

Reverse Engineering Mac Malware

BsidesNoLA

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Scope & Agenda

Malware Triage

~20% Static, ~80% Dynamic

No Assembly

Agenda:

- Static Analysis
 - File Types
 - Analysis Tools
- Dynamic Analysis
 - Virtualization
 - Application Tracing
 - Analysis Tools
- Analysis Examples

Static Analysis

Locate & Extract the Executable Files

File Types:

- Application Bundles
- Mach-O
- PKG Files

Tools:

- MachOView
- lipo
- Strings || srch_strings
- nm
- codesign
- Hopper

Locate the Malware

Application Bundle (*.app)

PKG File

Mach-O Executable

...

Office Document

ZIP Archive

JAR File

...others...

Application Bundle

Directory

Contents:

- Info.plist (*required*)
 - Configuration Information
- Executable (*required*)
 - Located anywhere in bundle
- MacOS Directory
 - Executable may be in here too!
- Resources Directory
 - Supporting Files

Safari.app/

```
└─ Contents
   └─ Info.plist
   └─ MacOS
   └─ PkgInfo
   └─ Resources
   └─ _CodeSignature
   └─ version.plist
```

Dashboard.app/

```
└─ Contents
   └─ Info.plist
   └─ MacOS
       └─ Dashboard
   └─ PkgInfo
   └─ Resources
       └─ Dashboard.icns
   └─ _CodeSignature
       └─ CodeResources
   └─ version.plist
```

Application Bundle Crisis Sample

- Executables:
 - IZsROY7X.-MP
 - lUnsA3Ci.Bz7
 - mWgpX-al.8Vq
- Kernel Extension = 6EaqyFfo.zIK.kext

Key	Type	Value
▼ Information Property List	Dictionary	(11 items)
Localization native development region	String	English
Executable file	String	IZsROY7X.-MP
Bundle identifier	String	com.apple.mdworker-user
InfoDictionary version	String	6.0
Bundle name	String	mdworker-user
Bundle OS Type code	String	APPL
Bundle creator OS Type code	String	????
Bundle version	String	1.0
Main nib file base name	String	MainMenu
Principal class	String	NSApplication
NSUIElement	String	1

```
jlc3V7we.app/  
├─ Contents  
│   ├── Info.plist  
│   ├── MacOS  
│   └── Resources  
│       └── 6EaqyFfo.zIK.kext  
│           ├── Contents  
│           │   ├── Info.plist  
│           │   ├── MacOS  
│           │   └── 6EaqyFfo.zIK  
│           └── Resources  
├─ IZsROY7X.-MP  
├─ WeP1xpBU.wa-  
├─ eiYNz1gd.Cfp  
├─ krfhIqFRqIqxU8x6eqo68hVjjq.gai  
├─ krfhIqFRxIqxU8x6eqojjUo8jq.gai  
├─ krfhIqFjqIqxU8x6e68UoHoQqq.gai  
├─ krfhIqFjqIqxU8x6e68eqUxHjq.gai  
├─ krfhIqFjqIqxU8x6e6hFUee6qq.gai  
├─ krfhIqFjqIqxU8x6e6hFVVFVjq.gai  
├─ krfhIqFjqIqxU8x6e6hVDRHjq.gai  
├─ krfhIqFjqIqxU8x6e6hVhU8Zqq.gai  
├─ krfhIqFjqIqxU8x6e6hjFQqRjq.gai  
├─ krfhIqFjqIqxU8x6e6hxQ6joqq.gai  
├─ krfhIqFjqIqxU8x6e6hxqxhDjq.gai  
├─ krfhIqFjqIqxU8x6eFFVHeFDqq.gai  
├─ krfhIqFjqIqxU8x6eFUR8FZZjq.gai  
├─ krfhIqFjqIqxU8x6eFVHoHHjq.gai  
├─ krfhIqFjqIqxU8x6eFVx6QRFqq.gai  
├─ krfhIqFjqIqxU8x6eFqDFDHZjq.gai  
├─ krfhIqFjqIqxU8x6eFqHjoUxqq.gai  
├─ krfhIqFjqIqxU8x6eFxDhDRqq.gai  
├─ krfhIqFjqIqxU8x6eFxbj6Qxqq.gai  
├─ krfhIqFjqIqxU8x6exU6jejojq.gai  
├─ krfhIqFjqIqxU8x6exUQhFhZqq.gai  
├─ krfhIqFjqIqxU8x6exUUHHxqq.gai  
├─ krfhIqFjqIqxU8x6exUjFQVjq.gai  
├─ krfhIqFjqIqxU8x6exUoJZ8qq.gai  
├─ krfhIqFjqIqxU8x6exoF8VUjjq.gai  
├─ krfhIqFjqIqxU8x6eqojjUo8jq.gai  
├─ lUnsA3Ci.Bz7  
├─ mWgpX-al.8Vq  
├─ mdworker.flg  
└─ q45tyh
```

PKG File

eXtensible ARchiver
(XAR) Archive

Flashback used a fake
“FlashPlayer-11-
macos.pkg” Installer



FlashPlayer-11-macos.pkg

PKG Files

List & Extract the Malware

```
nibble:malware sledwards$ xar -t -v -f FlashPlayer-11-macos.pkg
-rw-r--r--      alis/wheel      729 2011-10-06 09:09:44 Distribution
drwxr-xr-x      alis/wheel      0 2011-10-06 09:09:44 Resources
drwxr-xr-x      alis/wheel      0 2011-10-06 09:09:44 Resources/en.lproj
-rw-r--r--      alis/wheel    128522 2011-07-22 14:18:25 Resources/en.lproj/background
drwxr-xr-x      alis/wheel      0 2011-10-06 09:09:44 license.pkg
-rw-r--r--      alis/wheel     267 2011-10-06 09:09:44 license.pkg/PackageInfo
-rw-r--r--      alis/wheel    35129 2011-10-06 09:09:43 license.pkg/Bom
-rw-r--r--      alis/wheel     115 2011-10-06 09:09:43 license.pkg/Payload
-rw-r--r--      alis/wheel    32942 2011-10-06 09:09:43 license.pkg/Scripts
```

```
nibble:malware sledwards$ unar FlashPlayer-11-macos.pkg -o flashback_extract/
FlashPlayer-11-macos.pkg: XAR
  license.pkg/ (dir)... OK.
  license.pkg/PackageInfo (267 B)... OK.
  license.pkg/Bom (35129 B)... OK.
  license.pkg/Payload (115 B)... OK.
  license.pkg/Scripts (32942 B)... OK.
  Resources/ (dir)... OK.
  Resources/en.lproj/ (dir)... OK.
  Resources/en.lproj/background (128522 B)... OK.
  Distribution (729 B)... OK.
Successfully extracted to "flashback_extract/FlashPlayer-11-macos".
```

PKG Files

List & Extract the Malware

```
nibble:license.pkg sledwards$ file *  
Bom:          Mac OS X bill of materials (BOM) file  
PackageInfo: ERROR: line 163: regex error 17, (illegal byte sequence)  
Payload:      gzip compressed data, from Unix  
Scripts:      gzip compressed data, from Unix
```



```
nibble:license.pkg sledwards$ unar -r Payload  
Payload: Gzip  
Payload... OK.  
Successfully extracted to "./Payload-1".  
nibble:license.pkg sledwards$ unar -r Scripts  
Scripts: Gzip  
Scripts... OK.  
Successfully extracted to "./Scripts-1".
```



```
nibble:license.pkg sledwards$ unar -r Payload-1  
Payload-1: Cpio  
./ (dir)... OK.  
./license (0 B)... OK.  
Successfully extracted to "Payload-1-1".  
nibble:license.pkg sledwards$ unar -r Scripts-1  
Scripts-1: Cpio  
./ (dir)... OK.  
./postinstall (99268 B)... OK.  
Successfully extracted to "Scripts-1-1".
```

PKG Files

List & Extract the Malware

- *-1 (First unar - gzip)
- *-1-1 (Second unar - cpio)

```
nibble:license.pkg sledwards$ file *
Bom:          Mac OS X bill of materials (BOM) file
PackageInfo: ERROR: line 163: regex error 17, (illegal byte sequence)
Payload:      gzip compressed data, from Unix
Payload-1:    ASCII cpio archive (pre-SVR4 or odc)
Payload-1-1:  directory
Scripts:      gzip compressed data, from Unix
Scripts-1:    ASCII cpio archive (pre-SVR4 or odc)
Scripts-1-1:  directory
nibble:license.pkg sledwards$ file Payload-1-1/*
Payload-1-1/license: empty
nibble:license.pkg sledwards$ file Scripts-1-1/*
Scripts-1-1/postinstall: Mach-0 universal binary with 2 architectures: [x86_64: Mach-0 64-bit
x86_64 executable] [i386: Mach-0 i386 executable]
```

Mach-O Binaries

- Executable Format used on OS X
- Universal (Fat) Binaries
- File Signatures:
 - 0xCAFEBAFE – Fat binary
 - 0xFEEDFACE – 32-bit
 - 0xFEEDFACF – 64-bit
 - 0xCEFAEDFE – 32-bit, Little Endian
 - 0xCFFAEDFE – 64-bit, Little Endian

32-Bit/Little Endian

```
nibble:jlc3V7we.app sledwards$ file IZsROY7X.-MP
IZsROY7X.-MP: Mach-O i386 executable
```

```
00000000: cefa edfe 0700 0000 0300 0000 0200 0000 .....
0000010: 2300 0000 5412 0000 8500 0001 0100 0000 #...T.....
0000020: 3800 0000 5f5f 5041 4745 5a45 524f 0000 8...__PAGEZERO..
0000030: 0000 0000 0000 0000 0010 0000 0000 0000 .....
```


Mach-O Binaries

Universal/Fat Binaries

```
00000000: cafe babe 0000 0002 0100 0007 8000 0003 .....
00000010: 0000 1000 0000 60e8 0000 000c 0000 0007 .....`.....
00000020: 0000 0003 0000 8000 0000 5e24 0000 000c .....^$....
00000030: 0000 0000 0000 0000 0000 0000 0000 0000 .....

```

Intel 32 & 64-bit

```
nibble:jlc3V7we.app sledwards$ file mWgpX-a1.8Vq
mWgpX-a1.8Vq: Mach-O universal binary with 2 architectures: [x86_64: Mach-O 64-bit x86_64
executable] [i386: Mach-O i386 executable]
```

Universal – PowerPC & Intel 32-bit

```
nibble:malware sledwards$ file MacKontrol
MacKontrol: Mach-O universal binary with 2 architectures: [ppc_7400: Mach-O ppc_7400 executable]
[i386: Mach-O i386 executable]
```


Universal/Fat Binary File Info

lipo

Review Architecture Details:

- `-info <file>`
- `-detailed_info <file>`

```
nibble:malware sledwards$ lipo -info MacKontrol
Architectures in the fat file: MacKontrol are: ppc7400 i386
nibble:malware sledwards$ lipo -detailed_info MacKontrol
Fat header in: MacKontrol
fat_magic 0xcafebabe
nfat_arch 2
architecture ppc7400
    cputype CPU_TYPE_POWERPC
    cpusubtype CPU_SUBTYPE_POWERPC_7400
    offset 4096
    size 44852
    align 2^12 (4096)
architecture i386
    cputype CPU_TYPE_I386
    cpusubtype CPU_SUBTYPE_I386_ALL
    offset 49152
    size 50692
    align 2^12 (4096)
```

Universal/Fat Binary File Info

lipo

Extract Binaries:

- `-extract <architecture type>`
- `-output <output file>`

```
nibble:malware sledwards$ lipo -extract i386 -output MacKontrol_i386 MacKontrol
nibble:malware sledwards$ file MacKontrol_i386
MacKontrol_i386: Mach-0 universal binary with 1 architecture: [i386: Mach-0 i386 executable]
```

MachOView - Mach Header

sourceforge.net/projects/machoview/

IZsROY7X.-MP

RAW RVA

▼ Executable (X86) [SDK10.6 Target10.5]

Mach Header

- Load Commands
- ▼ Section (__TEXT,__text)
 - Assembly
- ▼ Section (__TEXT,__symbol_stub)
 - Symbol Stubs
- ▼ Section (__TEXT,__stub_helper)
 - Assembly
- ▼ Section (__TEXT,__cstring)
 - C String Literals
- Section (__TEXT,__const)
- Section (__TEXT,__unwind_info)
- ▼ Section (__TEXT,__eh_frame)
 - Call Frame 0x53EE0

Offset	Data	Description	Value
00000000	FEEDFACE	Magic Number	MH_MAGIC
00000004	00000007	CPU Type	CPU_TYPE_I386
00000008	00000003	CPU SubType	CPU_SUBTYPE_I386_ALL
0000000C	00000002	File Type	MH_EXECUTE
00000010	00000023	Number of Load Commands	35
00000014	00001254	Size of Load Commands	4692
00000018	01000085	Flags	
		00000001	MH_NOUNDEFS
		00000004	MH_DYLDLINK
		00000080	MH_TWOLEVEL
		01000000	MH_NO_HEAP_EXECUTION

