WHEN MACS GET HACKED

Sarah Edwards
@iamevltwin
oompa@csh.rit.edu

ABOUT ME

- Senior Digital Forensics Analyst @ Harris Corporation
- Northern Virginia
- Federal Law Enforcement
- Intrusion Analysis
- Counter-Intelligence, Counter-Terrorism, Criminal Cases
- Mac Nerd at Heart

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CURRENT THREATS:

Suspicious Use	Insider Threat	Data Exfiltration
Keylogger	Ad-Click Malware	Information Stealer
Phishing	Backdoors	Commercial Spyware

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CURRENT THREATS: FLASHBACK

- Infected 600,000+ systems
- $10,000/day ad-click revenue for attackers
- Java Vulnerabilities
- Fake Adobe Flash Installer
- Drive-by-Download
  - Compromised Wordpress Blogs

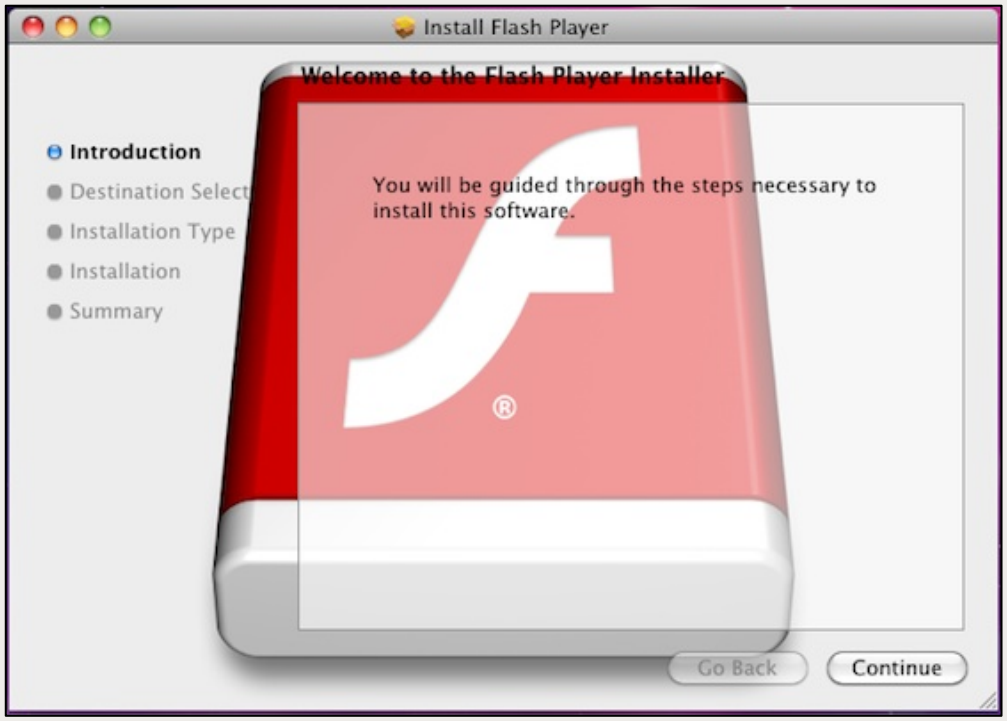

Image Source: http://www.cultofmac.com/124840/new-flashback-os-x-trojan-is-in-the-wild-and-it-can-kill-os-xs-anti-malware-scams/

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CURRENT THREATS: IMULER

- Hidden .app file in Zip Archive
- Installs backdoor
- Information Stealer
  - Files
  - Screenshots
- Another variant:
  - Targets Tibetan Activists
  - Photos of Tibetan Organization

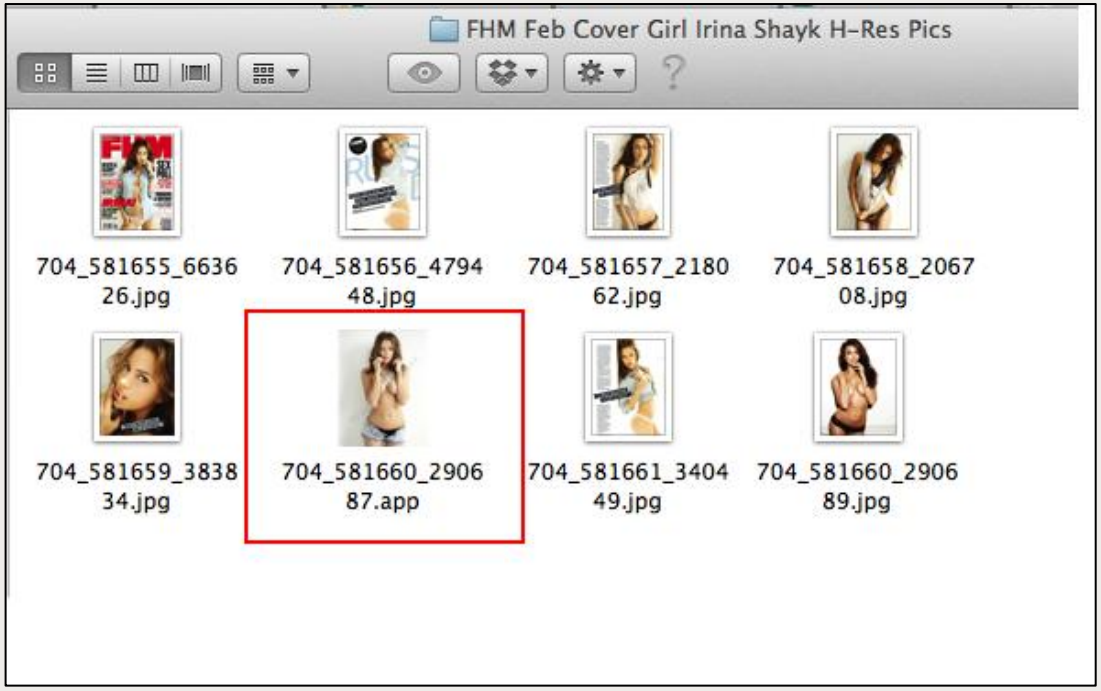

Image Source: http://blog.eset.com/2012/03/16/osximuler-updated-still-a-threat-on-mac-os-x

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CURRENT THREATS: SABPUB

- Vulnerabilities
  - Java
  - MS Word
- Malicious/Decoy Word Document
- Targeting Tibetan NGOs
- Backdoor
  - Download/Upload Files
  - Screenshots
  - Shell Execution

Image Source: http://totaldefense.com/blogs/2012/04/18/OSX/SabPub-New-Backdoor-Malware-Threat-for-Mac-OS-X.aspx

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CURRENT THREATS: MACCONTROL

- MS Word Vulnerability
- Remote Access Trojan
  - Possible complete control of system
- Targets Tibetan NGOs via phishing emails

Your Excellency
The United Nations Commission for Human Rights
The United Nations Commission for Human Rights Office
Geneva, Switzerland.
Dated: 9th March 2012.
Your Excellency,
The Tibetans throughout the Globe will co-mmemorate the 53rd Anniversary of the Tibetan National Uprising Day in Lhasa, Tibet in 1959, against the Peoples Republic of China. During these 53 long years of struggle, thousands of innocent Tibetans were tortured, imprisoned and killed by the Chinese government,without a fair trial.
Tibet
s rich resources are plundered and the environment destroyed with deforestation, elimination of its rare species of wildife and diverting and damming of Tibet
s holy rivers which are source of lifeline for many Asian countries.
Since 2008, massive crackdowns and indoctrination of Tibetan monks and nuns were imposed by the Chinese Government. Due to heavy handedness of the Chinese authorities, and the unbearable condition of the Tibetans under their most repressive rule, the Tibetans from all parts of Tibet, especiall y Ngaba and Karzi regions unitedly protested, demanding the return of Tibet
s spiritual leader H.Holiness the Dalai Lama and freedom for Tibet. Instead of addressing the problems being faced by the Tibetans under the Chinese repressive rule in Tibet, the Chinese authorities sought to use forceful methods by firing on unarmed Tibetan protestors, beating and injuring them. Since 16th March 2011, over 24 Tibetans have self-immolated, calling for return of Tibet
s spiritual leader H.Holiness the Dalai Lama and freedom for Tibet. In short, Tibet is cut off from outside world, with ban on the entry of foreign media personnel and tourists.
We therefore, appeal to your Excellency and the representatives of the United Nations member countries to take immediate action on the following demands:-
 1) Insist the Peoples Republic of China to immediately call back all Chinese Security personnel from Ngaba and Karzi regions of Tibet.

2) All the monks and nuns must be allowed to return unconditionally to their respective monasteries
3) Insist the Chinese authorities to release all the political prisoners, especially the young Panchen Lama, Gedun Choekyi Nyima and Tulku Tenzin Delek
 4) Allow foreign diplomats and independent media unfettered access to all the Tibetan areas for observation
Stop all forms of percecution in Tibet and adhere to Global Human Rights norms.
Your Excellency, we Tibetans inside Tibet and in other parts of the world, appeal and look forward eagerly to genuine political support from the United Nations like any other weaker nations who are facing tremendous aggression from more powerful nations in the world.
As you are aware, we Tibetans, under the leadership of His Holiness the Dalai Lama, the non-violent and compassionate leader who follows non-violent even to last resort, continue to follow His steps to gain Freedom for the Tibetans.
Thanking you,
With due respect and hope,
TENZIN WANGMO PHURBU LHAMO
President President
RTWA Bylakuppe, Karnataka State RTWA Kollegal, Karnataka State

Image Source: http://labs.alienvault.com/labs/index.php/2012/ms-office-exploit-that-targets-macos-x-seen-in-the-wild-delivers-mac-control-rat/

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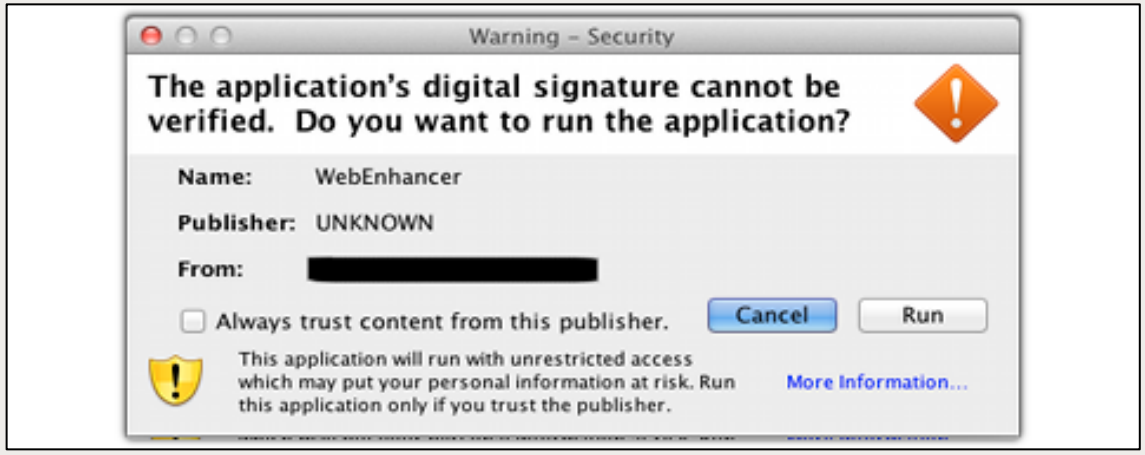
CURRENT THREATS: CRISIS / MORCUT

