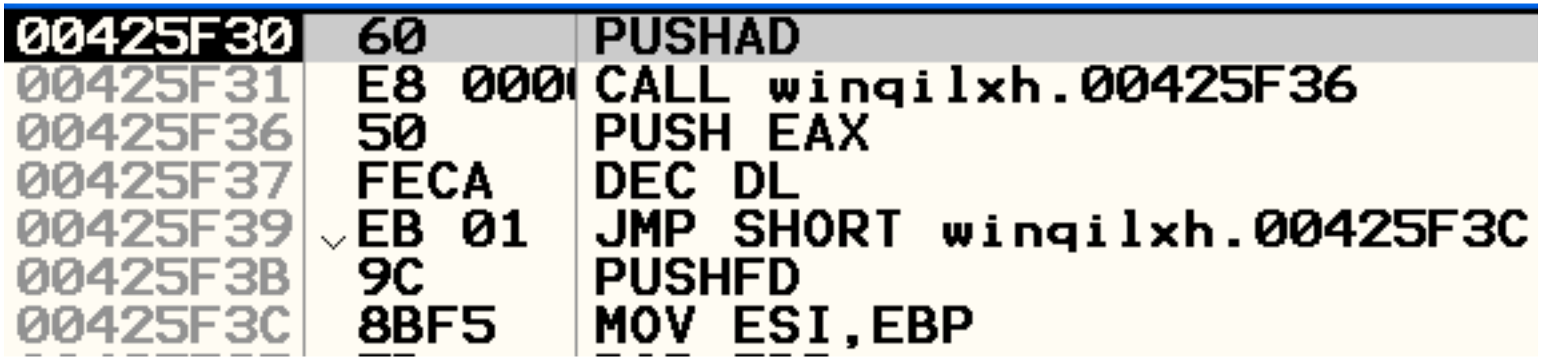
Subsystem: Win32 GUI

Nothing found *

☑ Stay on top

Manual unpacking

- Entry point at 0x425F30:

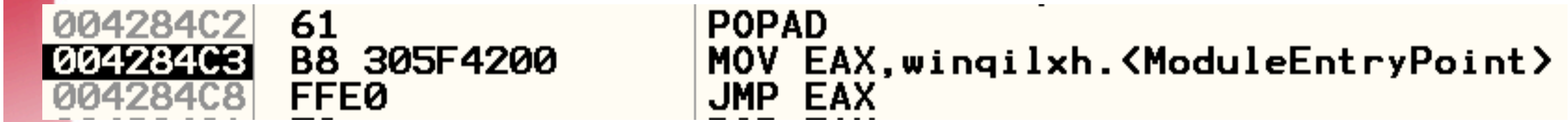


```
00425F30   60          PUSHAD
00425F31   E8 000(     CALL winqilxh.00425F36
00425F36   50          PUSH EAX
00425F37   FECA        DEC DL
00425F39 ⌄ EB 01       JMP SHORT winqilxh.00425F3C
00425F3B   9C          PUSHFD
00425F3C   8BF5        MOV ESI,EBP
```

- PUSHAD pushes all registers onto stack
- PUSHAD & POPAD usually surround the packer logic

Manual Unpacking Cont.

- Step the PUSHAD
- Set a hardware access breakpoint on the location of the stack pointer
- Pray
- Continue

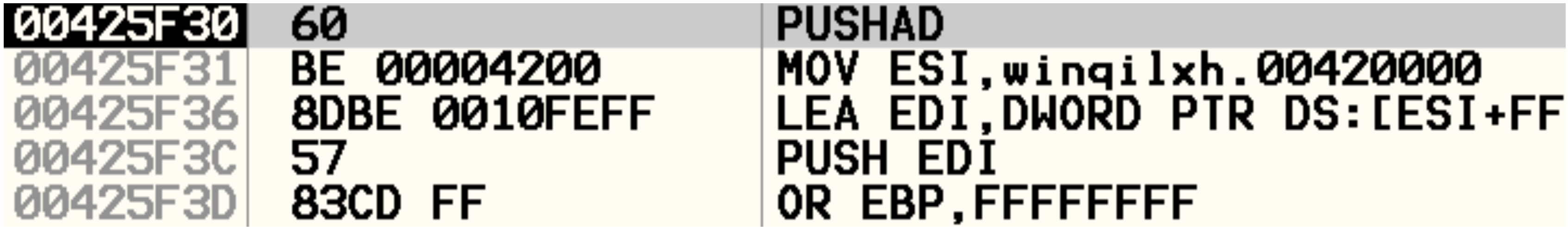


```
004284C2   61            POPAD
004284C3   B8 305F4200   MOV EAX,winqilxh.<ModuleEntryPoint>
004284C8   FFE0          JMP EAX
```