Executables Strings

strings || srch_strings

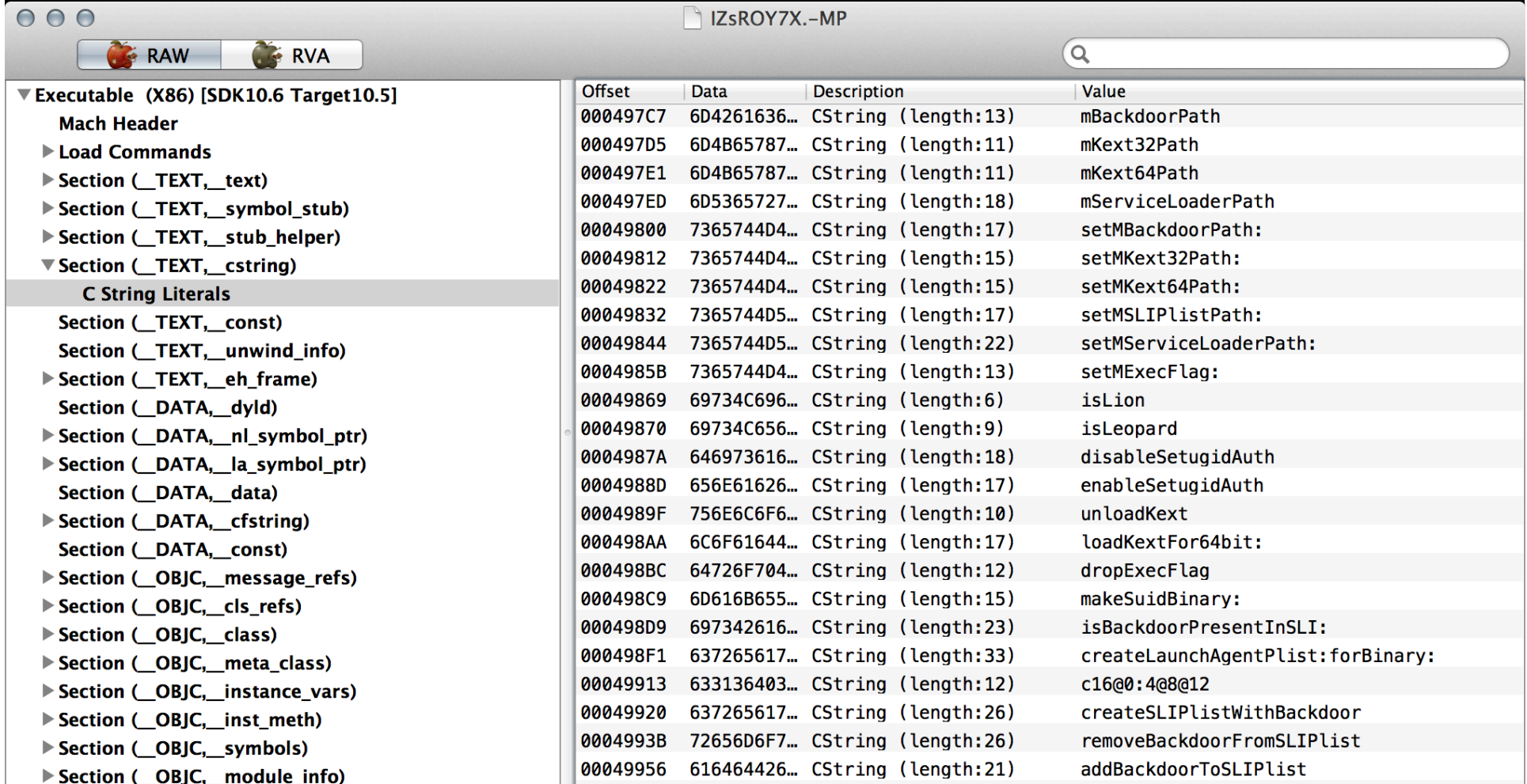
Extract all strings:

- ASCII Strings
 - `strings -a`
- Unicode Strings (The Sleuth Kit)
 - `srch_strings -a -t`

```
mBackdoorPath
mKext32Path
mKext64Path
mServiceLoaderPath
setMBackdoorPath:
setMKext32Path:
setMKext64Path:
setMSLIPListPath:
setMServiceLoaderPath:
setMExecFlag:
isLion
isLeopard
disableSetugidAuth
enableSetugidAuth
unloadKext
loadKextFor64bit:
dropExecFlag
makeSuidBinary:
isBackdoorPresentInSLI:
createLaunchAgentPlist:forBinary:
c16@0:4@8@12
createSLIPListWithBackdoor
removeBackdoorFromSLIPList
addBackdoorToSLIPList
```

MachOView - Strings

sourceforge.net/projects/machoview/



Offset	Data	Description	Value
000497C7	6D4261636...	CString (length:13)	mBackdoorPath
000497D5	6D4B65787...	CString (length:11)	mKext32Path
000497E1	6D4B65787...	CString (length:11)	mKext64Path
000497ED	6D5365727...	CString (length:18)	mServiceLoaderPath
00049800	7365744D4...	CString (length:17)	setMBackdoorPath:
00049812	7365744D4...	CString (length:15)	setMKext32Path:
00049822	7365744D4...	CString (length:15)	setMKext64Path:
00049832	7365744D5...	CString (length:17)	setMSLIPListPath:
00049844	7365744D5...	CString (length:22)	setMServiceLoaderPath:
0004985B	7365744D4...	CString (length:13)	setMExecFlag:
00049869	69734C696...	CString (length:6)	isLion
00049870	69734C656...	CString (length:9)	isLeopard
0004987A	646973616...	CString (length:18)	disableSetugidAuth
0004988D	656E61626...	CString (length:17)	enableSetugidAuth
0004989F	756E6C6F6...	CString (length:10)	unloadKext
000498AA	6C6F61644...	CString (length:17)	loadKextFor64bit:
000498BC	64726F704...	CString (length:12)	dropExecFlag
000498C9	6D616B655...	CString (length:15)	makeSuidBinary:
000498D9	697342616...	CString (length:23)	isBackdoorPresentInSLI:
000498F1	637265617...	CString (length:33)	createLaunchAgentPlist:forBinary:
00049913	633136403...	CString (length:12)	c16@0:4@8@12
00049920	637265617...	CString (length:26)	createSLIPListWithBackdoor
0004993B	72656D6F7...	CString (length:26)	removeBackdoorFromSLIPList
00049956	616464426...	CString (length:21)	addBackdoorToSLIPList

Display Symbols nm

- Variable and Function Names
- Crisis Example:
 - “nm IZsROY7X.-MP”

```
000576b8 S _gAgentCrisis
000576c0 S _gAgentCrisisApp
000576bc S _gAgentCrisisNet
000545d0 D _gBackdoorID
00057698 S _gBackdoorName
000545f0 D _gBackdoorSignature
0005769c S _gBackdoorUpdateName
00054580 D _gConfAesKey
000576a0 S _gConfigurationName
000576a4 S _gConfigurationUpdateName
00057690 S _gControlFlagLock
00054620 D _gDemoMarker
000576a8 S _gInputManagerName
000545b0 D _gInstanceId
000576c4 S _gIsDemoMode
000576ac S _gKext32Name
000576b0 S _gKext64Name
00054550 D _gLogAesKey
00054664 D _gMemCommandMaxSize
00054668 D _gMemLogMaxSize
00054640 D _gMode
0005466c D _gMyXPCName
000576d4 S _gOSBugFix
000576cc S _gOSMajor
000576d0 S _gOSMinor
00057688 S _gOriginalDesktopImage
00057694 S _gSessionKey
000576dc S _gSharedMemoryCommand
000576e0 S _gSharedMemoryLogging
000576c8 S _gSkypeQuality
0005768c S _gSuidLock
000576e4 S _gUtil
00054690 D _gVersion
000576b4 S _gXPCName
000074e1 T _getActiveWindowInfo
00007c87 T _getBSDProcessList
00006f5f T _getHostname
00010ceb T _getRootDomain
00007b3f T _getSystemSerialNumber
```


MachOView - Symbols

sourceforge.net/projects/machoview/

IZsROY7X.-MP

RAW RVA

Section (__DATA,__const)

- ▶ Section (__OBJC,__message_refs)
- ▶ Section (__OBJC,__cls_refs)
- ▶ Section (__OBJC,__class)
- ▶ Section (__OBJC,__meta_class)
- ▶ Section (__OBJC,__instance_vars)
- ▶ Section (__OBJC,__inst_meth)
- ▶ Section (__OBJC,__symbols)
- ▶ Section (__OBJC,__module_info)
- ▶ Section (__OBJC,__cls_meth)
- ▶ Section (__OBJC,__property)
- ▶ Section (__OBJC,__class_ext)
- ▶ Section (__OBJC,__category)
- ▶ Section (__OBJC,__cat_inst_meth)
- ▶ Section (__OBJC,__protocol)
- ▶ Section (__OBJC,__cat_cls_meth)
- ▶ Section (__OBJC,__image_info)
- ▶ Function Starts
- ▼ Symbol Table

Symbols

- ▼ Dynamic Symbol Table
- External Relocations
- Indirect Symbols
- String Table

Offset	Data	Description	Value
0005D8CC	00000B7F	String Table Index	_gAgentCrisis
0005D8D0	0F	Type	
		0E	N_SECT
		01	N_EXT
0005D8D1	0F	Section Index	15 (__DATA,__common)
0005D8D2	0000	Description	
0005D8D4	000576B8	Value	358072 (\$+48)
0005D8D8	00000B8D	String Table Index	_gAgentCrisisApp
0005D8DC	0F	Type	
		0E	N_SECT
		01	N_EXT
0005D8DD	0F	Section Index	15 (__DATA,__common)
0005D8DE	0000	Description	
0005D8E0	000576C0	Value	358080 (\$+56)
0005D8E4	00000B9E	String Table Index	_gAgentCrisisNet
0005D8E8	0F	Type	
		0E	N_SECT
		01	N_EXT
0005D8E9	0F	Section Index	15 (__DATA,__common)
0005D8EA	0000	Description	
0005D8EC	000576BC	Value	358076 (\$+52)
0005D8F0	00000BAF	String Table Index	_gBackdoorID
0005D8F4	0F	Type	

Hopper - hopperapp.com

IZsROY7X.hop

Labels Strings

Search

Tag Scope

- RCSMSharedMemory
- RCSMTaskManager
- ✓ RCSMUtils
- RESTNetworkProtocol

[RCSMUtils copyWithZone:]

[RCSMUtils retain]

[RCSMUtils retainCount]

[RCSMUtils release]

[RCSMUtils autorelease]

[RCSMUtils isLeopard]

[RCSMUtils isLion]

[RCSMUtils executeTask:withArguments:waitUntil...]

[RCSMUtils removeBackdoorFromSLIPList]

[RCSMUtils createSLIPListWithBackdoor]

[RCSMUtils isBackdoorPresentInSLI:]

[RCSMUtils openSLIPList]

[RCSMUtils makeSuidBinary:]

[RCSMUtils dropExecFlag]

[RCSMUtils init]

+ [RCSMUtils allocWithZone:]

+ [RCSMUtils sharedInstance]

[RCSMUtils setMBackdoorPath:]

[RCSMUtils mBackdoorPath]

[RCSMUtils setMKext32Path:]

[RCSMUtils mKext32Path]

[RCSMUtils setMKext64Path:]

[RCSMUtils mKext64Path]

[RCSMUtils setMSLIPListPath:]

[RCSMUtils mSLIPListPath]

[RCSMUtils setMServiceLoaderPath:]

[RCSMUtils mServiceLoaderPath]

[RCSMUtils setMExecFlag:]

[RCSMUtils mExecFlag]

[RCSMUtils disableSetuidAuth]

[RCSMUtils enableSetuidAuth]

[RCSMUtils unloadKext]

[RCSMUtils loadKextFor64bit:]

[RCSMUtils createLaunchAgentPlist:forBinary:]

[RCSMUtils saveSLIPList:atPath:]

[RCSMUtils searchSLIPListForKey:]

[RCSMUtils addBackdoorToSLIPList]

```
0x00005384 mov     dword [ss:esp+0xc], eax
0x00005388 lea     eax, dword [ds:esi-0x50cd+cfstring__sbin_kextload] ; @"/sbin/kextload"
0x0000538e mov     dword [ss:esp+0x8], eax
0x00005392 jmp     ; endp

===== BEGINNING OF PROCEDURE =====

-[RCSMUtils createLaunchAgentPlist:forBinary:]:
0x00005397 push    esp
0x00005398 mov     ebp, esp
0x0000539a push    ebx
0x0000539b push    edi
0x0000539c push    esi
0x0000539d sub     esp, 0x5c
0x000053a0 call   0x53a5
0x000053a5 pop     esi
0x000053a6 mov     eax, dword [ds:esi-0x53a5+cls_NSMutableDictionary] ; XREF--[RCSMUtils createLaunchAgentPlist:
0x000053ac ecx, dword [ds:esi-0x53a5+objc_msg_dictionaryWithCapacity_] ; @selector(dictionaryWithCapacity:)
0x000053b2 mov     dword [ss:esp+0x4], ecx
0x000053b6 mov     dword [ss:esp], eax
0x000053b9 mov     dword [ss:esp+0x8], 0x1
0x000053c1 call   imp__symbol_stub_objc_msgSend
0x000053c6 mov     dword [ss:ebp-0x68+var_88], eax
0x000053c9 call   imp__symbol_stub_getuid
0x000053ce test    eax, eax
0x000053d0 jne     0x54f6

0x000053d6 mov     eax, dword [ds:esi-0x53a5+cls_NSBundle]
0x000053dc ecx, dword [ds:esi-0x53a5+objc_msg_mainBundle] ; @selector(mainBundle)
0x000053e2 mov     dword [ss:esp+0x4], ecx
0x000053e6 mov     dword [ss:esp], eax
0x000053e9 call   imp__symbol_stub_objc_msgSend
0x000053ee mov     ecx, dword [ds:esi-0x53a5+objc_msg_bundlePath] ; @selector(bundlePath)
0x000053f4 mov     dword [ss:esp+0x4], ecx
0x000053f8 mov     dword [ss:esp], eax
0x000053fb call   imp__symbol_stub_objc_msgSend
0x00005400 mov     ecx, dword [ds:esi-0x53a5+objc_msg_rangeOfString_] ; @selector(rangeOfString:)
0x00005406 lea     edx, dword [ds:esi-0x53a5+cfstring_Library_Preferences] ; @"/Library/Preferences"
0x0000540c mov     dword [ss:esp+0x8], edx
0x00005410 mov     dword [ss:esp+0x4], ecx
0x00005414 mov     dword [ss:esp], eax
0x00005417 call   imp__symbol_stub_objc_msgSend
0x0000541c cmp     eax, 0x7fffffff
0x00005421 je     0x57e5

0x00005427 mov     eax, dword [ds:esi-0x53a5+cls_NSBundle]
0x0000542d mov     ecx, dword [ds:esi-0x53a5+objc_msg_mainBundle] ; @selector(mainBundle)
0x00005433 mov     dword [ss:esp+0x4], ecx
0x00005437 mov     dword [ss:esp], eax
0x0000543a call   imp__symbol_stub_objc_msgSend
0x0000543f mov     ecx, dword [ds:esi-0x53a5+objc_msg_bundlePath] ; @selector(bundlePath)
0x00005445 mov     dword [ss:esp+0x4], ecx
0x00005449 mov     dword [ss:esp], eax
0x0000544c call   imp__symbol_stub_objc_msgSend
0x00005451 mov     ecx, dword [ds:esi-0x53a5+objc_msg_rangeOfString_] ; @selector(rangeOfString:)
0x00005457 lea     edx, dword [ds:esi-0x53a5+cfstring_Users_] ; @"/Users/"
0x0000545d mov     dword [ss:esp+0x8], edx
0x00005461 mov     dword [ss:esp+0x4], ecx
0x00005465 mov     dword [ss:esp], eax
0x00005468 call   imp__symbol_stub_objc_msgSend
0x0000546d cmp     eax, 0x7fffffff
0x00005472 je     0x57e5
```

Instruction Encoding: 55

Format: Argument 0 Default

Comment

Colors and Tags

Area: Set Clear

Address: RCSMUtils

Block

Procedure

Manage Tags

Is Referenced By

Address Instruction

Remove Reference Add Reference

Have Reference To

Address Instruction

Remove Reference Add Reference

Procedure: 12 basic blocks

Basic Block

Input Regs: esp
Killed Regs: eax ecx esp esi eip

Predecessors

Address 0x5397, Segment __TEXT, -[RCSMUtils createLaunchAgentPlist:forBinary:] + 0, Section __text, file offset 0x4397