- Rootkit & Spyware
- Arrives as AdobeFlashPlayer.jar
  - WebEnhancer.class
- Cross-platform (Windows!)
- Backdoor Access: Screenshots, keylog, webcam, location, microphone, files, IM data, etc.



http://nakedsecurity.sophos.com/2012/07/25/mac-malware-crisis-on-mountain-lion-eve/

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CURRENT THREATS: PINT-SIZED

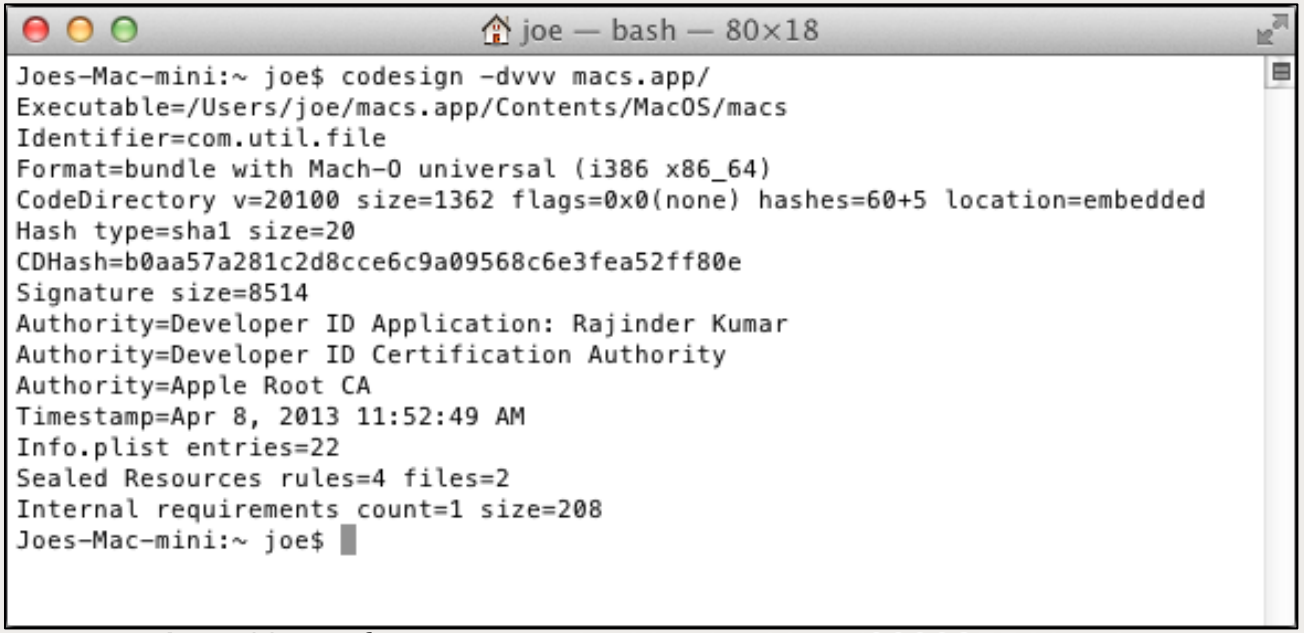
- iPhoneDevSDK.com compromised
  - Mobile Developer Forum
  - Javascript Injected
- Zero-day Exploit via the Java Browser Plugin
- Infected:
  - Apple
  - Facebook
  - Twitter
  - Microsoft

CURRENT THREATS: PINT-SIZED

- Bypasses Gatekeeper
- Opens Reverse Shell
- Encrypted C2 Communication
  - C2 Server at corp-aapl.com (now sinkholed)
  - RSA Keys
  - OpenSSH
- Hides itself as printer related files
- Perl scripts used for communication

CURRENT THREATS: KITM

- Found on activist's system at Oslo Freedom Forum
- Backdoor
- Takes periodic screenshots
- Signed with Apple Developer ID



http://www.f-secure.com/weblog/archives/00002554.html

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WINDOWS INVESTIGATIONS

Incident Response	Autoruns	Prefetch	Internet History
Email	User Accounts	Temporary Directories	Log Analysis
Antivirus Logs	Time Stomping	Memory Analysis	Malware Reverse Engineering

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INCIDENT RESPONSE

What

- System Information
- Network Data
- Users Logged On
- Running Processes
- Open Files
- Memory Analysis
- Other Tools

Why

- Collect Volatile Data
- Triage Analysis
- Dead-Box Analysis
- Encryption

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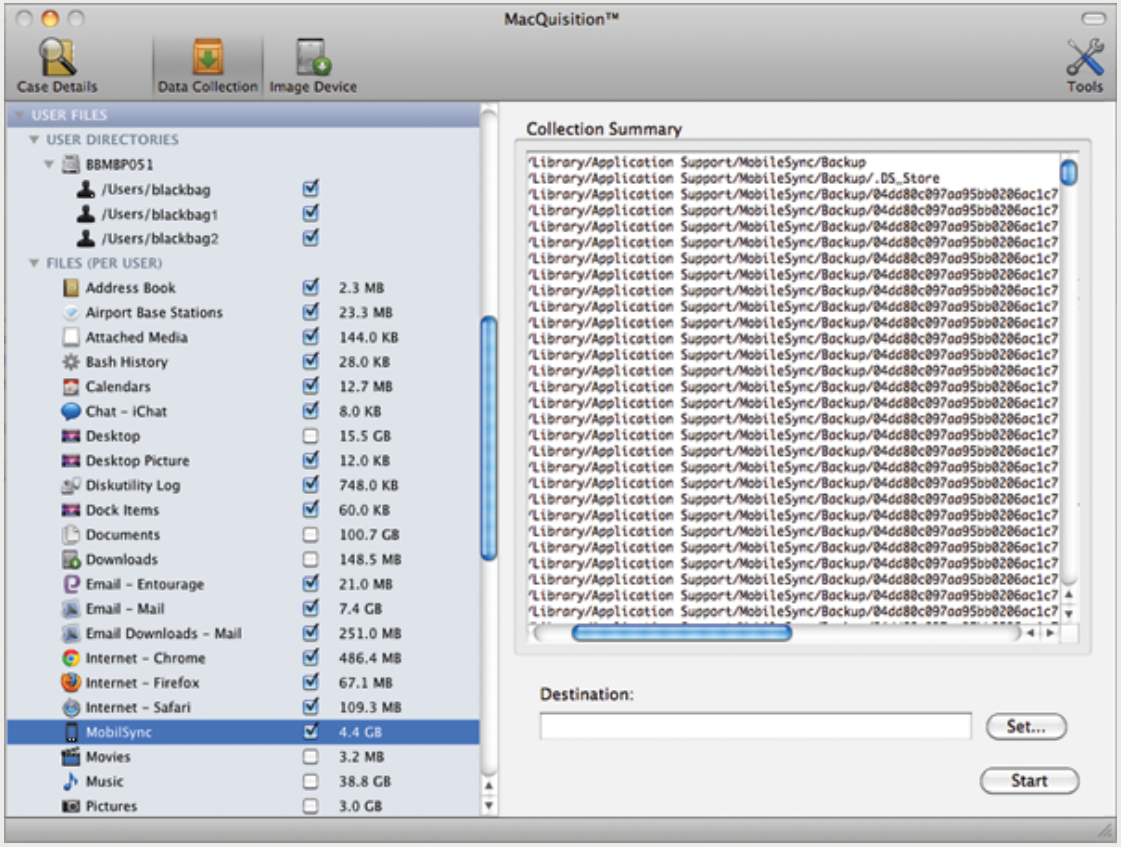
INCIDENT RESPONSE: MACQUISITION BY BLACKBAG

- Volatile Data
  - System Processes
  - Attached Media
  - Bash History
- Memory Acquisition
- HDD Acquisition too!



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INCIDENT RESPONSE: MAC MEMORY READER (ATC-NY)

- Supports 10.4 – 10.8 32/64
- dd or Mach-O Formats
- http://cybermarshal.com/index.php/cyber-marshal-utilities/mac-memory-reader

```
bit:MacMemoryReader oompa$ sudo ./MacMemoryReader -p ../lion_10_7_4.dd
Dumping memory regions:
available  0000000000000000-000000000008e000                    [WRITTEN]
ACPI_NVS   000000000008f000-0000000000090000                    [WRITTEN]
available  0000000000090000-00000000000a0000                    [WRITTEN]
LoaderData 0000000000100000-000000000010e000                    [WRITTEN]
available  000000000010e000-0000000000200000                    [WRITTEN]
LoaderData 0000000000200000-0000000000732000                    [WRITTEN]
available  0000000000732000-0000000000800000                    [WRITTEN]
LoaderData 0000000000800000-000000000257a000                    [WRITTEN]
RT_data    000000000257a000-0000000002583000                    [WRITTEN]
RT_data    0000000002583000-0000000002585000                    [WRITTEN]
RT_code    0000000002585000-0000000002589000                    [WRITTEN]
RT_code    0000000002589000-0000000002590000                    [WRITTEN]
RT_code    0000000002590000-0000000002593000                    [WRITTEN]
RT_data    0000000002593000-0000000002594000                    [WRITTEN]
RT_code    0000000002594000-0000000002596000                    [WRITTEN]
RT_code    0000000002596000-000000000259b000                    [WRITTEN]
RT_data    000000000259b000-000000000259e000                    [WRITTEN]
RT_data    000000000259e000-000000000259f000                    [WRITTEN]
RT_data    000000000259f000-00000000025b9000                    [WRITTEN]
RT_code    00000000025b9000-00000000025ce000                    [WRITTEN]
RT_data    00000000025ce000-00000000025cf000                    [WRITTEN]
LoaderData 00000000025cf000-00000000025fc000                    [WRITTEN]
available  00000000025fc000-00000000a7095000 [..............  ]  41.0% |
```

