AntiRE en Masse

Investigating Ferrie's Documented AntiUnpacking Tricks in the World's Worst Mal-Families

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http://www.virusbtn.com/

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Agenda:

- Ferrie's Virus Bulletin Series – Anti-unpacking Tricks I – VII
- CARO Conference Paper and Presentation
- Packers, Crypto, Compression, AntiRE
- Unpacking Tools
- Malware Anti-unpacking - Worst Families of 2008,2009
- Observations, Implications, Conclusion

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Ferrie's Virus Bulletin Papers – Anti-unpacking Tricks Series I-VII

- Seven part Addendum to his 25 page CARO workshop paper
- Anti-debug, anti-emulation, anti-dumping, anti-interception

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Pre-Virus Bulletin Series - Ferrie's CARO Presentation and Accompanying Paper

- Four anti-unpacking trick categories
- 25 pages dedicated to anti-dumping, anti-debug, anti-emulation, anti-interception
- 2 pages = anti-dump, 18 pages = anti-debug, 3 pages = anti-emulation, 1 page = anti-interception
- 8 reversing/debugging tools covered specifically
- 4 anti-utilities mentioned

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Ferrie's Virus Bulletin Series

Part One
Anti-dump
Anti-debug
Anti-emulation

Part Two
Implemented anti-debug

Part Three
Syser Anti-debug

Part Four
"Speculative" Generic Anti-debug

Part Five
"Speculative" Anti-Ollydbg Tricks

Part Six
"Speculative" Anti-Ollydbg-plugin Tricks

Part Seven
Mixed bag of "Speculative" Tricks

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Ferrie’s Papers - Packer Content

Mentions publicly available legitimate and grey (19)
Yoda's Crypter, Armadillo, Shrinker, VMprotect, ExeCrypter, Themida, SafeDisc, HyperUnpackMe2,Yoda's Protector, PC Guard, Invius, ASProtect, tELock, PECompact, MEW, PE-Crypt32, TryGames, ASPack, RLPack

Mentions underground packers (3)
Tibs, MSLRH, NsAnti

Spectrum of “Packers” - Legitimate, Grey, Malicious

Legitimate executable packers compress PE file contents, adding an unpacking stub used to decompress contents at runtime.

Open source gold standard - UPX

“UPX is a free, portable, extendable, high-performance executable packer for several different executable formats.
It achieves an excellent compression ratio and offers very fast decompression. Your executables suffer no memory overhead or other drawbacks for most of the formats supported, because of in-place decompression.”
http://upx.sourceforge.net/#abstract

Themida

“Advanced Windows software protection system, developed for software developers who wish to protect their applications against advanced reverse engineering and software cracking.”
http://www.themida.com/

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Packers' Characteristics

Shared by grey and malicious "packers"

- Much more than simply compression and runtime decompression
- Anti-debug, anti-dump, anti-interception, anti-emulation
- Layers of protection target reversers' efforts

Specific to malicious packers

- Ease of server side polymorphism
- Frequently built for compatibility with multiple packers of buyer/distributor's choosing
- Distributed throughout layers of underground markets
- Layers of protection most often target file scanner's best efforts

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Unpacking Tools and Public Resources

Ollydbg, Titan, Windbg, the Ether project. Syser, SoftICE, ImpRec, LordPE, PETools, OllyDump by Gigapede, FKMA's PE Dumper, AdvancedOlly, StrongOD, InvisbleOD, Syser, IDA Pro

OpenRce.org, Woodmann RCE Library and forums, Google + Google Translate

Mebroot/Sinowal

Overview

Packed malcode components

Anti-unpacking tricks

Mebroot Overview

• Mebroot is an actively distributed Mbr infecting downloader and dropper component delivered via “outdated” commodity exploit packs and delivering banking password stealers and bot components

• Most functionality documented in last year’s fine “Stoned” paper from Kimmo Kasselin and Elia Florio

• Slight changes in code this year show development in progress, although not on the scale anticipated in the paper

Mebroot Overview (cont.)