Code Signed Binaries

```
codesign -dvvv <*.app or Mach-O>
```

```
nibble:Documents sledwards$ codesign -dvvv OSX_Kitmos_A_39FAA22EB9D6B750EC345EFCB38189F5
Executable=/Users/sledwards/Documents/OSX_Kitmos_A_39FAA22EB9D6B750EC345EFCB38189F5
Identifier=com.util.file
Format=Mach-O thin (x86_64)
CodeDirectory v=20100 size=1362 flags=0x0(none) hashes=60+5 location=embedded
Hash type=sha1 size=20
CDHash=b0aa57a281c2d8cce6c9a09568c6e3fea52ff80e
Signature size=8514
Authority=Developer ID Application: Rajinder Kumar
Authority=Developer ID Certification Authority
Authority=Apple Root CA
Timestamp=Apr 8, 2013, 4:52:49 AM
Info.plist=not bound
Sealed Resources=none
Internal requirements count=1 size=208
```

KitM Sample = “Kumar In the Mac”

Dynamic Analysis

Virtualization

- XProtect
- Gatekeeper

Application Tracing

Analysis Tools (File, Process & Network)

- Dtrace
- Xcode Instruments
- fs_usage
- fseventer
- Activity Monitor
- procp
- CocoaPacketAnalyzer
- Wireshark
- tcpdump
- lsock

Virtualization

Virtualization Tools

- VMware Fusion
- Parallels

Virtualization Issues

- Capable Versions - 10.7+ (10.6 Server)
- Xprotect & Gatekeeper

XProtect

Files

- /System/Library/CoreServices/CoreTypes.bundle/Contents/Resources
- XProtect.meta.plist
 - Last Update Date & Version (10.7 & 10.8)
 - Java Minimum Version & Blacklisted Plugins
- XProtect.plist
 - AV Signatures

Weaknesses

- Apple updates it...when they want to.
- Very few signatures on blacklist.
- No Heuristics
- Only checks “quarantined” files
 - com.apple.quarantine Extended Attribute
- Mac Threats Only

```
nibble:Downloads sledwards$ ls -l xmount-0.5.0-x86_64.pkg
-rw-r--r-@1 sledwards  staff  909305 Dec 24 07:40 xmount-0.5.0-x86_64.pkg
nibble:Downloads sledwards$ xattr -plx com.apple.quarantine xmount-0.5.0-x86_64.pkg
com.apple.quarantine:
00000000  30 30 32 31 3B 35 32 62 39 38 30 62 30 3B 47 6F |0021;52b980b0;Go|
00000010  6F 67 6C 65 5C 78 32 30 43 68 72 6F 6D 65 3B 36 |ogle.x20Chrome;6|
00000020  46 35 41 38 46 44 30 2D 34 33 31 34 2D 34 45 44 |F5A8FD0-4314-4ED|
00000030  33 2D 42 44 30 45 2D 45 32 33 44 35 37 33 33 38 |3-BD0E-E23D57338|
00000040  34 45 35                                     |4E5|
```

XProtect

Signature by Hash

SHA256: c6b0f2b35deaab5a85d039fa142a4ecec495391f15bf26e9b9cc338eb3f202d

File name: sig

Detection ratio: 8 / 49

Analysis date: 2014-02-13 18:04:47 UTC (3 weeks ago)



Analysis Additional information Comments 1 Votes

File identification

MD5	26d5f81486e4588990a126d51ad5140a
SHA1	c2b81f705670c837c0bf5a2ddd1e398e967c0a08
SHA256	c6b0f2b35deaab5a85d039fa142a4ecec495391f15bf26e9b9cc338eb3f202d
ssdeep	49152:1XCptSSCLkOwYOzbC2E6Cyp4tiZLDDERV6PPzY3Sc
File size	2.2 MB (2292411 bytes)
File type	BZIP
Magic literal	bzip2 compressed data, block size = 900k

▼ Item 2	Dictionary	(3 items)
Description	String	OSX.CoinThief.B
LaunchServices	Dictionary	(1 item)
LSItemContentType	String	com.apple.application-bundle
▼ Matches	Array	(1 item)
▼ Item 0	Dictionary	(2 items)
MatchType	String	MatchAny
▼ Matches	Array	(2 items)
▼ Item 0	Dictionary	(3 items)
Identity	Data	<c2b81f70 5670c837 c0bf5a2d dd1e398e 967c0a08>
▼ MatchFile	Dictionary	(1 item)
NSURLNameKey	String	.sig
MatchType	String	Match
▼ Item 1	Dictionary	(3 items)
Identity	Data	<02e24315 7dbc8803 a364e941 0a5c41b3 6de64c95>
▼ MatchFile	Dictionary	(1 item)
NSURLNameKey	String	.sig
MatchType	String	Match

"Identity" Key = SHA1 Hash

XProtect

Signature by Launch Service & Pattern

▼ Item 20	Dictionary	(3 items)
Description	String	OSX.Mdropper.i
▼ LaunchServices	Dictionary	(1 item)
LSItemContentType	String	com.microsoft.word.doc
▼ Matches	Array	(1 item)
▼ Item 0	Dictionary	(3 items)
▼ MatchFile	Dictionary	(1 item)
NSURLTypeIDentifierKey	String	com.microsoft.word.doc
MatchType	String	Match
Pattern	String	2F746D702F6C61756E63682D68



000	2F	74	6D	70	2F	6C	61	75	6E	63	68	2D	68	73	65	/tmp/launch-hs\
015	2F	74	6D	70	2F	6C	61	75	6E	63	68	2D	68	73	65	/tmp/launch-hse
030	00	2F	74	6D	70	2F	00	23	21	2F	62	69	6E	2F	73	\tmp/\#!/bin/s
045	68	0A	2F	74	6D	70	2F	6C	61	75	6E	63	68	2D	68	h\tmp/launch-h
060	73	65	20	26	0A	6F	70	65	6E	20	2F	74	6D	70	2F	se &lopen /tmp/
075	66	69	6C	65	2E	64	6F	63	20	26	0A	0A	00	00	5F	file.doc &f\
090	5F	50	41	47	45	5A	45	52	4F	00	00	5F	5F	6D	68	_PAGEZERO__mh
105	5F	65	78	65	63	75	74	65	5F	68	65	61	64	65	72	_execute_header

Disable XProtect

Delete/Edit XProtect Files ...or...

Remove com.apple.quarantine Extended Attribute

- `xattr -d com.apple.quarantine <filename>`



Gatekeeper

- Introduced in 10.7.5
- Anti-malware Feature
- Application Execution Restrictions
- Security Settings
 - Mac App Store
 - Users can only run apps from the store.
 - Mac App Store & Identified Developers
 - Default Setting (10.8+)
 - Users can only run software signed using Apple Developer ID
 - Anywhere
 - Default Setting (10.7.5)
 - Users can run anything from anywhere



Disable Gatekeeper

- Permanent: Change to “Allow Applications Downloaded From:” to “Anywhere” ...or...
- Case-by-case basis: Control+Click Application



Application Tracing

“Trace” program execution, file system events, network communications for use in troubleshooting.

Low-level logging

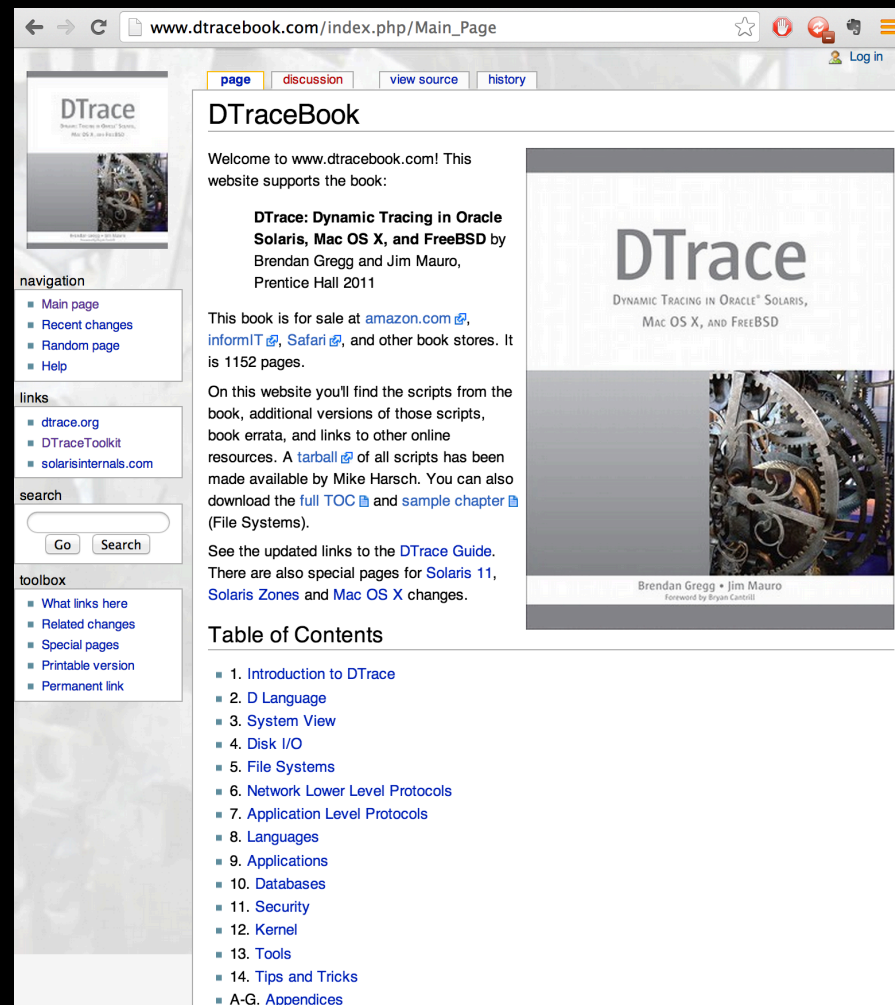
Verbose

Very useful for reverse engineering!

Tools: Dtrace, fs_usage, Xcode Instruments

Dtrace

- Troubleshooting Utility
- Designed by Sun Microsystems (Originally for Solaris)
- Added to OS X in 10.5
- Captures data from:
 - CPU
 - Memory
 - Network
 - File System
 - Processes
- Uses D Language (awk-ish)
- `dtracebook.com`
- `man -k dtrace`



Dtrace Example

- Files Opened by Process
- Example from dtracebook.com (filebyproc.d)

```
dtrace -n 'syscall::open*:entry { printf("%s %s", execname, copyinstr(arg0)); }
```

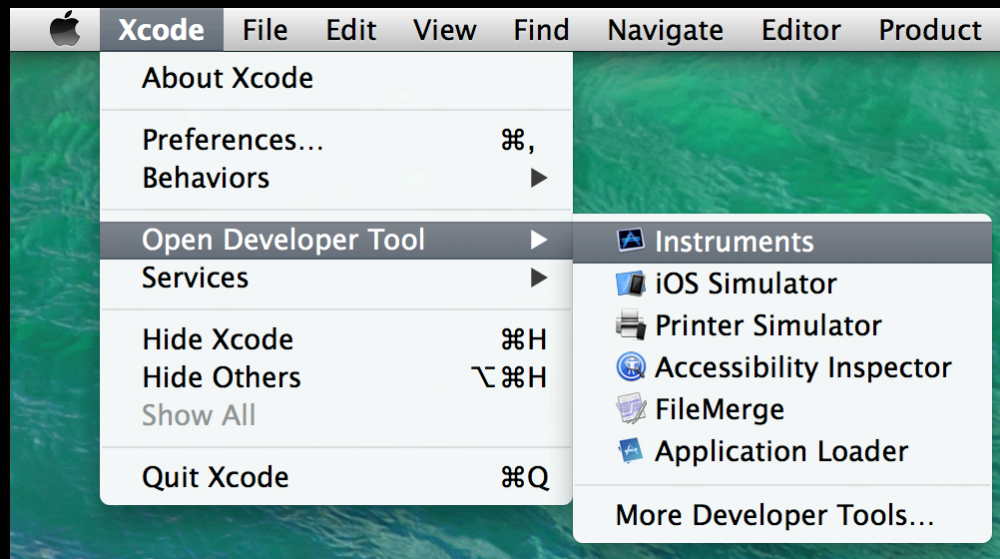
```
nibble:/ sledwards$ sudo dtrace -n 'syscall::open*:entry { printf("%s %s", execname, copyinstr(arg0)); }'
```

```
dtrace: description 'syscall::open*:entry ' matched 4 probes
```