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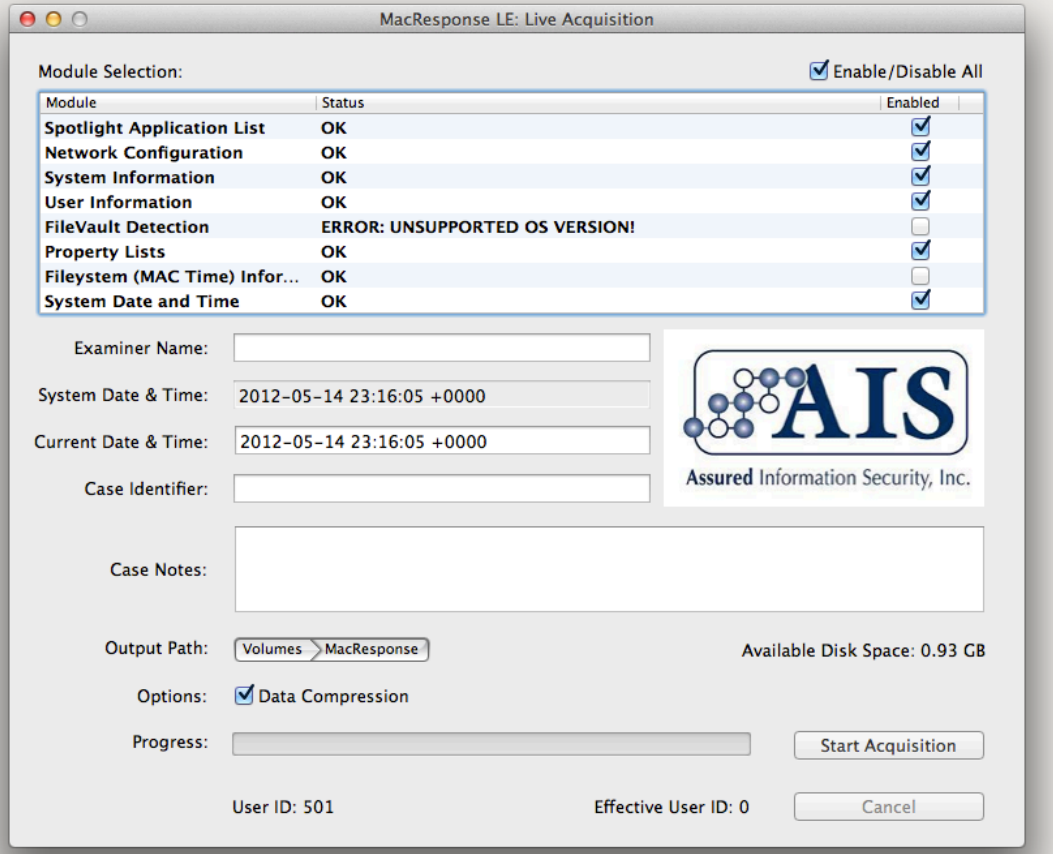
INCIDENT RESPONSE: MACRESPONSE BY AIS

- App on USB Drive
- Captures:
  - System Information
  - Disk Information
  - User Information
  - Drivers
  - Login Sessions
  - Network Data
  - Processes
  - Screenshot
  - Application Data
  - FileVault Detection
  - Property Lists
  - RAM (10.7 not supported)
- macresponseforensics.com



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INCIDENT RESPONSE: MAKE YOUR OWN IR LIVE CD

- Blog: irhowto.wordpress.com
- "Creating a OS X Live IR CD-ROM"
- Step-by-Step Process & Scripts
  - Static Binaries
- Not foolproof
  - May not work on all systems

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INCIDENT RESPONSE: SYSTEM INFORMATION

- date
- hostname
- uname –a
- sw_vers

```
bit:~ user$ date
Sun May 13 20:34:05 EDT 2012
bit:~ user$ hostname
bit
bit:~ user$ uname -a
Darwin bit 11.4.0 Darwin Kernel
Version 11.4.0: Mon Apr  9
19:32:15 PDT 2012;
root:xnu-1699.26.8~1/
RELEASE_X86_64 x86_64
bit:~ user$ sw_vers
ProductName:      Mac OS X
ProductVersion:   10.7.4
BuildVersion:     11E53
```

INCIDENT RESPONSE: NETWORK DATA

- netstat –an
- lsof -i

```
bit:~ user$ netstat –an
Active Internet connections (including servers)
Proto Recv-Q Send-Q  Local Address          Foreign Address        (state)
tcp4       0      0  192.168.1.101.60264    x.x.x.x.80             ESTABLISHED
tcp4       0      0  192.168.1.101.60094    x.x.x.x.993            ESTABLISHED
tcp4      37      0  192.168.1.101.59508    x.x.x.x.443            CLOSE_WAIT
tcp4       0      0  192.168.1.101.59437    x.x.x.x.993            ESTABLISHED
…
bit:~ user$ lsof -i
COMMAND    PID  USER   FD   TYPE             DEVICE SIZE/OFF NODE NAME
loginwind   65 user    8u   IPv4 0xffffff8012574490      0t0  UDP *:*
Mail       141 user    37u  IPv4 0xffffff80156e2320      0t0  TCP bit:59432-
>mail.some.thing.com:imaps (ESTABLISHED)
Google     144 user    8u   IPv4 0xffffff8015f184e0      0t0  TCP bit:59421->qc-in-
f125.1e100.net:jabber-client (ESTABLISHED)
iCal       149 user    17u  IPv4 0xffffff80156e1c00      0t0  TCP bit:49257-
>17.172.116.48:https (CLOSE_WAIT)
Finder     155 user    26u  IPv4 0xffffff80156e5500      0t0  TCP localhost:57669->localhost:
26164 (ESTABLISHED)
Dropbox    247 user    15u  IPv4 0xffffff8015717500      0t0  TCP bit:59418->sjc-
not18.sjc.dropbox.com:http (ESTABLISHED)
```

INCIDENT RESPONSE: NETWORK DATA – ROUTING TABLE

- `netstat –rn`

```
bit:~ user$ netstat -rn
Routing tables

Internet:
Destination        Gateway            Flags        Refs      Use   Netif Expire
default            192.168.1.254      UGSc           42        0     en1
127                127.0.0.1          UCS             0        0     lo0
127.0.0.1          127.0.0.1          UH              4  6677585     lo0
169.254            link#5             UCS             1        0     en1
169.254.204.125    b8:c7:5d:cc:5:80   UHLSW           0        7     en1
172.16.152/24      link#9             UC              2        0  vmnet8
172.16.152.255     ff:ff:ff:ff:ff:ff  UHLWbI          0        1  vmnet8
172.16.243/24      link#8             UC              2        0  vmnet1
172.16.243.255     ff:ff:ff:ff:ff:ff  UHLWbI          0        1  vmnet1
192.168.1          link#5             UC              5        0     en1
192.168.1.1        c0:3f:e:8c:59:59   UHLWIi          0      186     en1    900
192.168.1.101      127.0.0.1          UHS             0        0     lo0
192.168.1.133      3c:7:54:3:65:20    UHLWIi          1     2886     en1   1109
192.168.1.241      68:9:27:32:15:9c   UHLWIi          0        0     en1   1085
```

INCIDENT RESPONSE: NETWORK DATA – ARP TABLE

- arp –an
- ifconfig

```
bit:~ user$ arp -an
? (169.254.204.125) at b8:c7:5d:cc:5:80 on en1 [ethernet]
? (172.16.152.255) at ff:ff:ff:ff:ff:ff on vmnet8 ifscope [ethernet]
? (172.16.243.255) at ff:ff:ff:ff:ff:ff on vmnet1 ifscope [ethernet]
? (192.168.1.1) at c0:3f:e:8c:59:59 on en1 ifscope [ethernet]
? (192.168.1.133) at 3c:7:54:3:65:20 on en1 ifscope [ethernet]
bit:~ user$ ifconfig
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=2b<RXCSUM,TXCSUM,VLAN_HWTAGGING,TSO4>
    ether c4:2c:03:09:ca:fd
    media: autoselect (none)
    status: inactive
en1: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    ether 90:27:e4:f8:e6:5f
    inet6 fe80::9227:e4ff:fef8:e65f%en1 prefixlen 64 scopeid 0x5
    inet 192.168.1.101 netmask 0xffffff00 broadcast 192.168.1.255
    media: autoselect
    status: active
```

INCIDENT RESPONSE: OPEN FILES

- lsof

```
bit:~ user$ lsof
COMMAND    PID  USER   FD     TYPE   DEVICE  SIZE/OFF    NODE NAME
loginwind   65 user   cwd    DIR   14,4      1156       2 /
loginwind   65 user   txt    REG   14,4   1421280  501728 /System/Library/CoreServices/
loginwindow.app/Contents/MacOS/loginwindow
loginwind   65 user   txt    REG   14,4    118384  424796 /System/Library/LoginPlugins/
FSDisconnect.loginPlugin/Contents/MacOS/FSDisconnect
loginwind   65 user   txt    REG   14,4     19328  281526 /private/var/folders/xq/
yjffvqj90s313s17vy12w7nr0000gn/C/com.apple.scriptmanager.le.cache
loginwind   65 user   txt    REG   14,4     17284   27515 /System/Library/PrivateFrameworks/
CoreWLANKit.framework/Versions/A/Resources/AirPort3.pdf
…
Mail       141 user   41u    REG   14,4   1806336  604815 /Users/user/Library/Caches/
com.apple.mail/Cache.db
Mail       141 user   42w    REG   14,4     20748  282135 /Users/user/Library/Logs/Sync/
syncservices.log
Mail       141 user   43u    REG   14,4     40960  629603 /Users/user/Library/Application
Support/AddressBook/MailRecents-v4.abcdmr
…
Google     144 user   txt    REG   14,4    270336  769873 /Users/user/Library/Caches/Google/
Chrome/Default/Media Cache/data_1
Google     144 user   txt    REG   14,4      8192  769874 /Users/user/Library/Caches/Google/
Chrome/Default/Media Cache/data_2
Google     144 user   txt    REG   14,4      8192  769875 /Users/user/Library/Caches/Google/
Chrome/Default/Media Cache/data_3
```

INCIDENT RESPONSE: USERS LOGGED ON

- who –a
- w

```
bit:~ user$ who -a
reboot   ~        May 12 11:32 00:14       1
user     console  May 12 11:32  old       65
user     ttys000  May 12 11:33   .       189
user     ttys001  May 13 11:38 09:29    3199
user     ttys002  May 13 20:48   .      8781
user     ttys003  May 13 20:55 00:14    8850
   .       run-level 3
bit:~ user$ w
21:10  up 1 day,  9:38, 5 users, load averages: 1.06 1.55 1.81
USER     TTY      FROM              LOGIN@  IDLE WHAT
user     console  -                Sat11   33:37 -
user     s000     -                Sat11       - w
user     s001     -                11:38    9:29 more
user     s002     -                20:48       - /usr/bin/less -is
user     s003     -                20:55      14 -bash
```