- Normally you note where its jumping two and dump the process
- But its jumping back to the same entry point!

Manual Unpacking Cont.

- Follow the jump

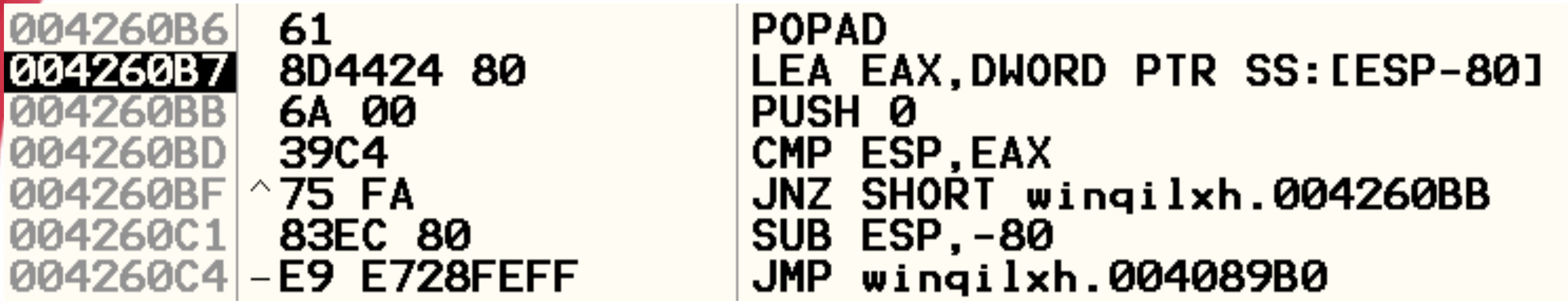


```
00425F30   60              PUSHAD
00425F31   BE 00004200     MOV ESI,winqilxh.00420000
00425F36   8DBE 0010FEFF   LEA EDI,DWORD PTR DS:[ESI+FF
00425F3C   57              PUSH EDI
00425F3D   83CD FF         OR EBP,FFFFFFFF
```

- Same 425F30
- Same PUSHAD
- Different Code
- Packed twice!

Manual Unpacking Cont.