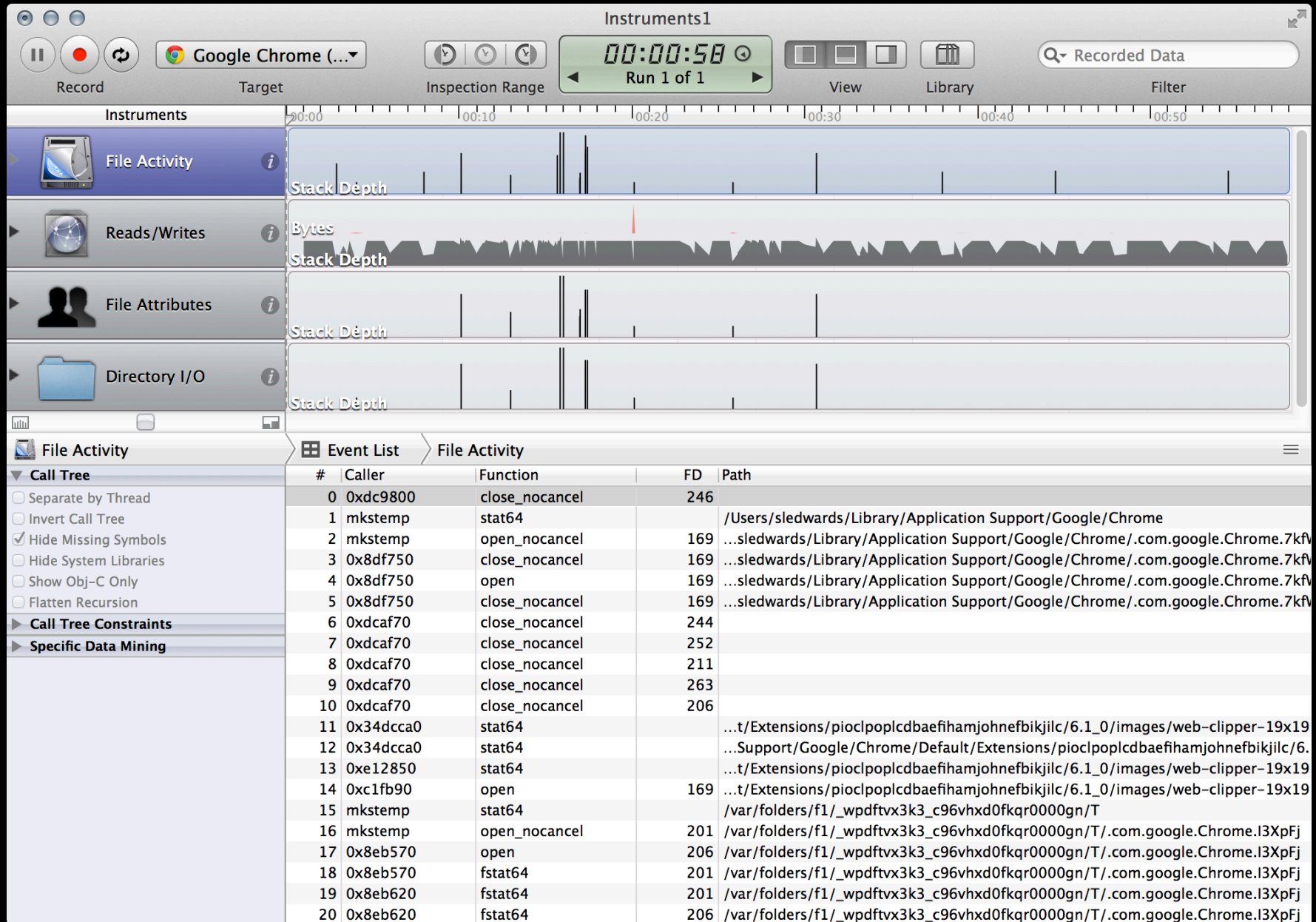
CPU	ID	FUNCTION:NAME
0	937	open_nocancel:entry kexthd //private/var/run/installld.commit.pid
1	151	open:entry mds_stores .
1	151	open:entry mds_stores .
0	937	open_nocancel:entry Google Chrome /Users/sledwards/Library/Application Support/Google/Chrome/Default/.com.google.Chrome.WWGUaH
0	151	open:entry Google Chrome /Users/sledwards/Library/Application Support/Google/Chrome/Default/.com.google.Chrome.WWGUaH
1	151	open:entry mds /Users/sledwards/Library/Application Support/Google/Chrome/Default/TransportSecurity
3	151	open:entry mds_stores .
0	937	open_nocancel:entry Mail /etc/hosts
2	937	open_nocancel:entry Mail /etc/hosts
0	151	open:entry mdworker /Users/sledwards/Library/Application Support/Google/Chrome/Default/TransportSecurity

Xcode Instruments

- Installed with Xcode (Xcode Tools)
- Apple Developer: Instruments User Guide
- GUI Tracing Application



Xcode Instruments



File Analysis

Dtrace

- filebyproc.d
- opensnoop
- losnoop
- creatbyproc.d

fs_usage

fseventer

File Analysis – Files Opened By Process

Dtrace - filebyproc.d

- CPU – CPU that received event
- ID – Dtrace Probe ID
- FUNCTION:NAME – Dtrace Probe Name
- Remaining – Process/Pathname

```
Cliffs-Mac:~ cliffstoll$ sudo filebyproc.d
```

```
Password:
```

```
dtrace: script '/usr/bin/filebyproc.d' matched 4 probes
```

CPU	ID	FUNCTION:NAME
1	151	open:entry touch /dev/dtracehelper
1	151	open:entry touch test.txt
1	151	open:entry Dock /Users/cliffstoll/Applications
1	151	open:entry Dock /Users/cliffstoll
1	151	open:entry Dock /Users/cliffstoll
1	151	open:entry Finder /Users/cliffstoll
0	151	open:entry mdworker /dev/dtracehelper
0	151	open:entry mdworker /dev/autofs_nowait
0	151	open:entry mdworker /Users/cliffstoll/.CFUserTextEncoding
0	151	open:entry mdworker /dev/autofs_nowait
0	151	open:entry mdworker /Users/cliffstoll/.CFUserTextEncoding
0	937	open_nocancel:entry mdworker /etc/localtime
0	937	open_nocancel:entry mdworker /System/Library/Frameworks/CoreServices.framework/Frameworks/Metadata.framework/Versions/
0	937	open_nocancel:entry mdworker /System/Library/Frameworks/CoreServices.framework/Frameworks/Metadata.framework/Versions/
0	151	open:entry mdworker /System/Library/Frameworks/CoreServices.framework/Frameworks/Metadata.framework/Versions/
0	151	open:entry mdworker /Library/Preferences/SystemConfiguration/com.apple.Boot.plist
0	151	open:entry cfprefsd /Users/cliffstoll/Library/Preferences/ByHost/com.apple.SpotlightServer.000c29f9c093.plist
0	151	open:entry cfprefsd /Users/cliffstoll/Library/Preferences/ByHost/com.apple.SpotlightServer.000c29f9c093.plist

File Analysis – Files Opened

Dtrace - opensnoop

- UID – User ID
- PID – Process ID
- COMM – Process Command Name
- FD – File Descriptor
- PATH – File Path

```
Cliffs-Mac:~ cliffstoll$ sudo opensnoop
```

UID	PID	COMM	FD	PATH
501	663	bash	3	.
501	1209	open	4	/System/Library/CoreServices/SystemVersion.plist
501	1209	open	4	/usr/bin
501	1209	open	4	/usr/bin
501	1209	open	4	/usr/bin/open
501	1209	open	4	/.vol/16777218/78/open/..namedfork/rsr
501	1209	open	3	/dev/dtracehelper
501	1209	open	3	.
501	1209	open	4	/Library/Application Support/CrashReporter/SubmitDiagInfo.domains
501	1209	open	4	/dev/random
501	1209	open	4	/dev/random
501	1209	open	4	/System/Library/CoreServices/CoreTypes.bundle/Contents/Library/AppExceptions.bundle/Exceptions.plist
501	1209	open	4	/private/var/db/launchd.db/com.apple.launchd.peruser.501/overrides.plist
501	1209	open	5	/private/var/db/launchd.db/com.apple.launchd.peruser.501/overrides.plist
501	1209	open	4	/System/Library/CoreServices/CoreTypes.bundle/Contents/Resources/Exceptions.plist
0	13	taskgated	3	/Applications/TextEdit.app
0	13	taskgated	3	/Applications/TextEdit.app/Contents
0	13	taskgated	3	/Applications/TextEdit.app/Contents/Info.plist
0	13	taskgated	3	/Applications/TextEdit.app/Contents/MacOS/TextEdit
0	13	taskgated	5	/Applications/TextEdit.app/Contents/MacOS/TextEdit
0	13	taskgated	3	/Applications/TextEdit.app/Contents/Info.plist
501	181	Dock	31	/Applications/TextEdit.app

File Analysis – Files Opened

Dtrace – opensnoop -a

- -a = All Data
 - TIME – Timestamp (Relative Microsecond Counter)
 - STRTIME – String Timestamp (Local System Time)
 - UID – User ID
 - PID – Process ID
 - FD – File Descriptor
 - ERR – Errno Value (See errno.h)
 - PATH – File Path
 - ARGS – Argument List

```
Cliffs-Mac:~ cliffstoll$ sudo opensnoop -a
```

TIME	STRTIME	UID	PID	FD	ERR	PATH	ARGS
22505562387	2014 Mar 22 13:44:34	501	1410	4	0	/dev/dtracehelper	cat\0
22505597664	2014 Mar 22 13:44:34	501	1411	4	0	/dev/dtracehelper	groff\0
22505629896	2014 Mar 22 13:44:34	501	1413	4	0	/dev/dtracehelper	less\0
22505549462	2014 Mar 22 13:44:33	501	1405	3	0	/usr/lib/libxcselect.dylib	man\0
22505549975	2014 Mar 22 13:44:33	501	1405	3	0	/dev/dtracehelper	man\0
22505552023	2014 Mar 22 13:44:33	501	1405	3	0	/usr/share/locale/en_US.UTF-8/LC_CTYPE	man\0
22505552291	2014 Mar 22 13:44:33	501	1405	3	0	/usr/share/locale/en_US.UTF-8/LC_MESSAGES/LC_MESSAGES	man\0
22505552381	2014 Mar 22 13:44:33	501	1405	3	0	/private/etc/man.conf	man\0
22505552985	2014 Mar 22 13:44:34	501	1405	-1	2	/usr/share/xcode-select/xcode_dir_path	man\0
22505553120	2014 Mar 22 13:44:34	501	1405	-1	2	/usr/share/man/html1/	man\0
22505553195	2014 Mar 22 13:44:34	501	1405	4	0	/usr/share/man/man1/	man\0
22505554577	2014 Mar 22 13:44:34	501	1405	4	0	/usr/share/man/man1/opensnoop.1m	man\0

File Analysis - Files Read/Written by Process

Dtrace - iosnoop

- UID – User ID
- PID – Process ID
- D – Direction (Read/Write)
- BLOCK – File System Block for Operation
- SIZE – Operation Size
- COMM – Process Command Name
- PATHNAME – File Path

```
Cliffs-Mac:~ cliffstoll$ sudo iosnoop
```

UID	PID	D	BLOCK	SIZE	COMM	PATHNAME
0	1	W	22281784	4096	launchd	??/asl/2014.03.21.G80.asl
0	1	W	22281768	4096	launchd	??/asl/2014.03.21.U0.G80.asl
0	1	W	16515088	4096	launchd	??/asl/StoreData
0	1	W	35040	8192	launchd	??/<unknown (NULL v_parent)>/<unknown (NULL v_name)>
0	1	W	36256	8192	launchd	??/<unknown (NULL v_parent)>/<unknown (NULL v_name)>
0	1	W	36720	8192	launchd	??/<unknown (NULL v_parent)>/<unknown (NULL v_name)>

File Analysis – Files Created by Process

Dtrace – creatbyproc.d

- CPU – CPU ID
- ID – Process ID
- FUNCTION:NAME – Dtrace Probe Name
- Remaining – Command/Application & File Path

```
nibble:Documents sledwards$ sudo creatbyproc.d
dtrace: script '/usr/bin/creatbyproc.d' matched 1 probe
CPU    ID      FUNCTION:NAME
0      151     open:entry Google Chrome /Users/sledwards/Library/Application Support/Google/Chrome/Default/Local Storage
1      151     open:entry Google Chrome /Users/sledwards/Library/Application Support/Google/Chrome/Default/Local Storage/http_www.rdio.com_0.localstorage-journal
1      151     open:entry Google Chrome /Users/sledwards/Library/Application Support/Google/Chrome/Default/Local Storage/http_www.rdio.com_0.localstorage-journal
0      151     open:entry Google Chrome /Users/sledwards/Library/Application Support/Google/Chrome/Default
0      151     open:entry man /dev/dtracehelper
0      151     open:entry tbl /dev/dtracehelper
0      151     open:entry cat /dev/dtracehelper
0      151     open:entry Google Chrome /var/folders/f1/_wpdftvx3k3_c96vhxd0fkqr0000gn/T/.com.google.Chrome.LcnDaW
1      151     open:entry sh /dev/dtracehelper
1      151     open:entry sh /dev/tty
1      151     open:entry cat /usr/share/man/man1/creatbyproc.d.1m
1      151     open:entry troff /dev/dtracehelper
1      151     open:entry less /dev/tty
1      151     open:entry grotty /dev/dtracehelper
1      151     open:entry Google Chrome /var/folders/f1/_wpdftvx3k3_c96vhxd0fkqr0000gn/T/.com.google.Chrome.hEiMHY
2      151     open:entry Google Chrome /Users/sledwards/Library/Application Support/Google/Chrome/Default/Cookies-journal
```

File Analysis

fs_usage

Very Verbose

Native to OS X

```
fs_usage -w -f <filter>
```

Filters:

- `pathname` – File Path Events
- `filesystem` – File System Events
- `exec` – New and Spawned Process Events
- `diskio` – Disk Input/Output Events
- `cachehit` – Cache Hits
- `network` – Network Events

File Analysis – Pathname Events

`fs_usage -f pathname`

- Columns
 - Timestamp
 - Call
 - File Descriptor (F=##)
 - [ERRNO] – Error Code
 - File Path
 - Time Interval (W = Wait Time)
 - Process Name
- Calls of Interest
 - `getattrlist` – Get file system attributes
 - `getxattr` – Get extended attribute
 - `setattrlist` – Set file system attribute
 - `stat64, lstat64` – Get file status
 - `open` – Open/Create File
 - `mkdir, rmdir` – Make/Remove a directory

File Analysis - Pathname Events

`fs_usage -w -f pathname`

```
08:05:21.631155  getattrlist /Applications/  
Messages.app    0.000011    Dock.513976
```

```
08:05:21.006391  open F=135 (R_____) /Users/  
sledwards/Library/Application Support/  
Google/Chrome/Default/Local Storage  
0.000022    Google Chrome.7460
```

File Analysis – Disk I/O Events

`fs_usage -f diskio`

- Columns
 - Timestamp
 - Call
 - Disk Block (D=##)
 - Byte Count (B=##)
 - Disk
 - File Path
 - Time Interval (W = Wait Time)
 - Process Name
- Calls of Interest
 - WrMeta – Write Metadata
 - WrData – Write Data
 - RdData – Read Data
 - PgIn – Page In
 - PgOut – Page Out

File Analysis – Disk I/O Events

`fs_usage -w -f diskio`

```
08:15:54.847585      WrMeta[AT3]      D=0x01471e78
B=0x2000    /dev/disk1  /Users/sledwards/Library/
Mail/V2/IMAP-sledwards@imap.gmail.com/[Gmail].mbox/
Trash.mbox/65AE84E4-7606-4E45-BC3F-E5E3398FDCE0/
Data/0/7/Messages  0.000262 W launchd.207
```

```
08:15:55.005800      WrData[AT1]      D=0x125f2870
B=0x1000    /dev/disk1  /Users/sledwards/Library/
Application Support/Google/Chrome/Default/Local
Storage/http_www.rdio.com_0.localstorage-journal
0.000169 W Google Chrome.7458
```