INCIDENT RESPONSE: RUNNING PROCESSES

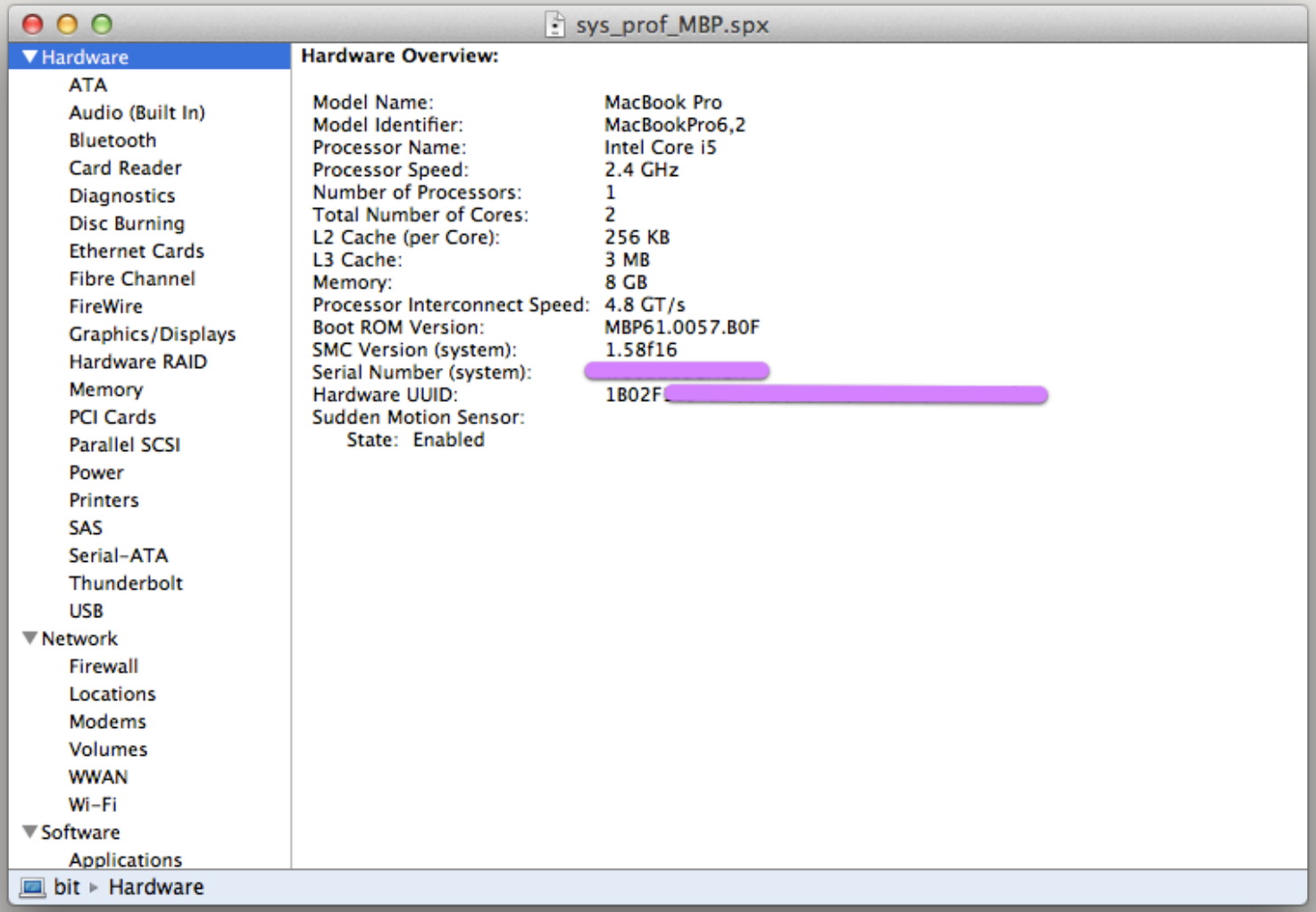
- `ps aux`

```
bit:~ user$ ps aux
USER   PID  %CPU %MEM      VSZ    RSS   TT  STAT STARTED      TIME COMMAND
user   143   1.2  0.8  2649292  62964   ??  R    Sat11AM   0:45.27 /
Applications/Utilities/Terminal.app/Contents/MacOS/Terminal -psn_0_36873
user   148   1.0  0.9  4009924  72300   ??  S    Sat11AM   9:43.59 /
Applications/iChat.app/Contents/MacOS/iChat -psn_0_57358
user   6851  0.9  1.2   944492  98236   ??  S     7:06PM   3:56.95 /
Applications/Evernote.app/Contents/MacOS/Evernote -psn_0_1245877
_windowserver    102   0.8  2.3  3456288 194720   ??  Ss   Sat11AM  35:09.10 /
System/Library/Frameworks/user         6700   0.2  user   145   0.1  1.1
1095472  93940   ??  S    Sat11AM   5:25.76 /Applications/Microsoft Office
2011/Microsoft Word.app/Contents/MacOS/Microsoft Word -psn_0_45067
user  8945   0.0  0.0  2434848    596 s002  S+    9:09PM   0:00.01 man who
user  8851   0.0  0.0  2435492   1124 s003  S+    8:55PM   0:00.01 –bash
root  8850   0.0  0.0  2466544   2076 s003  Ss    8:55PM   0:00.02 login -pf
user
user  8800   0.0  0.4  2503560  31720   ??  SN    8:49PM   0:02.62 /System/
Library/Frameworks/user   8782   0.0  0.0  2435492   1128 s002  S     8:48PM
0:00.02 –bash
```

INCIDENT RESPONSE: SYSTEM INFORMATION

- `system_profiler -xml -detaillevel full > /Volume/IR_CASE/sys_prof_MBP.spx`
- Open in “System Information.app”
- Contains:
  - Hardware Information
  - USB Information
  - Network Information
  - Firewall Settings
  - Mounted Volumes
  - System Information
  - Applications
  - Kernel Extensions
  - Log Data

INCIDENT RESPONSE: SYSTEM INFORMATION



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MEMORY ANALYSIS

What

- Volafox
- Volatility
- Macmemoryze

Why

- Volatile Data
  - Network Connections
  - Open Files
  - Kernel Extensions
  - Running Processes

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MEMORY ANALYSIS: MANDIANT MACMEMORYZE

- www.mandiant.com/resources/download/mac-memoryze
- Supports 10.6 – 10.8
- Acquire & Analyze
- Only runs on a Mac (Mach-O Binary)
- Parses:
  - Processes
  - Network Information
  - Open Files
  - Kernel Extensions
  - System Calls
  - Mach Trap Calls

MEMORY ANALYSIS: MANDIANT MACMEMORYZE

```
nibble:Mandiant Mac Memoryze sledwards$ ./macmemoryze kextlist -c -f ~/Documents/Mac\ OS\ X\ 10.8\ 64-bit-Snapshot1.vmem
INFO: [+] searching for lowGlo
INFO: [+] lowGlo [0000000024823000]
INFO: [+] found os [Mac OS X 10.8 (Mountain Lion)] [64-bit]
INFO: [+] PA PML4 [0000000025C56000]
INFO: [+] searching for kernel base
INFO: [+] found kaslr_base as [0000000024000000]
*****************************
KMOD CARVE LIST
*****************************
 100%
PADDR            KMOD INFO        START ADDR       SIZE             ID  REFS VERSION              NAME
---------------- ---------------- ---------------- ---------------- --- ---- -------------------- ----------------------------------------------
000000000B201470 0000000000000000 FFFFFF7FA5892000 0000000000009000 087 000 3.0                  com.apple.filesystems.autofs
000000000BC209D8 0000000000000000 FFFFFF7FA56E7000 0000000000003000 072 000 4.1.21               com.apple.driver.AppleUSBCDC
000000000BD36730 0000000000000000 FFFFFF7FA56A9000 000000000000E000 069 001 1.0.10d0             com.apple.driver.AppleSMBusController
000000000BF6E308 0000000000000000 FFFFFF7FA5610000 0000000000012000 059 001 1.0.0                com.apple.driver.IOPlatformPluginLegacy
00000000231CF800 0000000000000000 0000000000000000 0000000000000000 007 045 12.0.0              com.apple.kpi.unsupported
00000000231CF900 0000000000000000 0000000000000000 0000000000000000 006 030 12.0.0              com.apple.kpi.private
00000000231CFA00 0000000000000000 0000000000000000 0000000000000000 005 067 12.0.0              com.apple.kpi.mach
00000000231CFB00 0000000000000000 0000000000000000 0000000000000000 004 077 12.0.0              com.apple.kpi.libkern
```

```
nibble:Mandiant Mac Memoryze sledwards$ ./macmemoryze proclist -f ~/Documents/Mac\ OS\ X\ 10.8\ 64-bit-Snapshot1.vmem | more
INFO: [+] searching for lowGlo
INFO: [+] lowGlo [0000000024823000]
INFO: [+] found os [Mac OS X 10.8 (Mountain Lion)] [64-bit]
INFO: [+] PA PML4 [0000000025C56000]
INFO: [+] searching for kernel base
INFO: [+] found kaslr_base as [0000000024000000]
*****************************
WALK PROCESS LIST
*****************************
PADDR            VADDR            NAME                             PID        PPID       BITs STATE    STARTED              EUID     RUID     USERNAME
---------------- ---------------- -------------------------------- ---------- ---------- ---- -------- -------------------- -------- -------- --------------------
00000000248DA2E0 FFFFFF80248DA2E0 kernel_task                               0          0  64   RUNNABLE 2012-09-23 17:33:46        0        0
0000000029816A60 FFFFFF802A914A60 launchd                                  1          0  64   RUNNABLE 2012-09-23 17:33:46        0        0           _locationd
00000000298161A0 FFFFFF802A9141A0 UserEventAgent                          11          1  64   RUNNABLE 2012-09-23 17:33:49        0        0                root
00000000298178E0 FFFFFF802A9138E0 kextd                                   12          1  64   RUNNABLE 2012-09-23 17:33:49        0        0                root
0000000029817480 FFFFFF802A913480 securityd                               14          1  64   RUNNABLE 2012-09-23 17:33:49        0        0                root
0000000029817020 FFFFFF802A913020 notifyd                                 15          1  64   RUNNABLE 2012-09-23 17:33:49        0        0                root
00000000298180C0 FFFFFF802A912BC0 powerd                                  16          1  64   RUNNABLE 2012-09-23 17:33:49        0        0                root
0000000029818760 FFFFFF802A912760 configd                                 17          1  64   RUNNABLE 2012-09-23 17:33:49        0        0                root
0000000029818300 FFFFFF802A912300 syslogd                                 18          1  64   RUNNABLE 2012-09-23 17:33:49        0        0                root
0000000029819EA0 FFFFFF802A911EA0 distnoted                               19          1  64   RUNNABLE 2012-09-23 17:33:49        0        0                root
0000000029819A40 FFFFFF802A911A40 cfprefsd                                20          1  64   RUNNABLE 2012-09-23 17:33:49        0        0                root
```