- At the second POPAD



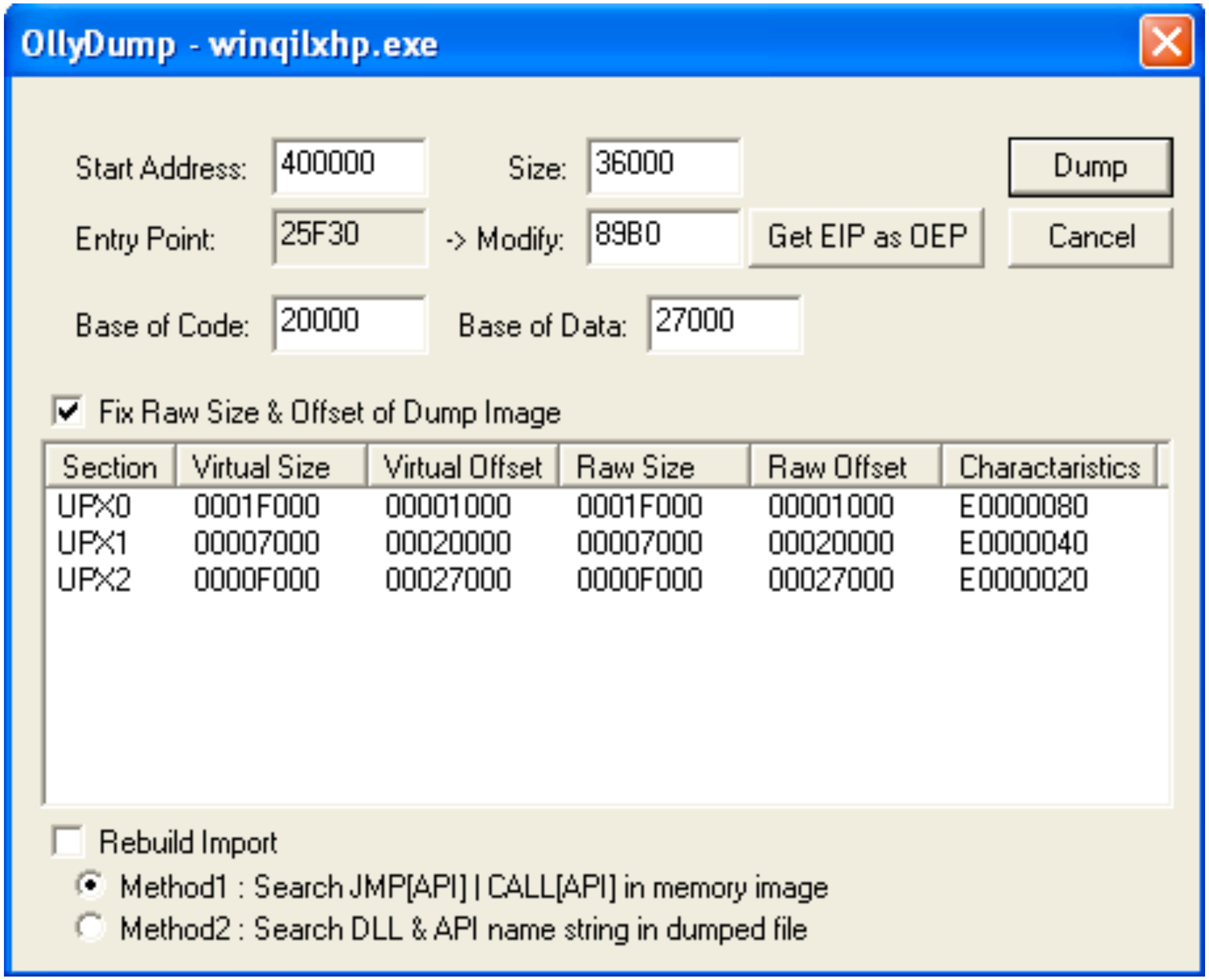
```
004260B6   61             POPAD
004260B7   8D4424 80      LEA EAX,DWORD PTR SS:[ESP-80]
004260BB   6A 00          PUSH 0
004260BD   39C4           CMP ESP,EAX
004260BF  ^75 FA          JNZ SHORT winqilxh.004260BB
004260C1   83EC 80        SUB ESP,-80
004260C4  -E9 E728FEFF    JMP winqilxh.004089B0
```

- Looks much better
- Short loop to zero out stack (?)
- Jump to 4089B0
- Dump to new PE file

Dumping

SOFTWARE ASSURANCE

- Used OllyDump to rebuild an unpacked version of the PE file



OllyDump - winqilxhp.exe

Start Address: 400000

Size: 36000

Entry Point: 25F30

-> Modify: 89B0

Base of Code: 20000

Base of Data: 27000

☑ Fix Raw Size & Offset of Dump Image

Section	Virtual Size	Virtual Offset	Raw Size	Raw Offset	Charactaristics
UPX0	0001F000	00001000	0001F000	00001000	E0000080
UPX1	00007000	00020000	00007000	00020000	E0000040
UPX2	0000F000	00027000	0000F000	00027000	E0000020