File Analysis fseventer

fernlightning.com

GUI Application

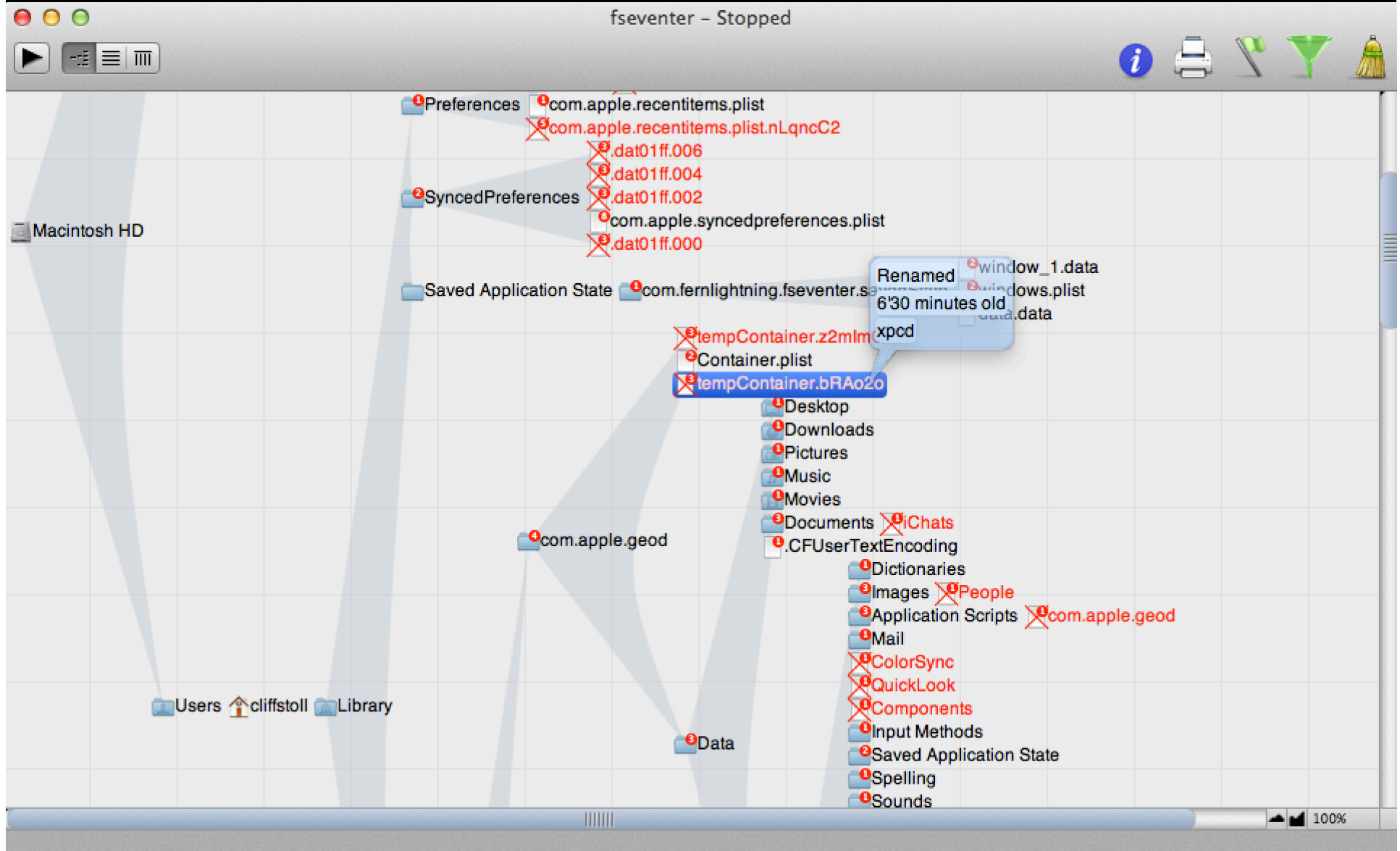
Different Views:

- Graphical “Tree” View
- Table View

Filtering

Save Output to Text File

File Analysis - fseventer



File Analysis - fseventer

fseventer - Stopped

Path	Time	Type	Process	Euid
/Users/cliffstoll/Library/Containers/com.apple.Maps/Container.plist	12:04:41 PM	Renamed	xpcd	
/Users/cliffstoll/Library/Containers	12:04:42 PM	Folder Changed	System	229777
/Users/cliffstoll/Library/Containers/com.apple.Maps/Data	12:04:42 PM	Folder Changed	System	229942
/Users/cliffstoll/Library/Containers/com.apple.Maps/Data/Library/Application Scripts	12:04:42 PM	Folder Changed	System	229966
/Users/cliffstoll/Library/Containers/com.apple.Maps/Data/Documents	12:04:42 PM	Folder Changed	System	229972
/Users/cliffstoll/Library/Containers/com.apple.Maps/Data/Library/Application Support	12:04:42 PM	Folder Changed	System	229975
/Users/cliffstoll/Library/Containers/com.apple.Maps/Data/Library/Images	12:04:42 PM	Folder Changed	System	229984
/Users/cliffstoll/Library/Containers/com.apple.Maps/Data/Library	12:04:42 PM	Folder Changed	System	229987
/Users/cliffstoll/Library/Containers/com.apple.Maps/Data/Library/Preferences	12:04:42 PM	Folder Changed	System	230005
/Users/cliffstoll/Library/Containers/com.apple.Maps	12:04:42 PM	Folder Changed	System	230015
/Users/cliffstoll/Library/Containers/com.apple.Maps/tempContainer.GbEXis	12:04:42 PM	File Created	xpcd	
/Users/cliffstoll/Library/Containers/com.apple.Maps/tempContainer.GbEXis	12:04:42 PM	Content Modified	xpcd	
/Users/cliffstoll/Library/Containers/com.apple.Maps/tempContainer.GbEXis	12:04:42 PM	Renamed	xpcd	
/Users/cliffstoll/Library/Containers/com.apple.Maps/Container.plist	12:04:42 PM	Renamed	xpcd	
/private/var/folders/fd/c2kwf8893ysdrkkgp5f77cj40000gn/T/com.apple.Maps	12:04:42 PM	Modified xattr	Maps	
/private/var/folders/fd/c2kwf8893ysdrkkgp5f77cj40000gn/T/com.apple.Maps	12:04:42 PM	Folder Created	Maps	
/Users/cliffstoll/Library/Saved Application...fernlightning.fseventer.savedState/data.data	12:04:42 PM	Content Modified	fseventer	
/Users/cliffstoll/Library/Saved Application...lightning.fseventer.savedState/windows.plist	12:04:42 PM	Stat Changed	fseventer	
/Users/cliffstoll/Library/Saved Application...lightning.fseventer.savedState/windows.plist	12:04:42 PM	Content Modified	fseventer	
/Applications/Maps.app	12:04:43 PM	Launched App	launchd	
/Users/cliffstoll/Library/Saved Application...ghtning.fseventer.savedState/window 1.data	12:04:43 PM	Stat Changed	fseventer	

File Analysis - fseventer

fseventer - Stopped

Any of the following are true

path includes plist

Path	Time	Type	Process	E...
☐ /Users/cliffstoll/Library/Containers/com.apple.HIToolbox.plist	12:04:43 PM	File Created	xpcd	
☐ /Users/cliffstoll/Library/Containers/com.apple.geod/Container.plist	12:04:43 PM	Renamed	xpcd	
☒ /Users/cliffstoll/Library/Containers/com.apple.a...a/Library/Preferences/com.apple.GEO.plist	12:04:43 PM	File Created	xpcd	
☒ /Users/cliffstoll/Library/Containers/com.apple.a...ByHost/com.apple.GEO.000c29f9c093.plist	12:04:43 PM	File Created	xpcd	
☐ /Users/cliffstoll/Library/Containers/com.apple.a.../Library/Preferences/com.apple.Maps.plist	12:04:44 PM	File Created	cfprefsd	
☐ /Users/cliffstoll/Library/Containers/com.apple.a.../Library/Preferences/com.apple.Maps.plist	12:04:44 PM	Chown	cfprefsd	
☒ /Users/cliffstoll/Library/Containers/com.apple.a...Preferences/com.apple.Maps.plist.NzSmbtL	12:04:44 PM	File Created	cfprefsd	
☒ /Users/cliffstoll/Library/Containers/com.apple.a...Preferences/com.apple.Maps.plist.NzSmbtL	12:04:44 PM	Chown	cfprefsd	
☒ /Users/cliffstoll/Library/Containers/com.apple.a...Preferences/com.apple.Maps.plist.NzSmbtL	12:04:44 PM	Chown	cfprefsd	
☒ /Users/cliffstoll/Library/Containers/com.apple.a...Preferences/com.apple.Maps.plist.NzSmbtL	12:04:44 PM	Content Modified	cfprefsd	
☒ /Users/cliffstoll/Library/Containers/com.apple.a...Preferences/com.apple.Maps.plist.NzSmbtL	12:04:44 PM	Renamed	cfprefsd	
☐ /Users/cliffstoll/Library/Containers/com.apple.a.../Library/Preferences/com.apple.Maps.plist	12:04:44 PM	Renamed	cfprefsd	
☐ /Users/cliffstoll/Library/Containers/com.apple.geod/Container.plist	12:04:45 PM	Renamed	xpcd	
☐ /Users/cliffstoll/Library/SyncedPreferences/com.apple.syncedpreferences.plist	12:04:47 PM	Renamed	511 (exited?)	
☐ /Users/cliffstoll/Library/SyncedPreferences/com.apple.syncedpreferences.plist	12:04:47 PM	Chown	511 (exited?)	
☒ /Users/cliffstoll/Library/Preferences/com.apple.recentitems.plist.nLqncC2	12:04:47 PM	File Created	cfprefsd	
☒ /Users/cliffstoll/Library/Preferences/com.apple.recentitems.plist.nLqncC2	12:04:47 PM	Chown	cfprefsd	
☒ /Users/cliffstoll/Library/Preferences/com.apple.recentitems.plist.nLqncC2	12:04:47 PM	Chown	cfprefsd	
☒ /Users/cliffstoll/Library/Preferences/com.apple.recentitems.plist.nLqncC2	12:04:47 PM	Content Modified	cfprefsd	
☒ /Users/cliffstoll/Library/Preferences/com.apple.recentitems.plist.nLqncC2	12:04:47 PM	Renamed	cfprefsd	
☐ /Users/cliffstoll/Library/Preferences/com.apple.recentitems.plist	12:04:47 PM	Renamed	cfprefsd	
☐ /Users/cliffstoll/Library/SyncedPreferences/com.apple.syncedpreferences.plist	12:04:47 PM	Renamed	511 (exited?)	
☐ /Users/cliffstoll/Library/SyncedPreferences/com.apple.syncedpreferences.plist	12:04:47 PM	Chown	511 (exited?)	

Process Analysis

Dtrace

- execsnoop
- newproc.d

fs_usage

procxp

Activity Monitor

Process Analysis – Snoop New Processes

Dtrace – newproc.d

- Timestamp
- Process ID
- Parent Process ID
- Architecture = 32b/64b
- Command & Arguments / Application

```
nibble:Documents sledwards$ sudo newproc.d
2014 Mar 25 07:55:13 2137 <151> 32b /Applications/Microsoft Office 2011/Office/Office365Service.app/Contents/MacOS/Office365Service
2014 Mar 25 07:55:17 2138 <151> 64b /System/Library/Frameworks/CoreServices.framework/Frameworks/Metadata.framework/Versions/A/Support/md
worker -s mdworker -c MDSImporterWorker -m <...>
2014 Mar 25 07:55:50 2142 <151> 64b /Applications/Notes.app/Contents/MacOS/Notes
2014 Mar 25 07:55:50 2143 <37> 64b /System/Library/Frameworks/CoreServices.framework/Frameworks/OSServices.framework/Versions/A/Support/S
FLIconTool com.apple.recentitems RecentApplications
2014 Mar 25 07:55:50 2144 <151> 64b /System/Library/Frameworks/OpenGL.framework/Versions/A/Libraries/CVMCompiler 3
2014 Mar 25 07:55:51 2145 <1> 64b xpcproxy /System/Library/Frameworks/Security.framework/Versions/A/XPCServices/XPCKeychainSandboxCheck.x
pc/Contents/MacOS/XPCKeychainSandb (...)
2014 Mar 25 07:55:51 2146 <1> 64b com.apple.iCloudHelper
2014 Mar 25 07:55:51 2146 <1> 64b xpcproxy /System/Library/PrivateFrameworks/AOSKit.framework/Versions/A/XPCServices/com.apple.iCloudHelp
er.xpc/Contents/MacOS/com.apple.iC (...)
2014 Mar 25 07:55:51 2145 <1> 64b com.apple.security.XPCKeychainSandboxCheck
2014 Mar 25 07:56:23 2157 <2154> 64b troff -Wall -mtty-char -mandoc -c -Tascii
2014 Mar 25 07:56:23 2148 <420> 64b man ifconfig
2014 Mar 25 07:56:43 2161 <37> 64b /System/Library/Frameworks/CoreServices.framework/Frameworks/OSServices.framework/Versions/A/Support/S
FLIconTool com.apple.recentitems RecentApplications
2014 Mar 25 07:56:43 2159 <420> 64b open -a TextWrangler
2014 Mar 25 07:56:43 2160 <151> 32b /Applications/TextWrangler.app/Contents/MacOS/TextWrangler
```

Process Analysis - New Processes

Dtrace – execsnoop

- TIME – Relative Timestamp
- STRTIME –Timestamp (String)
- PROJ – Project ID
- UID – User ID
- PID – Process ID
- PPID – Parent Process ID
- ARGS – Program/Application

```
nibble:Documents sledwards$ sudo execsnoop -a
```

TIME	STRTIME	PROJ	UID	PID	PPID	ARGS
1580104042	2014 Mar 25 08:06:08	0	501	2249	420	cat
1581769527	2014 Mar 25 08:06:10	0	501	2250	420	xxd
1584611113	2014 Mar 25 08:06:12	0	501	2252	151	TextWrangler
1584576058	2014 Mar 25 08:06:12	0	501	2251	416	open
1584848351	2014 Mar 25 08:06:13	0	501	2253	37	SFLIconTool
1593140847	2014 Mar 25 08:06:21	0	501	2254	151	cookied
1595461967	2014 Mar 25 08:06:23	0	0	2256	2255	find
1595448068	2014 Mar 25 08:06:23	0	501	2255	416	sudo
1611400046	2014 Mar 25 08:06:39	0	501	2257	412	man
1611442879	2014 Mar 25 08:06:39	0	501	2257	412	man
1611462816	2014 Mar 25 08:06:39	0	501	2267	2263	grotty
1611462074	2014 Mar 25 08:06:39	0	501	2266	2263	troff
1611457535	2014 Mar 25 08:06:39	0	501	2265	2264	less
1611450569	2014 Mar 25 08:06:39	0	501	2262	2260	cat
1611451542	2014 Mar 25 08:06:39	0	501	2263	2259	groff
1611452923	2014 Mar 25 08:06:39	0	501	2261	2259	tbl

Process Analysis – New Processes

`fs_usage -f exec`

- Columns
 - Timestamp
 - Call
 - Pathname
 - Time Interval (W = Wait Time)
 - Process Name
- Calls of Interest:
 - `execve` – New Process
 - `posix_spawn` – Spawned Process