• Deployed via multiple exploits, with the most popular targeting Adobe Acrobat Reader vulnerabilities

•The downloader (miniloader) copies out another component at runtime. It is a binary similiar to itself but much larger, and calls CreateProcessA triggered by an audio event activated as a timeSetEvent event callback, previous variants called SetWinEventHook

Mebroot Packed Components

- Downloader/miniloader
- Dropped user-mode executable files
- Drivers

Mebroot - Anti-unpacking tricks

•Anti-emulation - packer starts off the entry point with multiple api calls with bogus parameters with flow control based on return codes
These calls usually are functionally based in FileIO and handle fetches.
Changing calls and parameters = server side polymorphism

“Example code looks like this”:
DeviceIoControl(IoControlCode = 0, hDevice = Null)
GetExitCodeThread(hThread = Null, pExitCode = 0012fee0)
GetFileVersionInfoSizeA(FileName = "", pHandle = 0012fee0)

However, the mebroot custom packer implements this same process heap usage across every binary for the past year

Mebroot - Anti-unpacking tricks (cont.)

- Junk code placed in between the functions and the misaligned offset that is jumped into confuses Olly's analysis capabilities. Removing analysis from the module returns proper disassembly. Spaghetti jumps have dried up.

- Crypto is most often modified standard reference implementations

- Api strings are custom crypted, decoded and import table built at runtime

Mebroot - Anti-unpacking tricks (cont.) – Modified XTEA Decryption Loop

dec(z,(((y shl 4) xor (y shr 5)) + y) xor (sum+key[(sum shr 11) and 3]));

0x243f6a88 is ripped here (proposed key for Schneier's Blowfish algorithm)

Anti-crude crypto detection?

```
004067E3    POPFD
004067E4    MOV EBX,[ARG.2]
004067E7    MOV ESI,ECX
004067E9    SHR ESI,5
004067EC    MOV EDI,ECX
004067EE    SHL EDI,4
004067F1    XOR ESI,EDI
004067F3    PUSHFD
004067F4    JMP SHORT uninstal.0040681B
004067F6    POPFD
004067F7    SUB [ARG.1],243F6A88
004067FE    ADD ESI,ECX
00406800    XOR ESI,EDI
00406802    SUB EAX,ESI
00406804    PUSHFD
00406805    PUSH EAX
00406806    MOV EAX,EDX
00406808    AND EAX,0
0040680B    CMP EAX,0
0040680E    POP EAX
0040680F    JE uninstal.004068C2
00406815    ADD EDI,ESP
00406817    SUB EDI,ESP
00406819    POPFD
0040681A    RETN
0040681B    POPFD
0040681C    MOV EDI,[ARG.1]
0040681F    SHR EDI,0B
00406822    AND EDI,3
00406825    MOV EDI,DWORD PTR DS:[EBX+EDI*4]
00406828    ADD EDI,[ARG.1]
0040682B    PUSHFD
0040682C    PUSH EDI
```

Waledac

Overview

Packed malcode components

Anti-unpacking tricks

Waledac Overview

- Currently active, simply changed operational model from exclusively themed spam campaigns
- Waledac packer distributed with other software than spambot
- Packer targets both file scanners and reversers

- Currently 2 packed malcode components most active in India and Great Britain:
  - Current downloader
  - Email address harvesting, P2P chatting, DDoS'ing, spamming bot

- Packer's anti-unpacking tricks
  - Multiply aligned entry point
  - Int 0x2e, Int 3
  - Time locks

Waledac (Bredolab?) Downloader Overview

- Served via “poorly filtered” affiliate distribution network, i.e. pubcut[autogen].59.to/clickcontroller/9006/files/ “8c01.tmp”

- Automated domain generation scheme:
  pubcutranrat.59.to, pubcutpopgot.59.to, pubcutpopgot.59.to,etc
  Interesting that we now have downloaders served from Tongan (African) registered domains retrieving malicious file payloads from servers hosted in Amsterdam and the Russian Federation

- Nginx/0.8.15 http servers

- Currently downloads Waledac spambot and FakeAv
  - 95.211.8.215/pr/pic/abc_c.exe (%temp%_EX-08.exe = Waledac spambot)
    Russian Federation, phones back to http://topwale.com/index.php
  - 91.212.220.123/pr/pic/spyware.exe (Antivirus 2008/9 variant)
    Amsterdam, Netherlands

Waledac Downloader - Overview (cont.)