□ Rebuild Import

● Method1 : Search JMP[API] | CALL[API] in memory image

○ Method2 : Search DLL & API name string in dumped file

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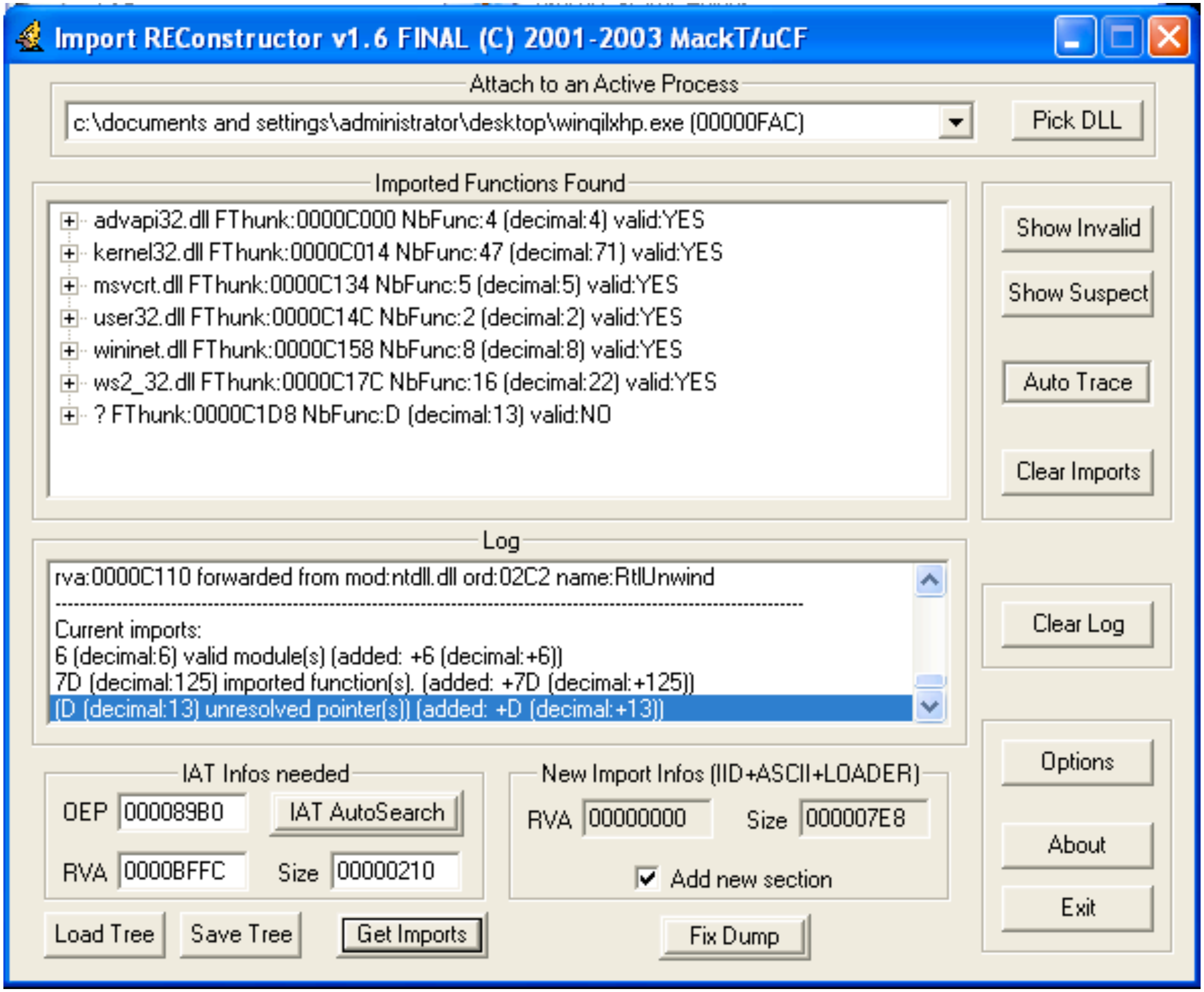
Fixing imports



Import REConstructor v1.6 FINAL (C) 2001-2003 MackT/uCF

Attach to an Active Process: c:\documents and settings\administrator\desktop\winqilxhp.exe (00000FAC)

Imported Functions Found

```
advapi32.dll FThunk:0000C000 NbFunc:4 (decimal:4) valid:YES
kernel32.dll FThunk:0000C014 NbFunc:47 (decimal:71) valid:YES
msvcrt.dll FThunk:0000C134 NbFunc:5 (decimal:5) valid:YES
user32.dll FThunk:0000C14C NbFunc:2 (decimal:2) valid:YES
wininet.dll FThunk:0000C158 NbFunc:8 (decimal:8) valid:YES
ws2_32.dll FThunk:0000C17C NbFunc:16 (decimal:22) valid:YES
? FThunk:0000C1D8 NbFunc:D (decimal:13) valid:NO
```