Process Analysis - New Processes

`fs_usage -w -f exec`

```
20:53:48.539284  posix_spawn /Applications/0xED.app/  
Contents/MacOS/0xED 0.000270 launchd.777421
```

```
20:54:04.592903  execve /usr/bin/man 0.000175 bash.777569
```

```
20:54:04.600445  posix_spawn /bin/sh 0.000165 man.777569
```

```
20:54:04.603848  execve /usr/bin/tbl 0.000224 sh.777573
```

```
20:54:04.604053  execve /usr/bin/groff 0.000173 sh.777574
```

Process Analysis – Real-time Processes

procxp

CLI Process Explorer (for Mac)

Scroll/sort processes via keys

Click Enter for more info on process

www.newosxbook.com/index.php?page=downloads

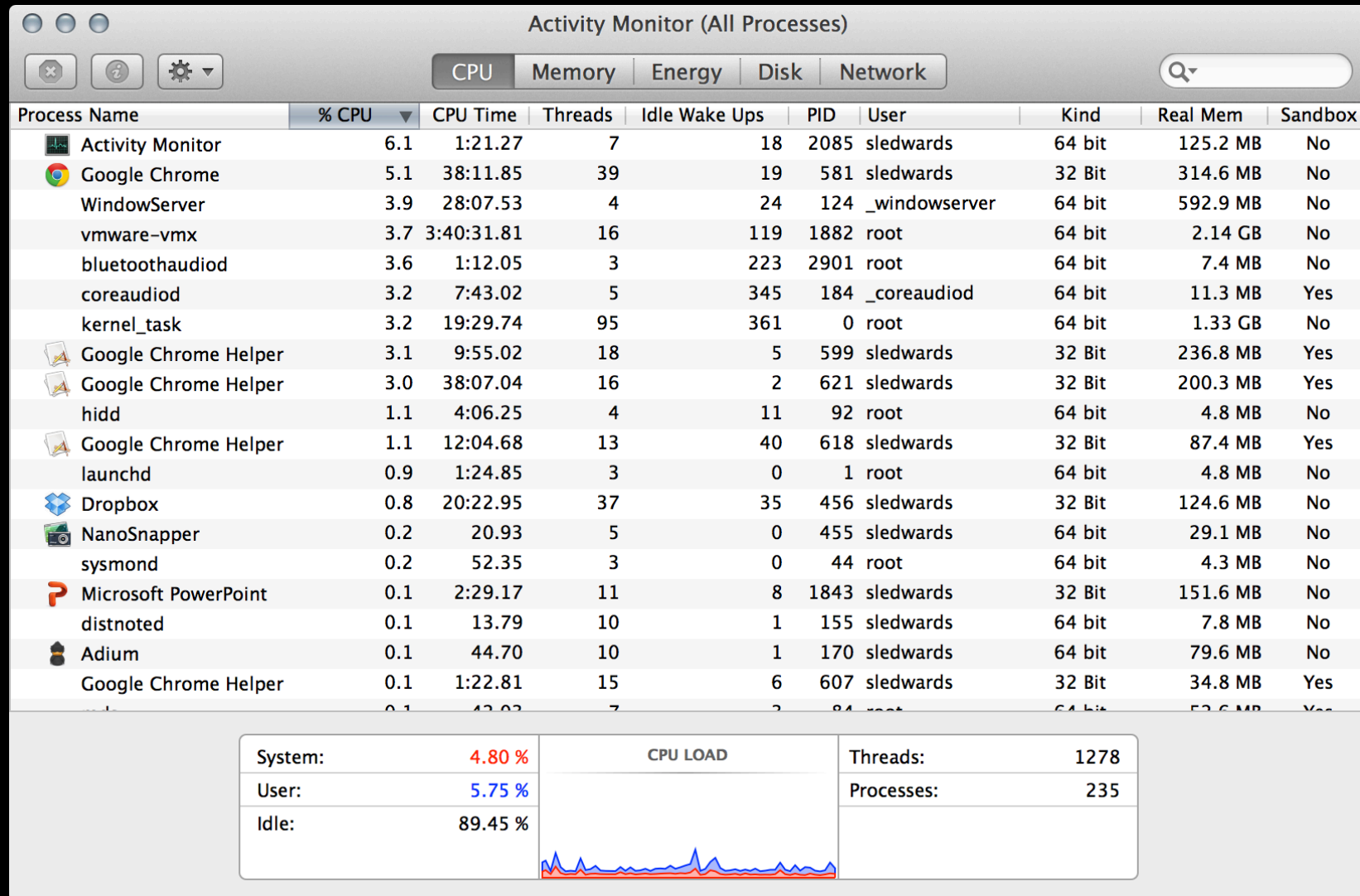
```

2Process: 243    Name: bash    Parent: 242    Status: runnable
2Flags: 64-bit, called exec, has control tty, has controlling terminal, may suspend
2UID: 501    RUID: 501    SVUID: 501
2GID: 20    RGID: 20    SVGID: 20
2
2Virtual size: 2385M (2501206016)    Resident size: 1244K (1273856)
2Time: 00.03 = 00.01 (User) + 00.02 (System)
2Syscalls: 1749    Mach Traps: 118
2Disk I/O: Read 8K    Written: 16K
2
2#Threads: 1    (Process has no workqueues)
2(press T to display Thread Information)
2
2Process Hierarchy:
2 243    bash
2  L 443    procexp.univers
2
2
23 File descriptors: 3 files (press F for detailed information)

```

Process Analysis – Real-time Processes

Activity Monitor



Network Analysis

CocoaPacketAnalyzer

Wireshark

Tcpdump

Activity Monitor

Isock

Network Analysis - CocoaPacketAnalyzer

www.tastycocoabytes.com/cpa/

The screenshot displays the CocoaPacketAnalyzer application window titled "Untitled_3262014-083017.pcap". The interface includes a toolbar with icons for Open, Capture, Jump, Find, and Print. A search bar at the top right allows for filtering packets with the text "Select a filter predicate".

The main window is divided into two panes. The top pane shows a list of captured packets with the following columns: Id, Source, Destination, Captured Length, Packet Length, Protocol, Date Received, Time Delta, and Information. The bottom pane shows the details of the selected packet (Id 7), which is an ICMP Echo request.

Id	Source	Destination	Captured Length	Packet Length	Protocol	Date Received	Time Delta	Information
1	172.16.148.135	172.16.148.1	76	76	UDP	2014-03-26 08:30:20.006	0.000000	60895 > DOMAIN
2	172.16.148.1	172.16.148.135	70	70	ICMP	2014-03-26 08:30:20.007	0.001410	Destination unreachable...
3	172.16.148.135	172.16.148.1	98	98	ICMP	2014-03-26 08:30:20.639	0.633687	Echo request (Code=0)
4	172.16.148.1	172.16.148.135	98	98	ICMP	2014-03-26 08:30:20.640	0.633816	Echo reply (Code=0)
5	172.16.148.135	172.16.148.1	76	76	UDP	2014-03-26 08:30:21.041	1.035184	60895 > DOMAIN
6	172.16.148.1	172.16.148.135	70	70	ICMP	2014-03-26 08:30:21.041	1.035376	Destination unreachable...
7	172.16.148.135	172.16.148.1	98	98	ICMP	2014-03-26 08:30:21.641	1.635041	Echo request (Code=0)
8	172.16.148.1	172.16.148.135	98	98	ICMP	2014-03-26 08:30:21.641	1.635171	Echo reply (Code=0)
9	172.16.148.135	172.16.148.1	98	98	ICMP	2014-03-26 08:30:22.642	2.636535	Echo request (Code=0)
10	172.16.148.1	172.16.148.135	98	98	ICMP	2014-03-26 08:30:22.642	2.636692	Echo reply (Code=0)

The details pane for the selected packet (Id 7) shows the following fields:

- Length: 64 bytes
- Type: 8 (Echo request)
- Code: 0
- Checksum: 0x91a8
- Identifier: 0x9702
- Sequence: 1

The data pane shows the raw packet data in hexadecimal and ASCII format. The ASCII column displays the following text: ".PV.....).....E..T....@.....S2.].....!\"#\$%&'() *+,-./01234567".

Fileformat: 2.4 Snaplength: 65535 bytes Linktype: ETHERNET (DLT_EN10MB) Filesize: 5752 bytes Packets: 52 of 52 (1 selected)

Network Analysis – Wireshark

www.wireshark.org/download.html

Wireshark 1.8.5 (SVN Rev 47350 from /trunk-1.8)

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
1089	26.419702000	fe80::60c5:300d:c4	ff02::1:3	LLMNR	86	Standard query 0x824f A isatap
1090	26.419899000	192.168.1.222	224.0.0.252	LLMNR	66	Standard query 0x824f A isatap
1091	27.649425000	169.254.1.63	255.255.255.255	UDP	1178	Source port: 21302 Destination port: 21302
1092	27.649776000	108.160.162.52	192.168.1.205	HTTP	245	HTTP/1.1 200 OK (text/plain)
1093	27.649833000	192.168.1.205	108.160.162.52	TCP	66	52796 > http [ACK] Seq=1 Ack=180 Win=8180 Le
1094	27.651265000	192.168.1.205	108.160.162.52	HTTP	446	GET /subscribe?host_int=829560406&ns_map=546
1095	27.743346000	108.160.162.52	192.168.1.205	TCP	66	http > 52796 [ACK] Seq=180 Ack=381 Win=83 Le
1096	27.844475000	Actionte_4b:83:fe	Spanning-tree-(fo	STP	60	Conf. Root = 61440/4095/ff:ff:90:4b:83:ff C
1097	28.262447000	192.168.1.222	192.168.1.255	NBNS	92	Name query NB ISATAP<00>
1098	29.491288000	fe80::60c5:300d:c4	ff02::c	SSDP	208	M-SEARCH * HTTP/1.1
1099	30.720081000	169.254.1.63	169.254.1.255	UDP	78	Source port: silhouette Destination port: s
1100	32.358202000	192.168.1.206	239.255.255.250	SSDP	343	NOTIFY * HTTP/1.1
1101	32.407665000	192.168.1.205	192.168.1.254	DNS	79	Standard query 0x5b14 A clients4.google.com

Frame 1092: 245 bytes on wire (1960 bits), 245 bytes captured (1960 bits) on interface 0

Ethernet II, Src: Pegatron_50:4c:06 (e0:69:95:50:4c:06), Dst: b8:e8:56:37:ec:06 (b8:e8:56:37:ec:06)

Internet Protocol Version 4, Src: 108.160.162.52 (108.160.162.52), Dst: 192.168.1.205 (192.168.1.205)

Transmission Control Protocol, Src Port: http (80), Dst Port: 52796 (52796), Seq: 1, Ack: 1, Len: 179

Source port: http (80)

Destination port: 52796 (52796)

[Stream index: 20]

Sequence number: 1 (relative sequence number)

[Next sequence number: 180 (relative sequence number)]

0000 b8 e8 56 37 ec 06 e0 69 95 50 4c 06 08 00 45 00 ..V7...i .PL...E.

0010 00 e7 b8 ce 40 00 34 06 bb f8 6c a0 a2 34 c0 a8@.4. ...l..4..

0020 01 cd 00 50 ce 3c 62 1a db c4 7c 6c 2a 3e 80 18 ...P.<b. ...|*>..

0030 00 53 78 9c 00 00 01 01 08 0a 2e ec 79 91 1c d7 .SX.....y... ..

0040 3f be 48 54 54 50 2f 31 2e 31 20 32 30 30 20 4f ?.HTTP/1 .1 200 0

0050 4b 0d 0a 58 2d 44 42 2d 54 69 6d 65 6f 75 74 3a K..X-DB- Timeout:

0060 20 31 32 30 0d 0a 50 72 61 67 6d 61 3a 20 6e 6f 120..Pr agma: no

File: "/var/folders/f1/_wpdf... Packets: 1281 Displayed: 1281 Ma... Profile: Default

Network Analysis

tcpdump

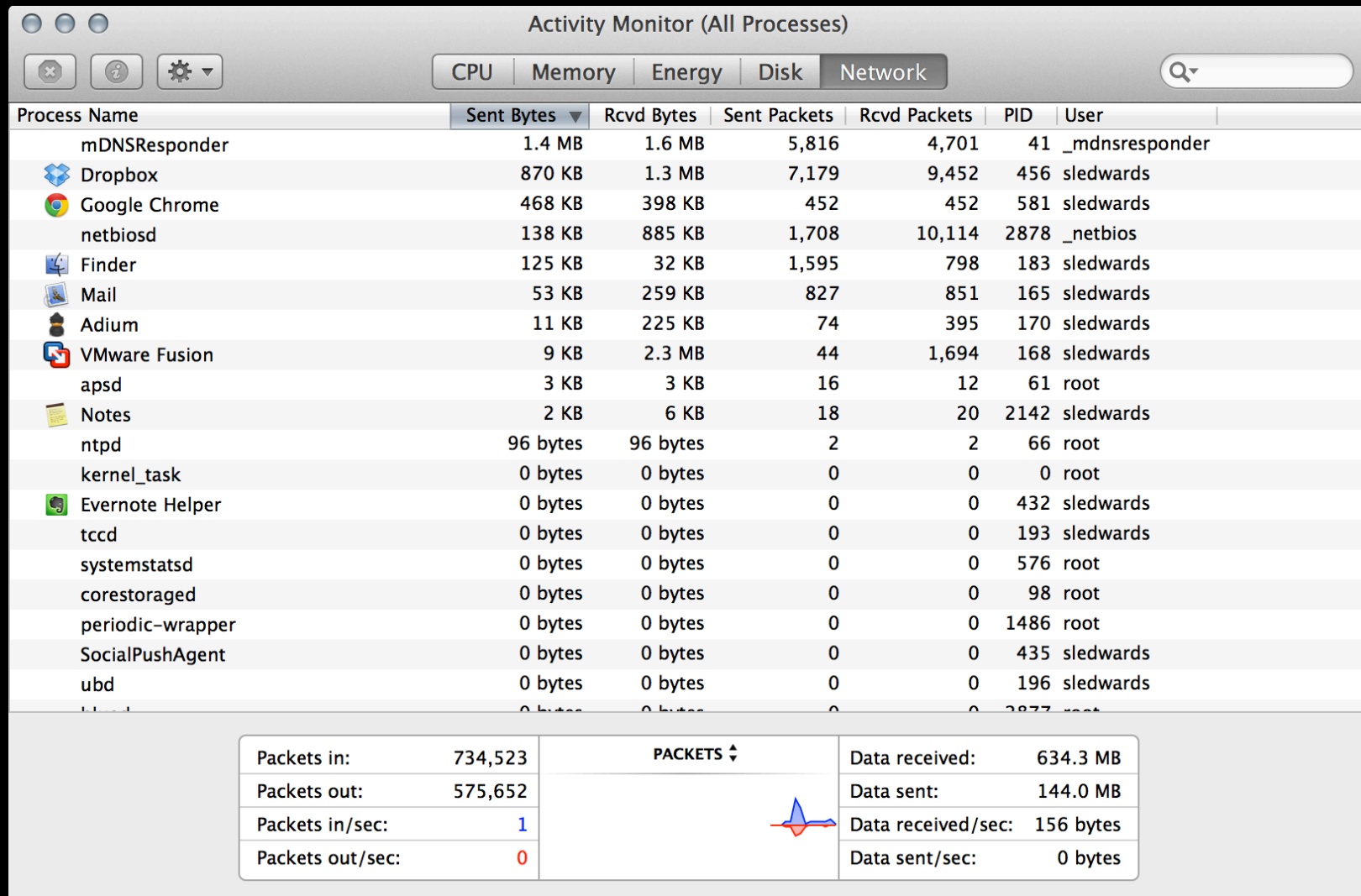
Without Content: `tcpdump -i en0 -n host #.#.#.#`

```
nibble:~ sledwards$ tcpdump -i en0 -n host 192.168.1.205
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on en0, link-type EN10MB (Ethernet), capture size 65535 bytes
16:26:16.626586 IP 192.168.1.205.53398 > 108.160.165.212.443: Flags [F.], seq 2979705787, ack 3210059276, win 8192, options [nop,nop,TS val 760117124 ecr 3433675004], length 0
16:26:17.202780 IP 192.168.1.205.52626 > 192.168.1.128.5001: Flags [P.], seq 222079171:222079481, ack 980612418, win 8192, options [nop,nop,TS val 760117699 ecr 2488032], length 310
16:26:17.202959 IP 192.168.1.205.52626 > 192.168.1.128.5001: Flags [P.], seq 310:382, ack 1, win 8192, options [nop,nop,TS val 760117699 ecr 2488032], length 72
16:26:17.204283 IP 192.168.1.128.5001 > 192.168.1.205.52626: Flags [.], ack 310, win 2641, options [nop,nop,TS val 2488537 ecr 760117699], length 0
```