- ~20kb in size delivered via client side
- Server side polymorphism
- Entry point trick + time lock puzzle

Waledac Downloader - Anti-unpacking tricks

- Packer EP begins with Int 0x2e 0xc0000005 location generation trick

  Anti-debug and anti-emulation

  Persistent AVkill

  Custom encoding and standard reference crypto

Waledac Downloader AntiRE Tricks – Anti-Debug/Anti-Emulation

- Hidden" Int 2e eax = 0x0000 0000, edx = 0x02eb 2ecd
- Debugger Anti-attach, much like a sysenter
- Predictably returns 0xc000 0005 in eax and the location of the offending call in edx, both required to transfer control to expected location

```
00401058 8c01.<ModuleEnt   81C1 35547489     add     ecx, 89745435
0040105E                   33C0              xor     eax, eax
00401060                   BA CD2EEB02       mov     edx, 2EB2ECD
00401065                 ^ EB FA             jmp     short 8c01.00401061
00401067                   C1C8 15           ror     eax, 15
0040106A                   2BD0              sub     edx, eax
0040106C                   81C2 974E0000     add     edx, 4E97
```

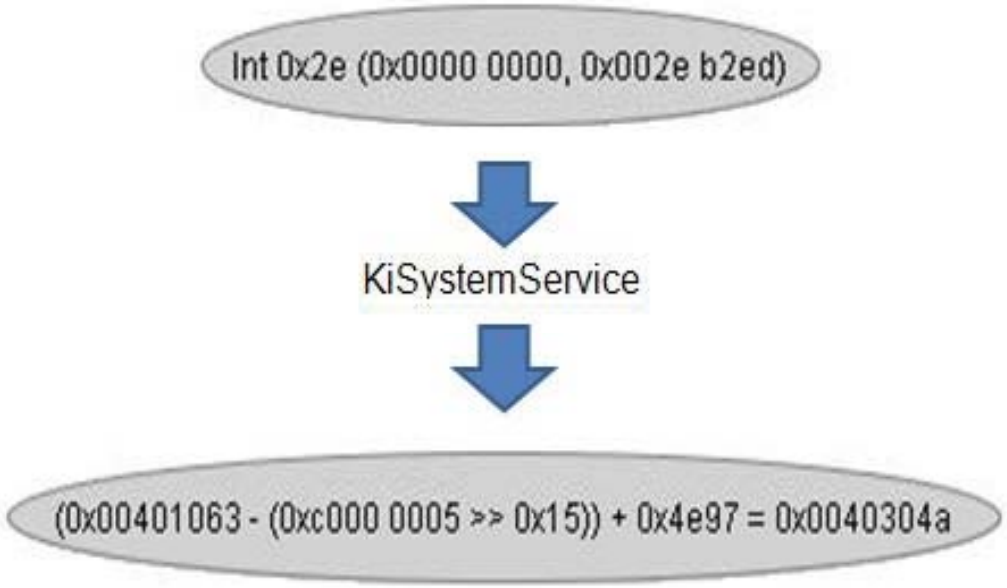
- Edx return value without debugger vs. debugger stepping

```
   CD 2E            int     2E
   EB 02            jmp     short 8c01.00401067
 ^ EB FA            jmp     short 8c01.00401061
   C1C8 15          ror     eax, 15
   2BD0             sub     edx, eax
   81C2 974E0000    add     edx, 4E97
   52               push    edx
   FF1424           call    near dword ptr ss:[esp]   8c01.004030FA
```

```
Registers (FPU)
EAX 00002E00
ECX 0012FFC4
EDX 004030FA 8c01.004030FA
EBX 7FFDF000
ESP 0012FFC0
EBP 0012FFF0
ESI 00000000
```

Waledac Anti-emulation/anti-debug KiSystemService predictable error condition

Visual/mathematical representation of the EP anti-debug/anti-emulation



Anti-debug/Anti-emulation (cont.)