Log

```
rva:0000C110 forwarded from mod:ntdll.dll ord:02C2 name:RtlUnwind
----------------------------------------------------------------------------------------
Current imports:
6 (decimal:6) valid module(s) (added: +6 (decimal:+6))
7D (decimal:125) imported function(s). (added: +7D (decimal:+125))
(D (decimal:13) unresolved pointer(s)) (added: +D (decimal:+13))
```

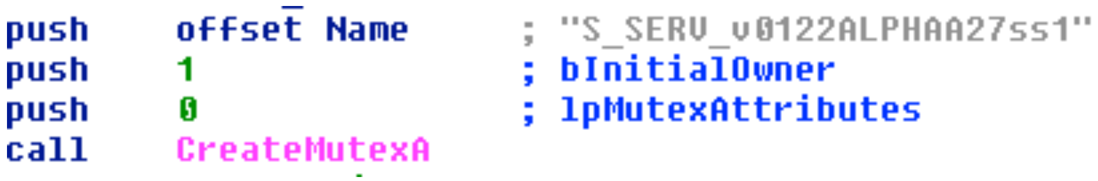
IAT Infos needed: OEP 000089B0; RVA 0000BFFC; Size 00000210

New Import Infos (IID+ASCII+LOADER): RVA 00000000; Size 000007E8

☑ Add new section

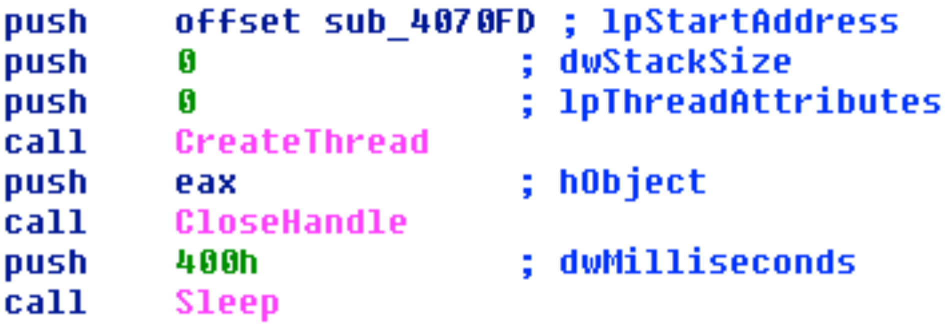
Assembly Stuff

- Mutex



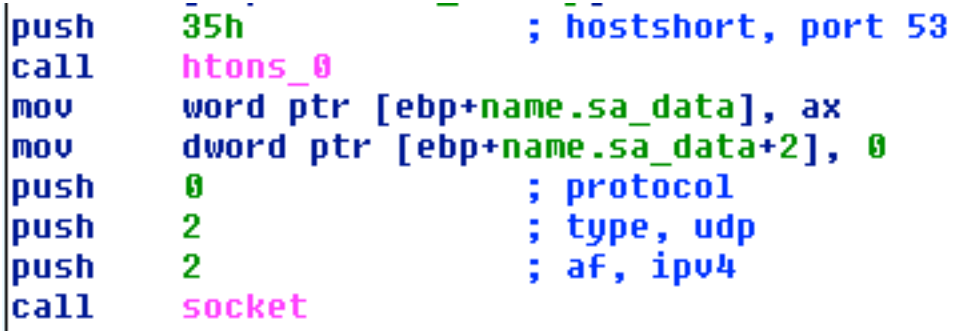
```
push    offset Name        ; "S_SERV_v0122ALPHAA27ss1"
push    1                  ; bInitialOwner
push    0                  ; lpMutexAttributes
call    CreateMutexA
```