MEMORY ANALYSIS: VOLAFOX

- http://code.google.com/p/volafox
- Mach-O Image from Mac Memory Reader => Volafox's flatty.py
- Download from source for latest updates.
- Supports 10.6 – 10.8
- Based upon the Volatility Framework
- Python-based

```
bit:volafox-read-only oompa$ python flatten.py ../lion_10_7_4.macho ../lion_10_7_4.flat
Copying: available  0000000000000000 000000000000008e
Copying: ACPI_NVS   000000000008f000 0000000000000001
Copying: available  0000000000090000 0000000000000010
Copying: LoaderData 0000000000100000 000000000000000e
Copying: available  00000000010e000 00000000000000f2
Copying: LoaderData 0000000000200000 0000000000000532
```

MEMORY ANALYSIS: VOLAFOX

- System Information
- Processes
- Open Files
- Possible Decrypt Candidates for Master Keychain
- Kernel Extensions
- Syscall Table
- Mach Trap Table
- Network Connections
- EFI & Boot Data
- Mounted Devices

```
bit:volafox-read-only oompa$ python vol.py -i /Volumes/WDPassport/lion_10_7_3.flat -o ps
[+] Process List
OFFSET(P)     PID  PPID PRIORITY NICE     PROCESS_NAME       USERNAME CREATE_TIME (GMT +0)
0x00BCCB80      0     0        0    0      kernel_task                Fri Apr 06 20:42:50 2012
0x00BCC300      1     0      128    0           launchd     _atsserver Fri Apr 06 20:42:50 2012
0x00BCDA80     10     1      128    0             kextd           root Fri Apr 06 20:43:11 2012
0x00BCDEC0     11     1      128    0   UserEventAgent           root Fri Apr 06 20:43:11 2012
0x00BCD640     12     1      255    0    mDNSResponder _mdnsresponder Fri Apr 06 20:43:11 2012
0x00BCD200     13     1      255    0   opendirectoryd _mdnsresponder Fri Apr 06 20:43:11 2012
0x00BCEDC0     14     1      128    0        fseventsd _mdnsresponder Fri Apr 06 20:43:11 2012
0x00BCE980     15     1      128    0          notifyd _mdnsresponder Fri Apr 06 20:43:11 2012
0x00BCE540     16     1      128    0          syslogd _mdnsresponder Fri Apr 06 20:43:11 2012
0x00BCFCC0     17     1      128    0          configd _mdnsresponder Fri Apr 06 20:43:24 2012
```

MEMORY ANALYSIS: VOLAFOX

```
bit:volafox-read-only oompa$ python vol.py -i ../lion_10_7_3.flat -o kextstat
[+] Kernel Extention List
OFFSET(P)   INFO KID                                                KEXT_NAME   VERSION
0x13672C120    1 140                                          com.atc-ny.devmem   1.0.0d1
0x1D159A9F0    1 137                              com.apple.driver.iPodSBCDriver     1.6.0
0x1BE812E20    1 135                            com.apple.driver.AppleUSBMergeNub     4.5.3
0x254F7CD60    1 132                                 com.apple.filesystems.afpfs       9.8
0x25C931600    1 131                       com.apple.security.SecureRemotePassword       1.0
0x16A1FA1D0    1 130                                        com.apple.nke.asp_tcp     6.0.1
0x08079970     1 129                                 com.apple.filesystems.smbfs     1.7.0
0x14DA56120    1 123           com.apple.driver.AppleProfileTimestampAction      85.2
0x14E123130    1 122         com.apple.driver.AppleProfileThreadInfoAction      85.2
```

```
bit:volafox-read-only oompa$ python vol.py -i ../lion_10_7_3.flat -o netstat
[+] NETWORK INFORMATION (hashbase)
[TCP] Local Address: 0.0.0.0:22, Foreign Address: 0.0.0.0:0, flag: 8000
[TCP] Local Address: 0.0.0.0:88, Foreign Address: 0.0.0.0:0, flag: 8000
[TCP] Local Address: 192.168.1.133:56742, Foreign Address: 207.8.65.20:80, flag: 40008000
[TCP] Local Address: 192.168.1.133:56743, Foreign Address: 207.8.65.20:80, flag: 40008000
[TCP] Local Address: 0.0.0.0:0, Foreign Address: 0.0.0.0:0, flag: 8000
[TCP] Local Address: 192.168.1.133:64945, Foreign Address: 204.245.162.41:80, flag: 40008000
[TCP] Local Address: 192.168.1.133:56704, Foreign Address: 199.47.217.177:443, flag: 40008000
[TCP] Local Address: 127.0.0.1:631, Foreign Address: 0.0.0.0:0, flag: 8000
[TCP] Local Address: 192.168.1.133:56844, Foreign Address: 72.36.210.254:80, flag: 40008000
[TCP] Local Address: 192.168.1.133:56748, Foreign Address: 74.125.228.3:443, flag: 40008000
```

MEMORY ANALYSIS: VOLATILITY

- Official Mac Support in Volatility 2.3
- Over 30 plugins!
  - Processes
  - Network Information
  - Open Files
  - File System Data

```
mac_arp                 - Prints the arp table
mac_check_syscalls      - Checks to see if system call table entries are hooked
mac_check_sysctl        - Checks for unknown sysctl handlers
mac_check_trap_table    - Checks to see if system call table entries are hooked
mac_dead_procs          - Prints terminated/de-allocated processes
mac_dmesg               - Prints the kernel debug buffer
mac_dump_maps           - Dumps memory ranges of processes
mac_find_aslr_shift     - Find the ASLR shift value for 10.8+ images
mac_ifconfig            - Lists network interface information for all devices
mac_ip_filters          - Reports any hooked IP filters
mac_list_sessions       - Enumerates sessions
mac_list_zones          - Prints active zones
mac_ls_logins           - Lists login contexts
mac_lsmod               - Lists loaded kernel modules
mac_lsof                - Lists per-process opened files
mac_machine_info        - Prints machine information about the sample
mac_mount               - Prints mounted device information
mac_netstat             - Lists active per-process network connections
mac_notifiers           - Detects rootkits that add hooks into I/O Kit (e.g. LogKext)
mac_pgrp_hash_table     - Walks the process group hash table
mac_pid_hash_table      - Walks the pid hash table
mac_print_boot_cmdline  - Prints kernel boot arguments
mac_proc_maps           - Gets memory maps of processes
mac_psaux               - Prints processes with arguments in user land (**argv)
mac_pslist              - List Running Processes
mac_pstree              - Show parent/child relationship of processes
mac_psxview             - Find hidden processes with various process listings
mac_route               - Prints the routing table
mac_tasks               - List Active Tasks
mac_trustedbsd          - Lists malicious trustedbsd policies
mac_version             - Prints the Mac version
mac_vfs_events          - Lists Mac VFS Events
mac_volshell            - Shell in the memory image
mac_yarascan            - A shell in the mac memory image
```

MAC AUTORUNS

What

- XPC Services
- Launch Daemons & Agents
- LoginItems
- StartupItems
- Login/Logout Scripts

Why

- Persistence
- Persistence
- Persistence

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AUTORUNS: LAUNCH AGENTS & DAEMONS

- Preferred Method
- Introduced in 10.4 (w/launchd)
- Property List File
- Popular with current Mac malware
- Reference: TN2083

AUTORUNS: LAUNCH AGENTS

- Agent – Background User Process
  - Can access user home directory
  - May have GUI (limited, if at all)
- Location:
  - /System/Library/LaunchAgents/
  - /Library/LaunchAgents/
  - ~/Library/LaunchAgents

AUTORUNS: LAUNCH AGENTS EXAMPLES

```
com.apple.AOSNotificationOSX.plist
com.apple.AddressBook.SourceSync.plist
com.apple.AddressBook.abd.plist
com.apple.AirPortBaseStationAgent.plist
com.apple.AppStoreUpdateAgent.plist
com.apple.AppleGraphicsWarning.plist
com.apple.BezelUI.plist
com.apple.CoreLocationAgent.plist
com.apple.DictionaryPanelHelper.plist
com.apple.DiskArbitrationAgent.plist
com.apple.Dock.plist
com.apple.FTCleanup.plist
com.apple.FileSyncAgent.PHD.plist
com.apple.FileSyncAgent.iDisk.plist
com.apple.Finder.plist
com.apple.FontRegistryUIAgent.plist
com.apple.FontValidator.plist
com.apple.FontValidatorConduit.plist
com.apple.FontWorker.plist
com.apple.KerberosHelper.LKDCHelper.plist
com.apple.LaunchServices.lsboxd.plist
com.apple.NetworkDiagnostics.plist
com.apple.PCIESlotCheck.plist
com.apple.PreferenceSyncAgent.plist
com.apple.PubSub.Agent.plist
com.apple.ReclaimSpaceAgent.plist
com.apple.RemoteDesktop.plist
com.apple.ReportCrash.Self.plist
com.apple.ReportCrash.plist
com.apple.ReportGPURestart.plist
com.apple.ReportPanic.plist
com.apple.ScreenReaderUIServer.plist
com.apple.ServiceManagement.LoginItems.plist
com.apple.SubmitDiagInfo.plist
com.apple.SystemUIServer.plist
com.apple.TMLaunchAgent.plist
com.apple.TrustEvaluationAgent.plist
com.apple.UserEventAgent-Aqua.plist
com.apple.UserEventAgent-LoginWindow.plist
com.apple.UserNotificationCenterAgent-LoginWindow.plist
com.apple.UserNotificationCenterAgent.plist
com.apple.VoiceOver.plist
com.apple.WebKit.PluginAgent.plist
com.apple.ZoomWindow.plist
com.apple.alf.useragent.plist
com.apple.aos.migrate.plist
com.apple.bluetoothUIServer.plist
com.apple.btsa.plist
com.apple.cfnetwork.AuthBrokerAgent.plist
com.apple.cookied.plist
com.apple.coredata.externalrecordswriter.plist
com.apple.coreservices.appleid.authentication.plist
com.apple.coreservices.uiagent.plist
com.apple.csuseragent.plist
com.apple.cvmsCompAgent_i386.plist
com.apple.cvmsCompAgent_x86_64.plist
com.apple.distnoted.xpc.agent.plist
com.apple.familycontrols.useragent.plist
com.apple.findmymacmessenger.plist
com.apple.fontd.useragent.plist
com.apple.gssd-agent.plist
com.apple.helpd.plist
com.apple.iCalPush.plist
com.apple.iChat.Theater.plist
com.apple.imagent.plist
com.apple.imklaunchagent.plist
com.apple.imtranscoderagent.plist
com.apple.imtransferagent.plist
```