With Content: `tcpdump -i en0 -n -X host #.#.#.#`

```
nibble:~ sledwards$ tcpdump -i en0 -n -X host 192.168.1.205
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on en0, link-type EN10MB (Ethernet), capture size 65535 bytes
16:47:15.694066 IP 192.168.1.128.5001 > 192.168.1.205.52626: Flags [P.], seq 980659379:980659434, ack 222192319, win 2641, options [nop,nop,TS val 2614360 ecr 761370136], length 55
    0x0000:  4500 006b 9396 4000 4006 2259 c0a8 0180  E..k..@."Y....
    0x0010:  c0a8 01cd 1389 cd92 3a73 acb3 0d3e 62bf  .....s...>b.
    0x0020:  8018 0a51 4fea 0000 0101 080a 0027 e458  ...Q0.....'.X
    0x0030:  2d61 9618 1703 0300 3235 192f 427b 51c0  -a.....25./B{Q.
    0x0040:  c1af 1984 6097 41cc 95fd 6a45 92ac 8720  ....`.A...jE....
    0x0050:  97e2 d240 9618 9489 8d4f 1325 8716 737d  ...@.....0.%..s}
    0x0060:  e191 16fe 457c 22c6 1e80 77          ....El"...w
16:47:15.694134 IP 192.168.1.205.52626 > 192.168.1.128.5001: Flags [.], ack 55, win 8188, options [nop,nop,TS val 761370908 ecr 2614360], length 0
    0x0000:  4500 0034 d3a7 4000 4006 e27e c0a8 01cd  E..4..@.@..~....
    0x0010:  c0a8 0180 cd92 1389 0d3e 62bf 3a73 acea  .....>b.:s..
    0x0020:  8010 1ffc eeae 0000 0101 080a 2d61 991c  .....-a..
    0x0030:  0027 e458          .'..X
```

Network Analysis Activity Monitor



Network Analysis – Isock

www.newosxbook.com/index.php?page=downloads

Time	Local Addr	Remote Addr	If	State	PID	(Name)	
14:39:03	fd85:971f:afda:26d4:f5c4:2bf:2800:b80:123	*.*			8	N/A	66
14:39:03	0.0.0.0:17500	*.*	0	N/A	596	(Dropbox)	
14:39:03	0.0.0.0:52988	*.*	1	N/A	20	(syslogd)	
14:39:03	fd85:971f:afda:26d4:f5c4:2bf:2800:b80:4500	*.*			8	N/A	612
14:39:03	fd85:971f:afda:26d4:f5c4:2bf:2800:b80:500	*.*			8	N/A	612
14:39:03	fe80::f5c4:2bf:2800:b80:123	*.*		8 N/A	66	(ntpd)	
14:39:03	::1:4500	*.*	1	N/A	612	(racoon)	
14:39:03	::1:500	*.*	1	N/A	612	(racoon)	
14:39:03	127.0.0.1:4500	*.*	1	N/A	612	(racoon)	
14:39:03	127.0.0.1:500	*.*	1	N/A	612	(racoon)	
14:39:03	fe80::1:4500	*.*	1	N/A	612	(racoon)	
14:39:03	fe80::1:500	*.*	1	N/A	612	(racoon)	
14:39:03	192.168.1.205:4500	*.*	4	N/A	612	(racoon)	
14:39:03	192.168.1.205:500	*.*	4	N/A	612	(racoon)	
14:39:03	fe80::f5c4:2bf:2800:b80:4500	*.*		8 N/A	612	(racoon)	
14:39:03	fe80::f5c4:2bf:2800:b80:500	*.*		8 N/A	612	(racoon)	
14:39:03	0.0.0.0:64835	*.*	0	N/A	170	(Adium)	
14:39:03	192.168.1.205:123	*.*	4	N/A	66	(ntpd)	
14:39:03	fe80::1:123	*.*	1	N/A	66	(ntpd)	
14:39:03	::1:123	*.*	1	N/A	66	(ntpd)	
14:39:03	:::61675	*.*	0	N/A	41	(mDNSResponder)	
14:39:03	0.0.0.0:0	*.*	0	N/A	106	(airportd)	
14:39:03	0.0.0.0:0	*.*	0	N/A	12	(UserEventAgent)	
14:39:03	192.168.1.205:52377	23.195.92.166:443	4	ESTABLISHED	161	(Google Chrome)	
14:39:03	192.168.1.205:51966	173.194.76.125:5222	4	ESTABLISHED	161	(Google Chrome)	
14:39:03	192.168.1.205:51863	173.194.68.108:993	4	ESTABLISHED	163	(Mail)	
14:39:03	192.168.1.205:51845	129.21.49.169:143	4	ESTABLISHED	163	(Mail)	
14:39:03	127.0.0.1:26164	*.*	1	LISTENING	596	(Dropbox)	
14:39:03	::1:631	*.*	1	LISTENING	1	(launchd)	
14:39:20	192.168.1.205:52397	108.160.165.212:443	4	SYN_SENT	596	(Dropbox)	
14:39:20	192.168.1.205:52398	108.160.165.212:443	4	SYN_SENT	596	(Dropbox)	
14:39:21	192.168.1.205:52399	23.23.226.102:443	4	SYN_SENT	596	(Dropbox)	

Malware Analysis Examples

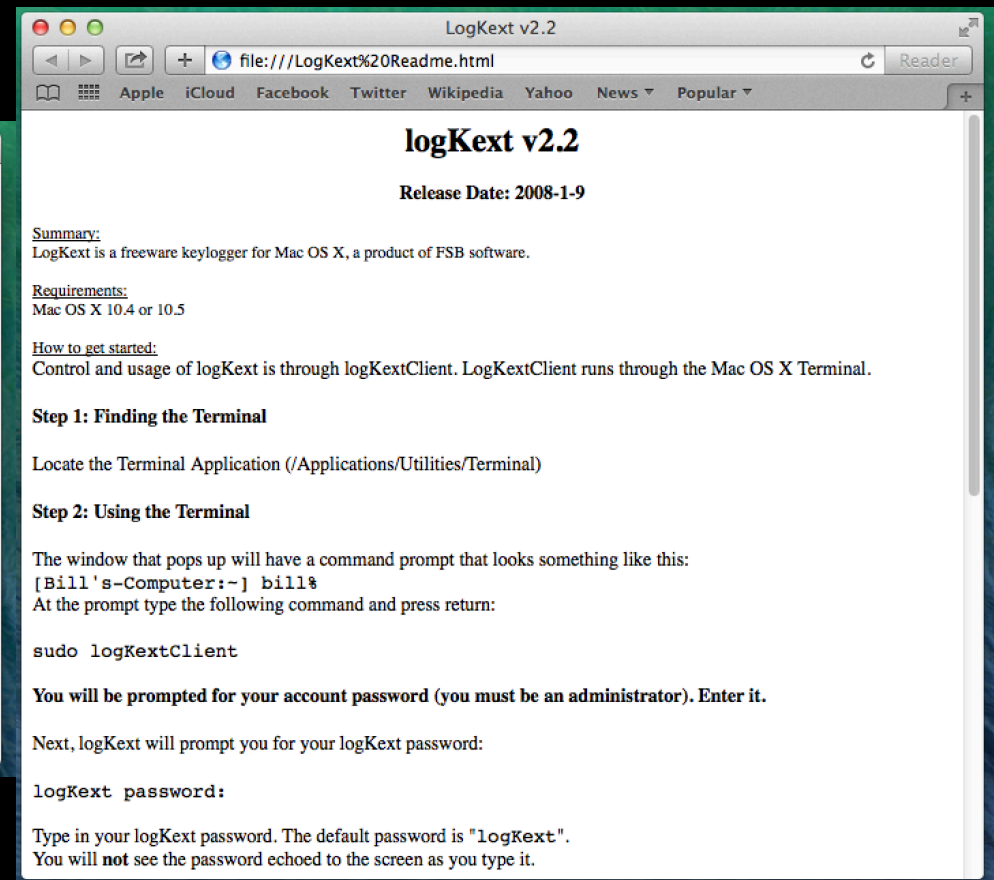
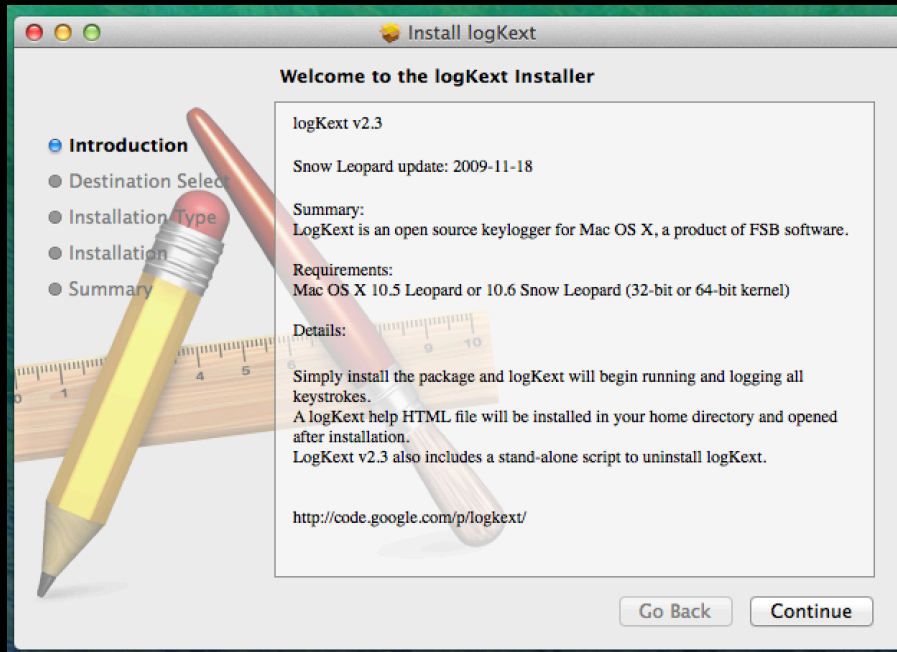
LogKext – Open Source Keylogger

- *.pkg Installer

Imuler – File/Screenshot Stealer

- *.app disguised as a photo

Example - LogKext



Example - LogKext newproc.d

```
2014 Apr 1 17:46:48 1445 <444> 64b /bin/sh /tmp/  
PKInstallSandbox.82TjPW/Scripts/  
com.fsb.logkext.logkextExt.pkg.V8BqhR/postinstall /Users/  
cliffstoll/Desktop/logKext-2.3.pkg /System/Library/  
Extensions / /
```

```
2014 Apr 1 17:46:49 1457 <1445> 64b /Library/Application  
Support/logKext/logKextKeyGen
```

```
2014 Apr 1 17:46:49 1458 <1445> 64b /bin/launchctl  
load /Library/LaunchDaemons/logKext.plist
```

```
2014 Apr 1 17:46:49 1460 <1445> 64b /usr/bin/open /  
LogKext Readme.html
```

Example - LogKext

newproc.d

```
2014 Apr 1 17:46:48 1455 <1445> 64b /sbin/kextunload -b  
com.fsb.kext.logKext
```

```
2014 Apr 1 17:46:49 1456 <1445> 64b /sbin/kextload /  
System/Library/Extensions/logKext.kext
```

```
2014 Apr 1 17:46:49 1459 <1> 64b /Library/Application  
Support/logKext/logKextDaemon
```

```
2014 Apr 1 17:47:00 1472 <897> 64b login -pf cliffstoll
```

```
2014 Apr 1 17:47:00 1473 <1472> 64b -bash
```

```
2014 Apr 1 17:47:11 1476 <1473> 64b sudo logKextClient
```

```
2014 Apr 1 17:47:11 1477 <1476> 64b logKextClient
```

Example - LogKext

fs_usage -f pathname

```
17:40:24.418176  getattrlist /Users/cliffstoll/Desktop/  
logKext-2.3.pkg 0.000004  Finder.7100
```

```
17:40:24.418285  getattrlist /System/Library/CoreServices/  
Installer.app 0.000012  Finder.7100
```

```
17:40:24.641275  open F=15 (RW_A_E) private/var/log/install.log  
0.000028  syslogd.30889
```

```
17:40:39.296222  statfs64 /Library/Application Support/logKext  
0.000021  mds.30953
```

```
17:40:39.296445  stat64 /System/Library/Extensions/logKext.kext  
0.000010  mds.30953
```

```
17:40:43.135053  getattrlist /LogKextUninstall.command 0.000014  
mds.31061
```


Example - LogKext

fs_usage -f pathname

```
17:40:58.946647  open F=3 (R____)  /usr/bin/logKextClient  
0.000007      logKextKeyGen.31301
```

```
17:40:59.028515  open [  2] (R____)  /Library/Preferences/  
com.fsb.logKext.plist 0.000003  cfprefsd.31142
```