- Threads



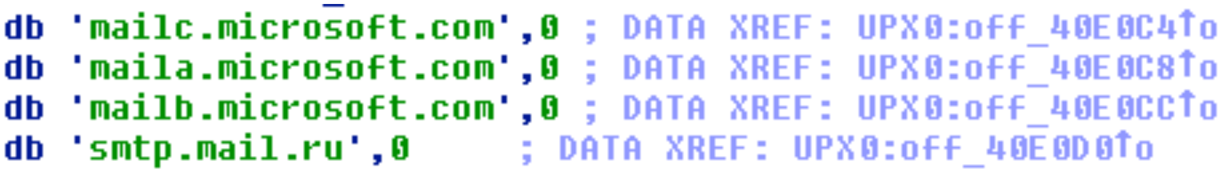
```
push    offset sub_4070FD ; lpStartAddress
push    0                  ; dwStackSize
push    0                  ; lpThreadAttributes
call    CreateThread
push    eax                ; hObject
call    CloseHandle
push    400h               ; dwMilliseconds
call    Sleep
```

- Sockets

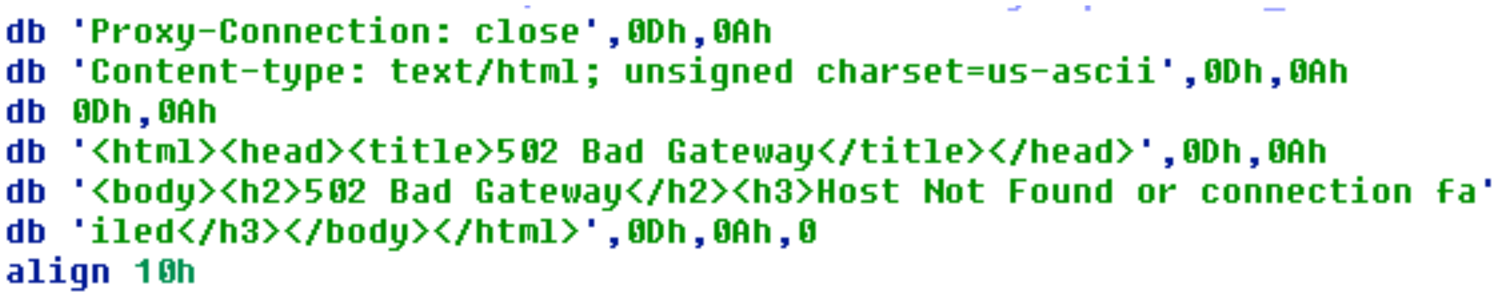


```
push    35h                ; hostshort, port 53
call    htons_0
mov     word ptr [ebp+name.sa_data], ax
mov     dword ptr [ebp+name.sa_data+2], 0
push    0                  ; protocol
push    2                  ; type, udp
push    2                  ; af, ipv4
call    socket
```

Strings



```
db 'mailc.microsoft.com',0 ; DATA XREF: UPX0:off_40E0C4↑o
db 'maila.microsoft.com',0 ; DATA XREF: UPX0:off_40E0C8↑o
db 'mailb.microsoft.com',0 ; DATA XREF: UPX0:off_40E0CC↑o
db 'smtp.mail.ru',0       ; DATA XREF: UPX0:off_40E0D0↑o
```



```
db 'Proxy-Connection: close',0Dh,0Ah
db 'Content-type: text/html; unsigned charset=us-ascii',0Dh,0Ah
db 0Dh,0Ah
db '<html><head><title>502 Bad Gateway</title></head>',0Dh,0Ah
db '<body><h2>502 Bad Gateway</h2><h3>Host Not Found or connection fa'
db 'iled</h3></body></html>',0Dh,0Ah,0
align 10h
```

Analysis Conclusion

SOFTWARE ASSURANCE

- A lot can be learned from simple tracing
- Anti-debugging tricks can slow down reverser significantly
  - Small effort for malware writer
  - Large effort for reverser
- Network analysis
  - Sniff traffic with protocol analyzer
  - Spoof servers to feed same payload
  - Now trace the virus
- Create wrappers to call functions in the malcode
  - Encrypt/decrypt
  - Rendezvous point generation function

Overall Conclusion

SOFTWARE ASSURANCE

- Not as bad as it could be
- Simple tracing/monitoring can give lots of information
- Static analysis of Malware can also yield many clues.
- Storing all bits of data and characteristics in a database can yield large dividends.
- Trend is toward decentralized botnets (P2P)
- New coordination efforts in botnet takedowns

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Thank You!

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