• Fcomp ebx → Illegal use of a register
(Compare Floating Point Values and Set EFLAGS)

•How to handle in illegal register use in Olly?
Options -> Debugging Options -> Security ->
Allow stepping into 'Unknown commands'

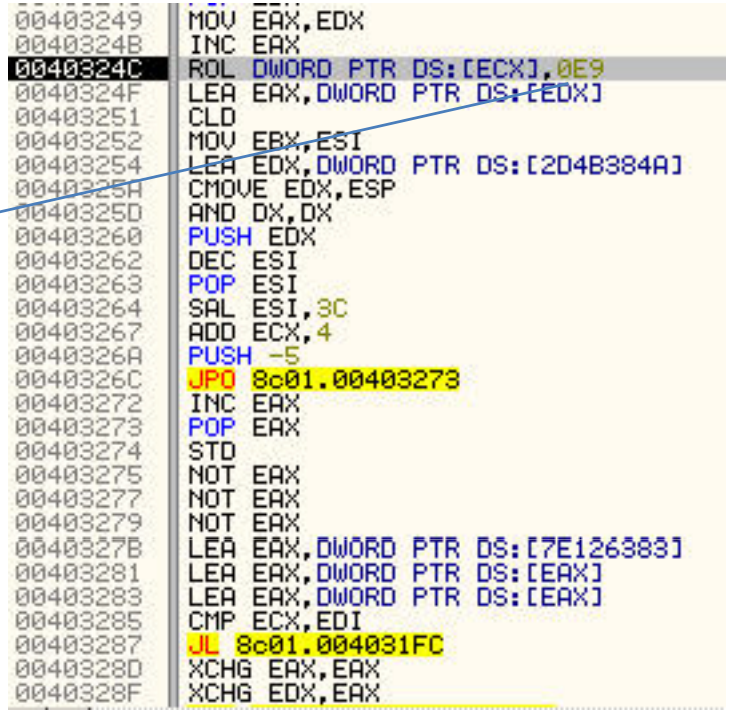
Repeated useless MMX instructions intermixed

• Int 3 cc breakpoint exception can be mishandled by Olly

Matt Pietrek's SEH discussion:
http://www.microsoft.com/msj/0197/Exception/Exception.aspx

Waledac Downloader Simple Decoding Loops

Simple ROL “0x0e9” loop
surrounded by garbage code

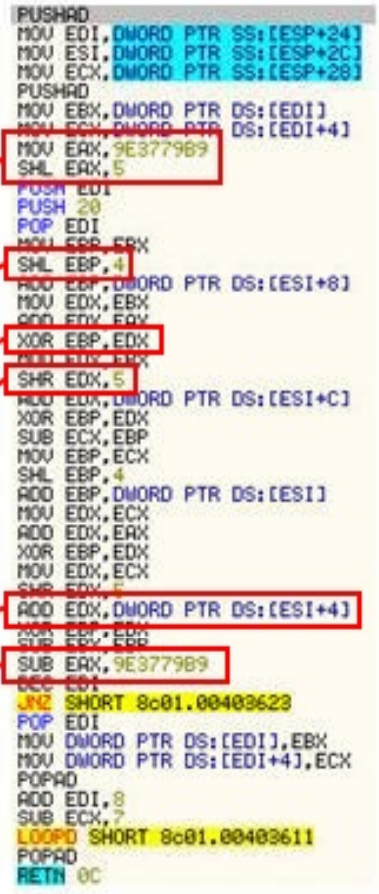


Waledac Downloader Decoding/Decryption Schemes

Modified TEA decryption loop following simple rol loop

- Step into this decoded data
- TEA loop 20 rounds
- delta = \x9e3779b9;
  sum = delta << 5;

```
for (i=0; i<=31; i++) {
  z -= (y << 4)+key[2] ^ y+sum ^ (y >> 5)+key[3];
  y -= (z << 4)+key[0] ^ z+sum ^ (z >> 5)+key[1];
  sum -= delta;
```



Waldec Spambot Custom Crypto

• Decryption routines littered with garbage code (i.e. from smsspy.exe)

Underlying simple decryption cipher function embedded within 140 “active” function-less instructions looks like this:

```
mov     bl, byte ptr ds:[esi]
ror     bl, 4
rol     bl, 1A
add     bl, 0B
xor     bl, 0D9
mov     bh, bl
mov     byte ptr ds:[esi], bh
```

```
for (i=0; i<0x669; i++) {
  x = y[i];
  y[i] = (((x >> 4) << 0x1a) + 0x0b ^ 0x0d9);
 }
```