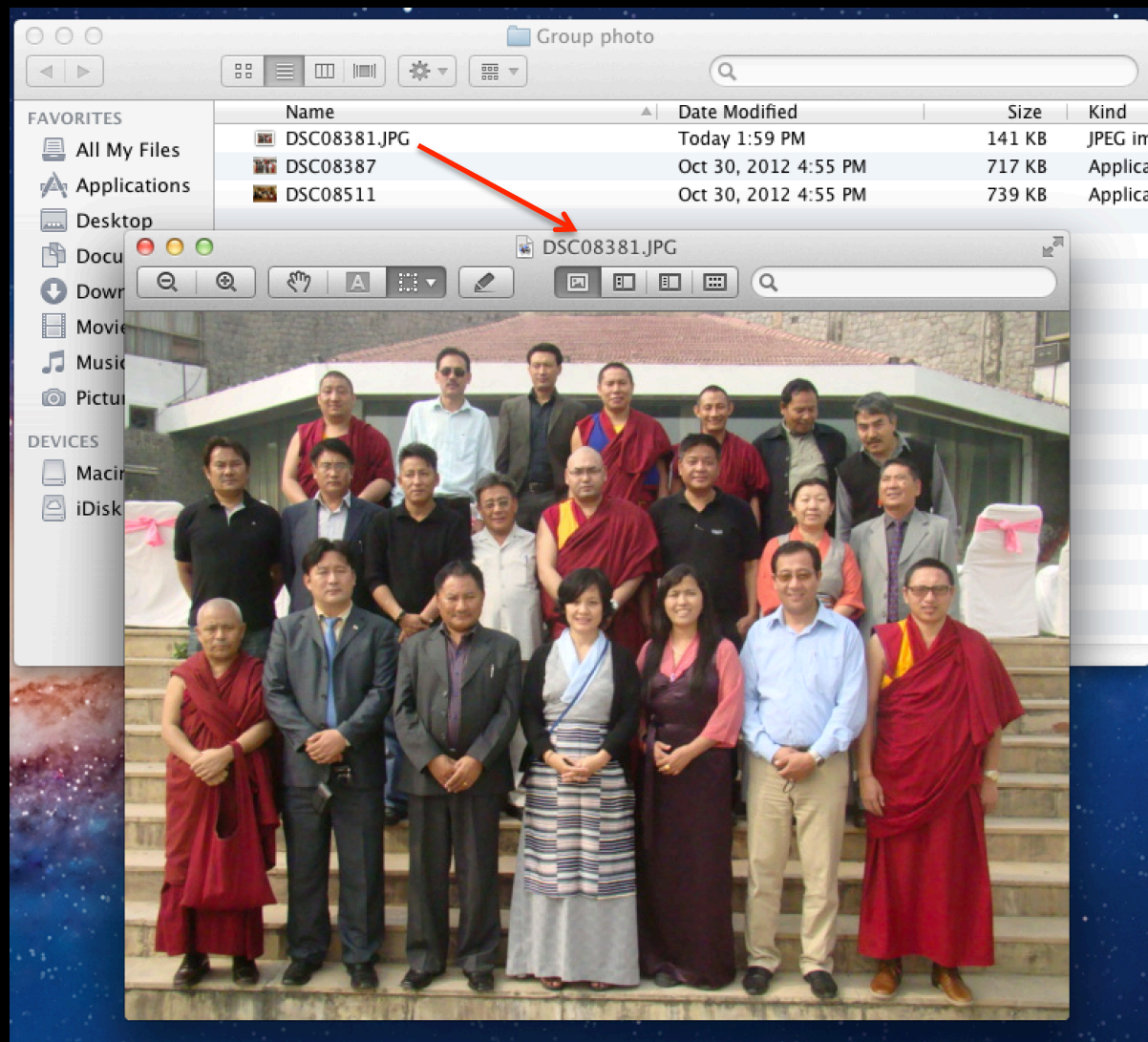
```
17:40:59.056241  statfs [  2] /Library/Preferences/com.fsb.logKext  
0.000018      logKextDaemon.31319
```

```
17:40:59.190232  open F=11 (R____)  /LogKext Readme.html 0.000007  
mds.31061
```

```
17:41:06.808873  open F=25 (_WC_T_)  /Users/cliffstoll/Library/  
Caches/Metadata/Safari/History/file:%2F%2F%2FLogKext  
%2520Readme.html.webhistory 0.000110  Safari.31520
```

```
17:41:31.191547  stat64 /usr/bin/logKextClient  
0.000007      sudo.31638
```

Example - Imuler



Example - Imuler fs_usage -f exec

```
Elwoods-Mac:~ elwoodblues$ sudo fs_usage -f exec
```

WARNING: Improper use of the sudo command could lead to data loss or the deletion of important system files. Please double-check your typing when using sudo. Type "man sudo" for more information.

To proceed, enter your password, or type Ctrl-C to abort.

Password:

14:17:50	posix_spawn	p/Group photo/DSC08381.app/Contents/MacOS/FileAgent	0.000641	W	launchd
14:17:50	posix_spawn	/usr/libexec/taskgated	0.000338	W	launchd
14:17:50	execve	OSServices.framework/Versions/A/Support/SFLIconTool	0.000371		coreservices
14:17:50	posix_spawn	/bin/sh	0.001594	W	FileAgent
14:17:50	execve	private/tmp/Spotlight	0.000223		sh
14:17:50	posix_spawn	/bin/sh	0.003831	W	FileAgent
14:17:50	execve	private/tmp/launch-ICS000	0.000232		sh
14:17:50	execve	/usr/bin/open	0.001563	W	sh
14:17:51	execve	A/Support/lssave	0.002305	W	coreservices
14:17:51	posix_spawn	/Applications/Preview.app/Contents/MacOS/Preview	0.003968	W	launchd
14:17:52	execve	OSServices.framework/Versions/A/Support/SFLIconTool	0.000363		coreservices
14:17:52	posix_spawn	/bin/sh	0.001929	W	FileAgent
14:17:52	execve	/bin/rm	0.000193		sh
14:17:52	posix_spawn	/usr/libexec/xpcproxy	0.005484	W	launchd
14:17:52	execve	y.pboxd.xpc/Contents/MacOS/com.apple.security.pboxd	0.004930	W	xpcproxy
14:17:53	execve	OSServices.framework/Versions/A/Support/SFLIconTool	0.000449		coreservices
14:17:53	posix_spawn	/usr/libexec/lsboxd	0.002383	W	launchd
14:17:54	posix_spawn	s/OpenGL.framework/Versions/A/Libraries/CVMCompiler	0.001632	W	launchd

Example - Imuler fseventer [1]

 /Users/elwoodblues/Desktop/Group photo/DSC08381.JPG	1:59:54 PM	File Created	950 (exited?)
 /Users/elwoodblues/Library/Preferences/SDMHelpData/AppleExtra/English/HelpSDMIndexFile	1:59:54 PM	Folder Changed	 System
 /Users/elwoodblues/Library/Saved Application State/com.fernlightning.fseventer.savedState	1:59:54 PM	Folder Changed	 System
 /private/tmp	1:59:54 PM	Folder Changed	 System
 /Users/elwoodblues/Desktop/Group photo/DSC08381.JPG	1:59:54 PM	Content Modified	950 (exited?)
 /private/tmp/DSC08381.JPG	1:59:54 PM	File Created	950 (exited?)
 /private/tmp/DSC08381.JPG	1:59:54 PM	Content Modified	950 (exited?)
 /private/tmp/launch-ICS000	1:59:54 PM	File Created	950 (exited?)
 /private/tmp/launch-ICS000	1:59:54 PM	Content Modified	950 (exited?)
 /private/tmp/launch-ICS000	1:59:54 PM	Chown	950 (exited?)
 /.Spotlight-V100/Store-V2/552B9C16-9B3A-4E91-B1C4-9128412E64ED/journalAttr.6	1:59:54 PM	File Created	mds
 /Users/elwoodblues/Library/LaunchAgents/ScheduledSync	1:59:54 PM	File Created	953 (exited?)
 /Users/elwoodblues/Library/LaunchAgents/ScheduledSync	1:59:54 PM	Content Modified	953 (exited?)
 /Users/elwoodblues/Library/LaunchAgents/ScheduledSync.plist	1:59:54 PM	File Created	Spotlight
 /Users/elwoodblues/Library/LaunchAgents/ScheduledSync.plist	1:59:54 PM	Content Modified	Spotlight
 /Users/elwoodblues/Library/LaunchAgents/ScheduledSync	1:59:54 PM	Chown	Spotlight
 /Users/elwoodblues/Library/LaunchAgents/ScheduledSync.plist	1:59:54 PM	Chown	Spotlight
 /Users/elwoodblues/Library/.confback	1:59:54 PM	File Created	Spotlight
 /Users/elwoodblues/Library/.confback	1:59:54 PM	Content Modified	Spotlight

Example - Imuler fseventer [2]

 /Users/elwoodblues/Desktop/Group photo/DSC08381.app	1:59:55 PM	Terminated App	 System
 /Applications/Preview.app	1:59:56 PM	Launched App	launchd
 /Users/elwoodblues/Library/Saved Application State/com.apple.finder.savedState/window_14.data	1:59:55 PM	Stat Changed	 Finder
 /Users/elwoodblues/Library/Saved Application State/com.apple.finder.savedState/window_14.data	1:59:55 PM	Modified xattr	 Finder
 /Users/elwoodblues/Library/Saved Application State/com.apple.finder.savedState/data.data	1:59:55 PM	Content Modified	 Finder
 /Users/elwoodblues/Library/Saved Application State/com.apple.finder.savedState/windows.plist	1:59:55 PM	Stat Changed	 Finder
 /Users/elwoodblues/Library/Saved Application State/com.apple.finder.savedState/windows.plist	1:59:55 PM	Content Modified	 Finder
 /Users/elwoodblues/Desktop/Group photo/DSC08381.app/Contents/Info.plist	1:59:55 PM	Deleted	959 (exited?)
 /Users/elwoodblues/Desktop/Group photo/DSC08381.app/Contents/MacOS/.cnf	1:59:55 PM	Deleted	959 (exited?)
 /Users/elwoodblues/Desktop/Group photo/DSC08381.app/Contents/MacOS/.confr	1:59:55 PM	Deleted	959 (exited?)
 /Users/elwoodblues/Desktop/Group photo/DSC08381.app/Contents/MacOS/.conft	1:59:55 PM	Deleted	959 (exited?)
 /Users/elwoodblues/Desktop/Group photo/DSC08381.app/Contents/MacOS/FileAgent	1:59:55 PM	Deleted	959 (exited?)
 /Users/elwoodblues/Desktop/Group photo/DSC08381.app/Contents/MacOS	1:59:55 PM	Deleted	959 (exited?)
 /Users/elwoodblues/Desktop/Group photo/DSC08381.app/Contents/PkgInfo	1:59:55 PM	Deleted	959 (exited?)
 /Users/elwoodblues/Desktop/Group photo/DSC08381.app/Contents/Resources/co.icns	1:59:55 PM	Deleted	959 (exited?)
 /Users/elwoodblues/Desktop/Group photo/DSC08381.app/Contents/Resources/English.lproj/InfoPlist.strings	1:59:55 PM	Deleted	959 (exited?)
 /Users/elwoodblues/Desktop/Group photo/DSC08381.app/Contents/Resources/English.lproj/MainMenu.nib	1:59:55 PM	Deleted	959 (exited?)
 /Users/elwoodblues/Desktop/Group photo/DSC08381.app/Contents/Resources/English.lproj	1:59:55 PM	Deleted	959 (exited?)
 /Users/elwoodblues/Desktop/Group photo/DSC08381.app/Contents/Resources	1:59:55 PM	Deleted	959 (exited?)
 /Users/elwoodblues/Desktop/Group photo/DSC08381.app/Contents	1:59:55 PM	Deleted	959 (exited?)
 /Users/elwoodblues/Desktop/Group photo/DSC08381.app	1:59:55 PM	Deleted	959 (exited?)

Example – Imuler tcpdump

- Beacons to “ouchmen.com”

```
13:47:04.202620 IP 172.16.148.1 > 172.16.148.136: ICMP 172.16.148.1 udp port 53 unreachable, length 36
  0x0000: 4500 0038 ccf6 0000 4001 2d24 ac10 9401 E..8....@.-$....
  0x0010: ac10 9488 0303 21f2 0000 0000 4500 0049 .....!.....E..I
  0x0020: e458 0000 ff11 56a0 ac10 9488 ac10 9401 .X....V.....
  0x0030: daa0 0035 0035 0000 ...5.5..
13:47:04.202647 IP 172.16.148.136.61721 > 172.16.148.1.53: 54710+ A? www.ouchmen.com. (33)
  0x0000: 4500 003d 6914 0000 ff11 0000 ac10 9488 E..=i.....
  0x0010: ac10 9401 f119 0035 0029 80e5 d5b6 0100 .....5.).....
  0x0020: 0001 0000 0000 0000 0377 7777 076f 7563 .....www.ouc
  0x0030: 686d 656e 0363 6f6d 0000 0100 01 hmen.com.....
13:47:04.202779 IP 172.16.148.1 > 172.16.148.136: ICMP 172.16.148.1 udp port 53 unreachable, length 36
  0x0000: 4500 0038 5461 0000 4001 a5b9 ac10 9401 E..8Ta..@.....
  0x0010: ac10 9488 0303 0b85 0000 0000 4500 003d .....E..=
  0x0020: 6914 0000 ff11 d1f0 ac10 9488 ac10 9401 i.....
  0x0030: f119 0035 0029 0000 ...5.)..
13:47:04.202807 IP 172.16.148.136.58918 > 172.16.148.1.53: 35328+ AAAA? www.ouchmen.com. (33)
  0x0000: 4500 003d d956 0000 ff11 0000 ac10 9488 E..=.V.....
  0x0010: ac10 9401 e626 0035 0029 80e5 8a00 0100 .....&.5.).....
  0x0020: 0001 0000 0000 0000 0377 7777 076f 7563 .....www.ouc
  0x0030: 686d 656e 0363 6f6d 0000 1c00 01 hmen.com.....
```

Resources & References

Blogs

- “Reverse Engineering OS X” - reverse.put.as (@osxreverser)
- “Reverse Engineering Resources” - <http://samdmarschall.com/re.html> (@dirk_gently)
- Hopper App Blog - hopperapp.tumblr.com (@hopperapp)

Resources

- Apple Developer Website
- man Pages

Malware Samples

- Contagio - contagiodump.blogspot.com
- VXShare - virusshare.com
- Open Malware - www.offensivecomputing.net
- Malwr - malwr.com

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