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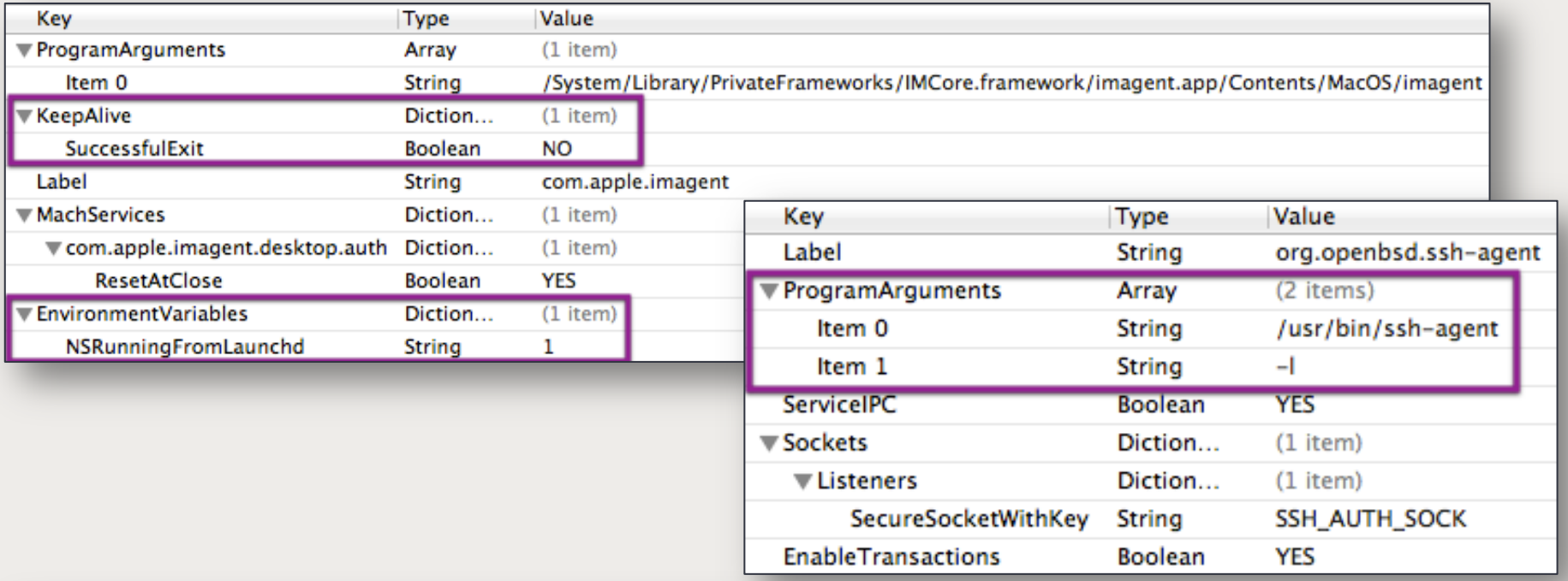
AUTORUNS: LAUNCH AGENTS EXAMPLES



Key	Type	Value
▼ ProgramArguments	Array	(1 item)
Item 0	String	/System/Library/PrivateFrameworks/IMCore.framework/imagent.app/Contents/MacOS/imagent
▼ KeepAlive	Diction…	(1 item)
SuccessfulExit	Boolean	NO
Label	String	com.apple.imagent
▼ MachServices	Diction…	(1 item)
▼ com.apple.imagent.desktop.auth	Diction…	(1 item)
ResetAtClose	Boolean	YES
▼ EnvironmentVariables	Diction…	(1 item)
NSRunningFromLaunchd	String	1

Key	Type	Value
Label	String	org.openbsd.ssh-agent
▼ ProgramArguments	Array	(2 items)
Item 0	String	/usr/bin/ssh-agent
Item 1	String	-l
ServiceIPC	Boolean	YES
▼ Sockets	Diction…	(1 item)
▼ Listeners	Diction…	(1 item)
SecureSocketWithKey	String	SSH_AUTH_SOCK
EnableTransactions	Boolean	YES

Key	Type	Value
Label	String	com.apple.bluetoothUIServer
▼ MachServices	Diction…	(1 item)
com.apple.bluetoothUIServer	Boolean	YES
Program	String	/System/Library/CoreServices/BluetoothUIServer.app/Contents/MacOS/BluetoothUIServer
LimitLoadToSessionType	String	Aqua

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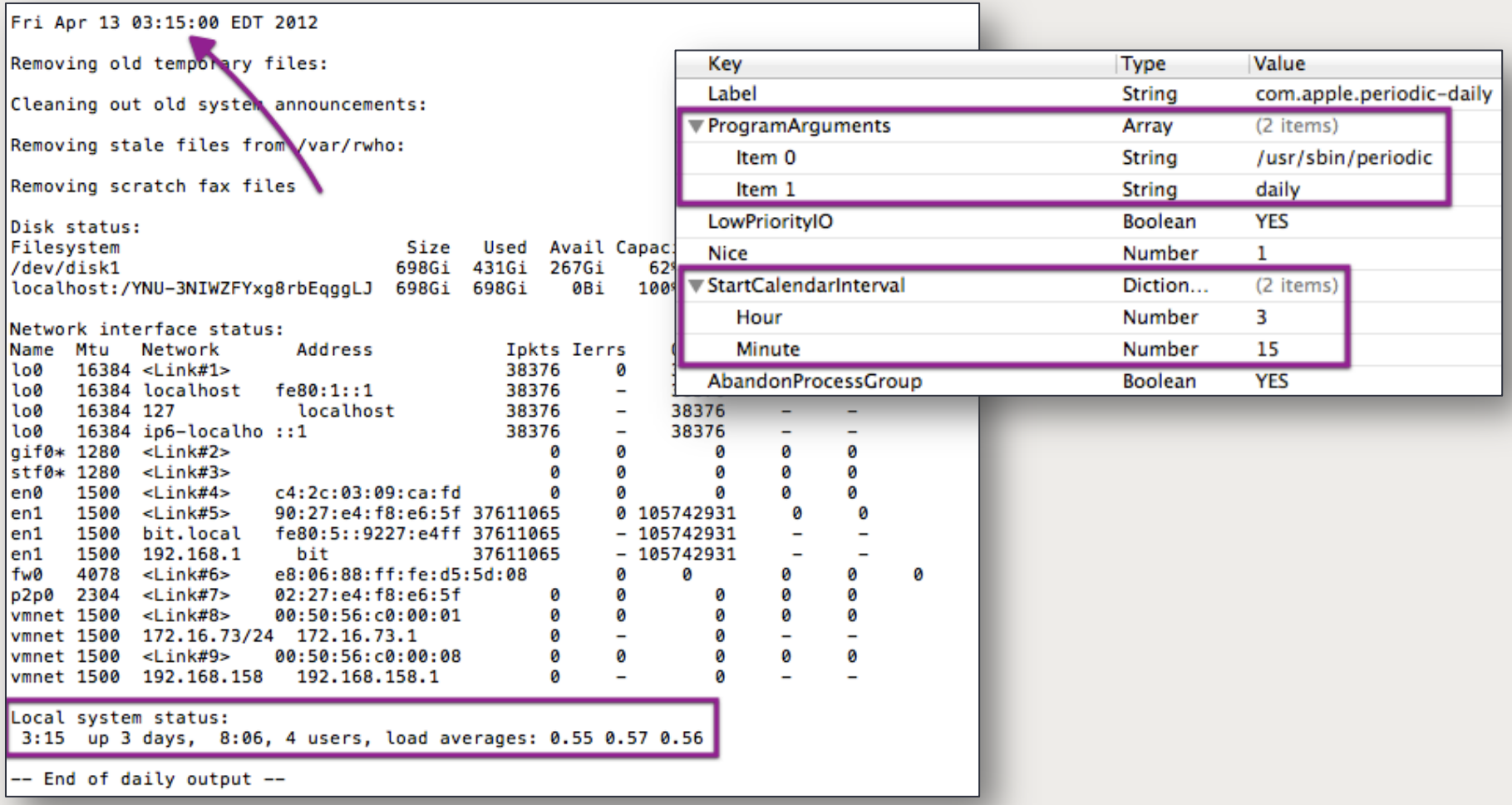
AUTORUNS: LAUNCH AGENTS – SESSION TYPES

Name	Session Type	Notes
GUI launchd agent	Aqua	Access to GUI Services (login item) - App Store Update - Screen Sharing
Non-GUI launchd agent	StandardIO	Runs only in non-GUI login sessions (i.e. SSH)
Per-user launchd agent	Background	Runs in context that is the parent of all contexts for a given user - mdworker (metadata)
Pre-login launchd agent	LoginWindow	Runs in the loginwindow context - Find My Mac

AUTORUNS: LAUNCH DAEMONS

- Daemon – Background System Process
- Location:
  - /System/Library/LaunchDaemons
  - /Library/LaunchDaemons

AUTORUNS: LAUNCH DAEMONS EXAMPLE



```
Fri Apr 13 03:15:00 EDT 2012

Removing old temporary files:

Cleaning out old system announcements:

Removing stale files from /var/rwho:

Removing scratch fax files

Disk status:
Filesystem                          Size   Used  Avail Capac
/dev/disk1                         698Gi  431Gi  267Gi    62
localhost:/YNU-3NIWZFYxg8rbEqggLJ  698Gi  698Gi    0Bi   100

Network interface status:
Name  Mtu   Network       Address            Ipkts Ierrs     
lo0   16384 <Link#1>                        38376     0     
lo0   16384 localhost   fe80:1::1           38376     -     
lo0   16384 127           localhost         38376     -    38376     -     -
lo0   16384 ip6-localho ::1                 38376     -    38376     -     -
gif0* 1280  <Link#2>                            0     0        0     0     0
stf0* 1280  <Link#3>                            0     0        0     0     0
en0   1500  <Link#4>    c4:2c:03:09:ca:fd       0     0        0     0     0
en1   1500  <Link#5>    90:27:e4:f8:e6:5f 37611065     0 105742931     0     0
en1   1500  bit.local   fe80:5::9227:e4ff 37611065     - 105742931     -     -
en1   1500  192.168.1     bit              37611065     - 105742931     -     -
fw0   4078  <Link#6>    e8:06:88:ff:fe:d5:5d:08         0     0        0     0     0
p2p0  2304  <Link#7>    02:27:e4:f8:e6:5f       0     0        0     0     0
vmnet 1500  <Link#8>    00:50:56:c0:00:01       0     0        0     0     0
vmnet 1500  172.16.73/24  172.16.73.1           0     -        0     -     -
vmnet 1500  <Link#9>    00:50:56:c0:00:08       0     0        0     0     0
vmnet 1500  192.168.158   192.168.158.1         0     -        0     -     -

Local system status:
 3:15  up 3 days,  8:06, 4 users, load averages: 0.55 0.57 0.56

-- End of daily output --
```