Waledac Spambot Anti-Unpacking Tricks

~380 - ~420 kb, binary size is generally based on size of p2p peer list

- **Int 0x2e calls with invalid eax/edx parameters**

Code looks like this:

```
int     2e                          ; eax = 0xffffffff, edx = 0x0007f800
edx,    ABCE2546                    ; eax = 0xc000001c, edx = 0x0046687a
jnz     20090422.004669C6 ; “should” always jump to 0x004669c6
inc     edi
```

Waledac Spambot Anti-Unpacking Tricks (cont.)

Entry point stack manipulation for fake system thread re-entry followed by time-lock puzzle (i.e. onlyyou.exe)

Waledac Spambot Anti-Unpacking Tricks (cont.)

Entry point stack manipulation + system thread re-entry followed by time-lock puzzle (i.e. onlyyou.exe), the two look like this…

```
mov     ecx, dword ptr ds:[ebx+8]    ; stack [0006FFC0]=0006FFF0
add     ecx, 8
mov     ebx, 00460013                ; several bytes after ep
mov     dword ptr ds:[ecx], ebx      ; stack location for ret from kernel32
Jmp     esi                          ; kernel32.77E7EB56
_BaseProcessStart -> ret -> 00460013
```

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Taterf…
Packed.NsAnti/Frethog/Trojan.Lineage/Gampass

Overview

Packed malcode components

Anti-unpacking tricks

Flowchart

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Taterf/Packed.NsAnti/Gampass Overview

- Worm that drops and injects gaming password stealing components
- High prevalence partly due to its autorun delivery mechanism, partly because gamers hate giving up clock cycles and memory to security software
- Loads of access violations in its worm/dropper from only a few virtual locations
- Avkill abusing “undocumented" call to ZwQuerySystemInformation with parameter 0x0b, driver load via ZwLoadDriver
- Actively hosted and distributed across China and India
- File names stay unusually consistent for extended periods of time, amvo.exe, xmg.exe, help.exe, am.exe, klif.sys, etc

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Taterf/Packed.NsAnti/Gampass Packed Components

- Worm/dropper component
- Multiple dropped dlls

Taterf/Packed.NsAnti/Gampass Anti-unpacking Tricks

- Custom crypto
- Multiple stages, loading and unpacking of code and dll's
- Thousands of access violations while it searches though memory
- Past finding OEP at each stage, no huge difficulty getting past first couple forced exceptions:
  EXCEPTION_INT_DIVIDE_BY_ZERO
  EXCEPTION_SINGLE_STEP

Koobface

Overview

Packed malcode components

Anti-unpacking tricks

Koobface Overview

- Identity/authentication, captcha cracking (via “online services”), password stealing worm exploiting multiple social networks’ trust, ease of connectivity and recognition confusion

- Often downloaded alongside other malware deliverables, like zbot, FakeAv, updated Virut variants, etc

- Most prevalent in US, Great Britain, Italy, etc over the past year

- Tweets!

Koobface Packed Malcode Components

- Most prevalent binaries = Upx packed

- Break up in-memory strings by assigning string array char by char, breaking up strings and concatenating via sprintf

- Nothing from Ferrie's papers

- Uses some OLE for HTML insertion, making reversing difficult but no antiRE

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Zbot…Infostealer.Banker/Wsnpoem/Notos Overview

• Zbot is the server bot component of the Zeus crimeware kit being actively developed and distributed

• Cost - last week, posts offered weekly zbot FUD service for $1400. Distributors offer “deep” interests more service and effort for more money

• Attack distribution – mostly in the U.S., England, Russia

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Zbot Packed Malcode Components

- Dropper/injector
- Injected malcode
- Anti-unpacking tricks per outer layer
  custom built cryptor
  layers depending on distributor

Observations, Implications, Conclusions

• Custom packers coupled with “tweaked” encryption algorithms and Implementations

• Limited set of anti-unpacking tricks implemented in active families

• Limited to tricks that most cause problems for performance-sensitive file scanners

• Surprisingly low use of “the ultimate” VM implementation at this point