Key	Type	Value
Label	String	com.apple.periodic-daily
▼ ProgramArguments	Array	(2 items)
Item 0	String	/usr/sbin/periodic
Item 1	String	daily
LowPriorityIO	Boolean	YES
Nice	Number	1
▼ StartCalendarInterval	Diction…	(2 items)
Hour	Number	3
Minute	Number	15
AbandonProcessGroup	Boolean	YES

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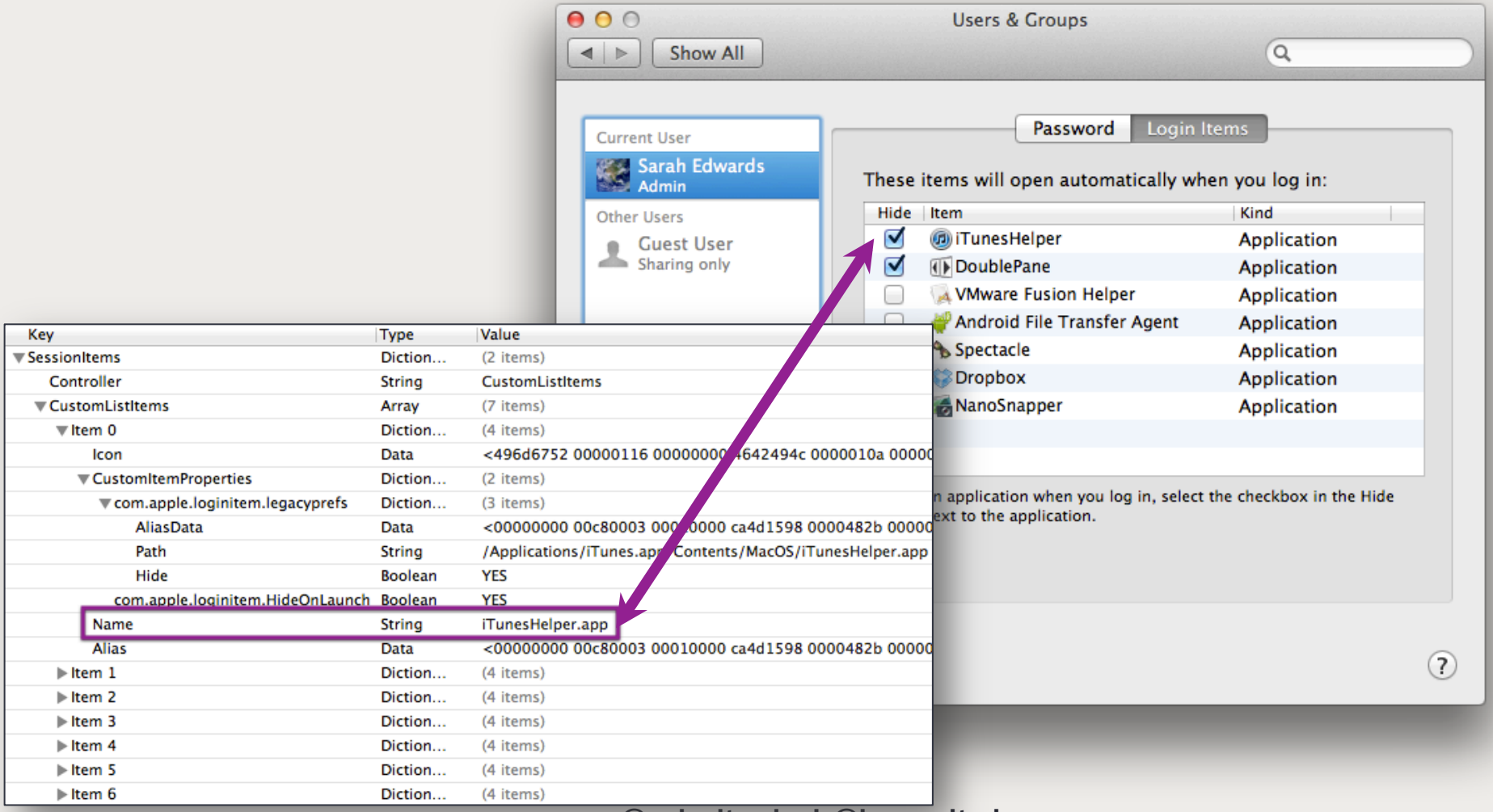
AUTORUNS: LOGIN ITEMS

- Launched when user logs into system via GUI
- Location:
  - ~/Library/Preferences/com.apple.loginitems.plist
  - <application>.app/Contents/Library/LoginItems/

AUTORUNS: LOGIN ITEMS EXAMPLE



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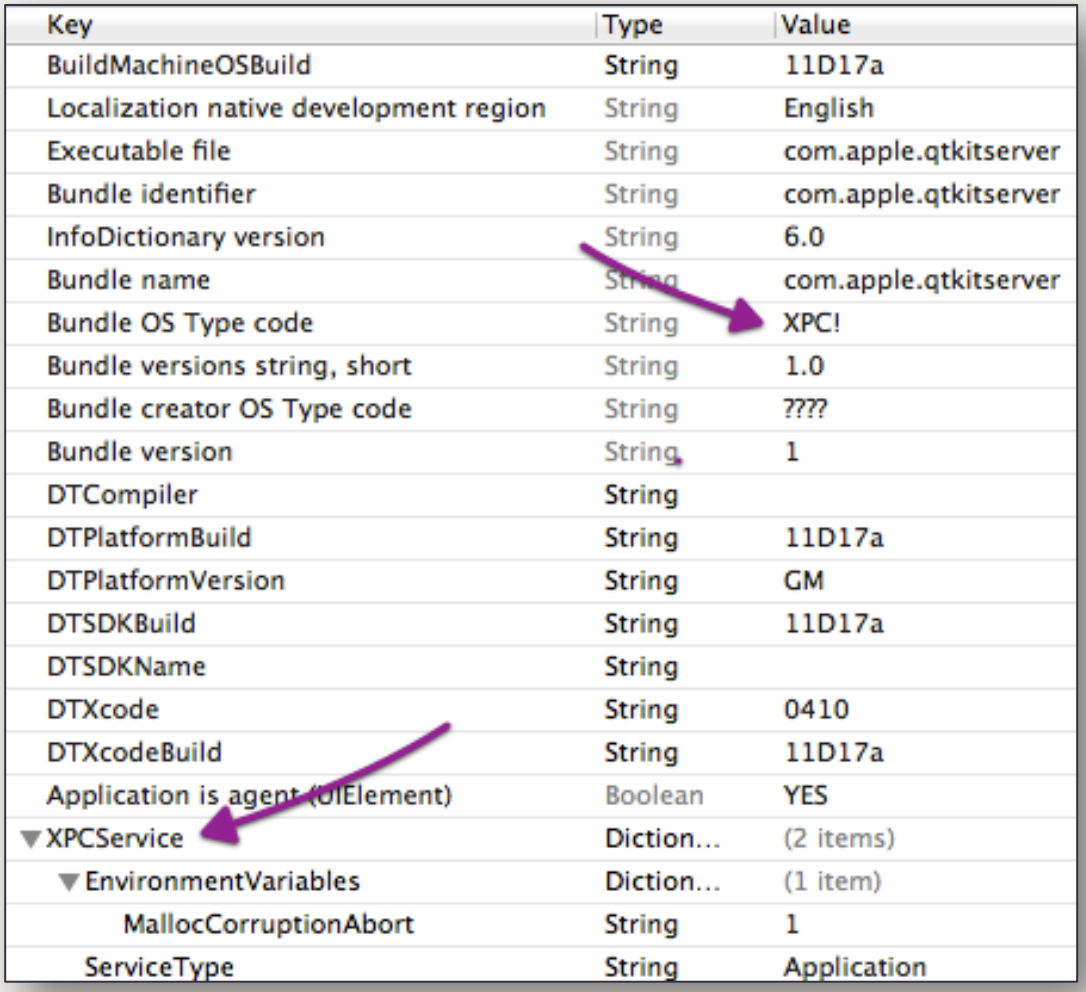
AUTORUNS: XPC SERVICES

- Privilege Separation & Stability
- Sandboxed Environment
- Runs in user context
- Services a single application
- Location:
  - Application Bundle: /Contents/XPCServices/
  - /System/Library/XPCServices/

AUTORUNS: XPC SERVICES EXAMPLE



Key	Type	Value
BuildMachineOSBuild	String	11D17a
Localization native development region	String	English
Executable file	String	com.apple.qtkitserver
Bundle identifier	String	com.apple.qtkitserver
InfoDictionary version	String	6.0
Bundle name	String	com.apple.qtkitserver
Bundle OS Type code	String	XPC!
Bundle versions string, short	String	1.0
Bundle creator OS Type code	String	????
Bundle version	String	1
DTCompiler	String	
DTPlatformBuild	String	11D17a
DTPlatformVersion	String	GM
DTSDKBuild	String	11D17a
DTSDKName	String	
DTXcode	String	0410
DTXcodeBuild	String	11D17a
Application is agent (UIElement)	Boolean	YES
▼ XPCService	Diction…	(2 items)
▼ EnvironmentVariables	Diction…	(1 item)
MallocCorruptionAbort	String	1
ServiceType	String	Application

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AUTORUNS: DEPRECATED METHODS

/etc/crontab	• Still supported, not recommended
Login/Logout Hooks **Deprected as of 10.6**	• Run as root • com.apple.loginwindow.plist – LoginHook/LogoutHook Keys
Startup Item **Deprecated as of 10.4**	• /Library/StartupItems • /System/Library/StartupItems
mach_init Daemon **Deprecated as of 10.5**	• Property List File in /etc/mach_init.d
mach_init Agent **Deprecated as of 10.5**	• Property List file in /etc/mach_init_per_user.d/
inetd/xinetd Daemon **Deprecated as of 10.4**	• Line in /etc/inetd.conf • Config file in /etc/xinetd.d/
System Login Item **Deprecated as of 10.5**	• Replaced with pre-login launchd agent.

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AUTORUNS: MALWARE EXAMPLES

Flashback	• ~/Library/LaunchAgents/com.java.update.plist • References .jupdate in user's home directory.
Imuler	• ~/Library/LaunchAgents/checkvir.plist • References checkvir file in same directory.
SabPub	• ~/Library/LaunchAgents/com.apple.PubSabAgent.plist • References ~/Library/Preferences/ com.apple.PubSabAgent.pfile
MacControl	• ~/Library/LaunchAgents/com.apple.FolderActionsxl.plist • References ~/Library/launched • "MacKontrol"
KitM	• Login Item to start macs.app Application

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INTERNET HISTORY

What

- Browsers
  - Safari
  - Chrome
  - FireFox

Why

- Temporary Internet Files
- Cache Files
- Downloads
- Search History

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INTERNET HISTORY: PREFERENCES

Safari

- ~/Library/Preferences/com.apple.Safari.plist
- Default Downloads Directory
- Recent Searches

Chrome

- ~/Library/Application Support/Google/Chrome/Default/Preferences
- JSON Formatted File
- Downloads Directory in “download” section

Firefox

- ~/Library/Application Support/Firefox/Profiles/********.default/prefs.js
  - "browser.download.dir”

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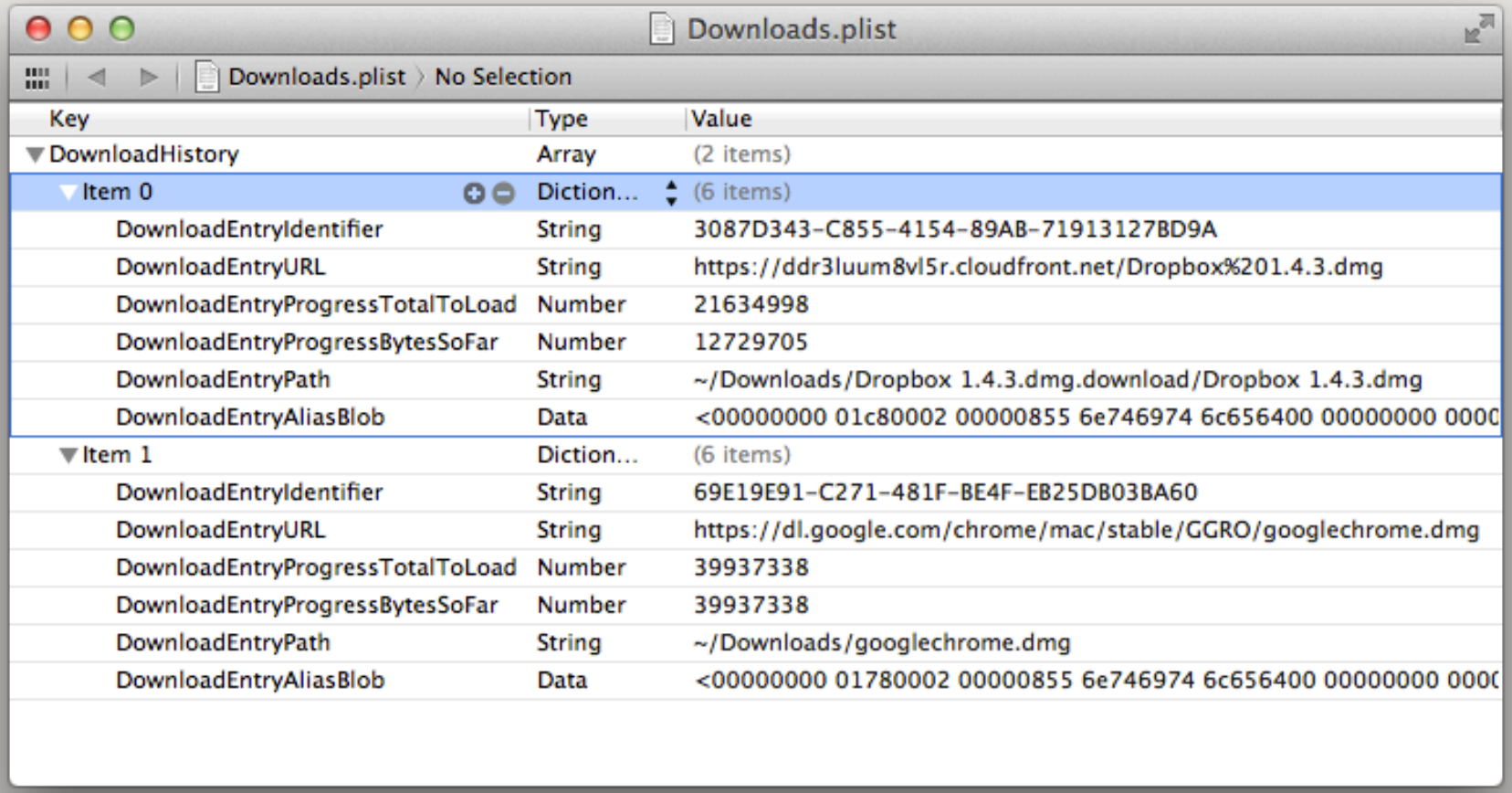
INTERNET HISTORY: SAFARI - DOWNLOADS

- ~/Library/Safari/Downloads.plist



Key	Type	Value
▼DownloadHistory	Array	(2 items)
▼Item 0	Diction…	(6 items)
DownloadEntryIdentifier	String	3087D343-C855-4154-89AB-71913127BD9A
DownloadEntryURL	String	https://ddr3luum8vl5r.cloudfront.net/Dropbox%201.4.3.dmg
DownloadEntryProgressTotalToLoad	Number	21634998
DownloadEntryProgressBytesSoFar	Number	12729705
DownloadEntryPath	String	~/Downloads/Dropbox 1.4.3.dmg.download/Dropbox 1.4.3.dmg
DownloadEntryAliasBlob	Data	<00000000 01c80002 00000855 6e746974 6c656400 00000000 0000
▼Item 1	Diction…	(6 items)
DownloadEntryIdentifier	String	69E19E91-C271-481F-BE4F-EB25DB03BA60
DownloadEntryURL	String	https://dl.google.com/chrome/mac/stable/GGRO/googlechrome.dmg
DownloadEntryProgressTotalToLoad	Number	39937338
DownloadEntryProgressBytesSoFar	Number	39937338
DownloadEntryPath	String	~/Downloads/googlechrome.dmg
DownloadEntryAliasBlob	Data	<00000000 01780002 00000855 6e746974 6c656400 00000000 0000

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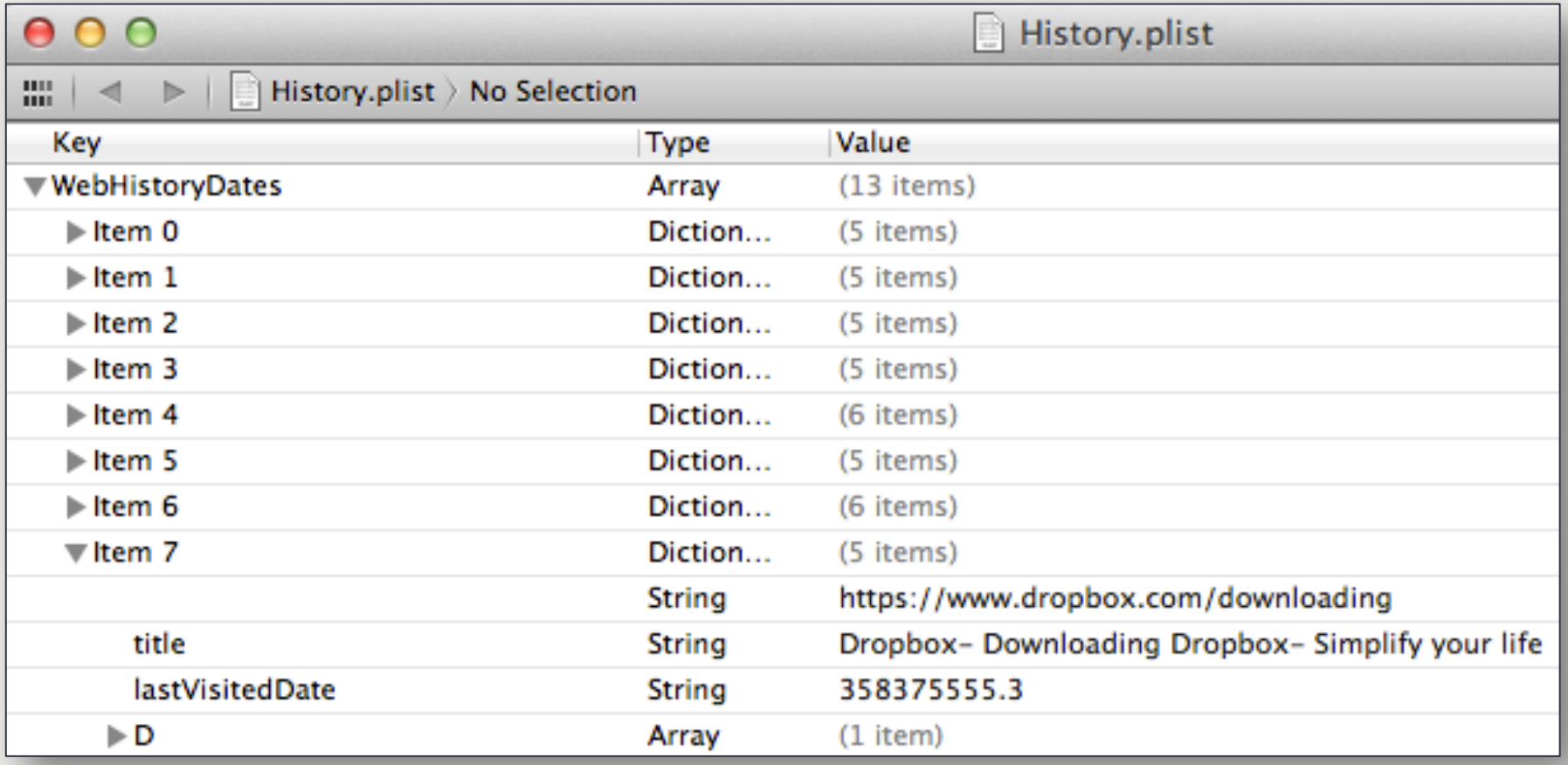
INTERNET HISTORY: SAFARI - HISTORY

- ~/Library/Safari/History.plist



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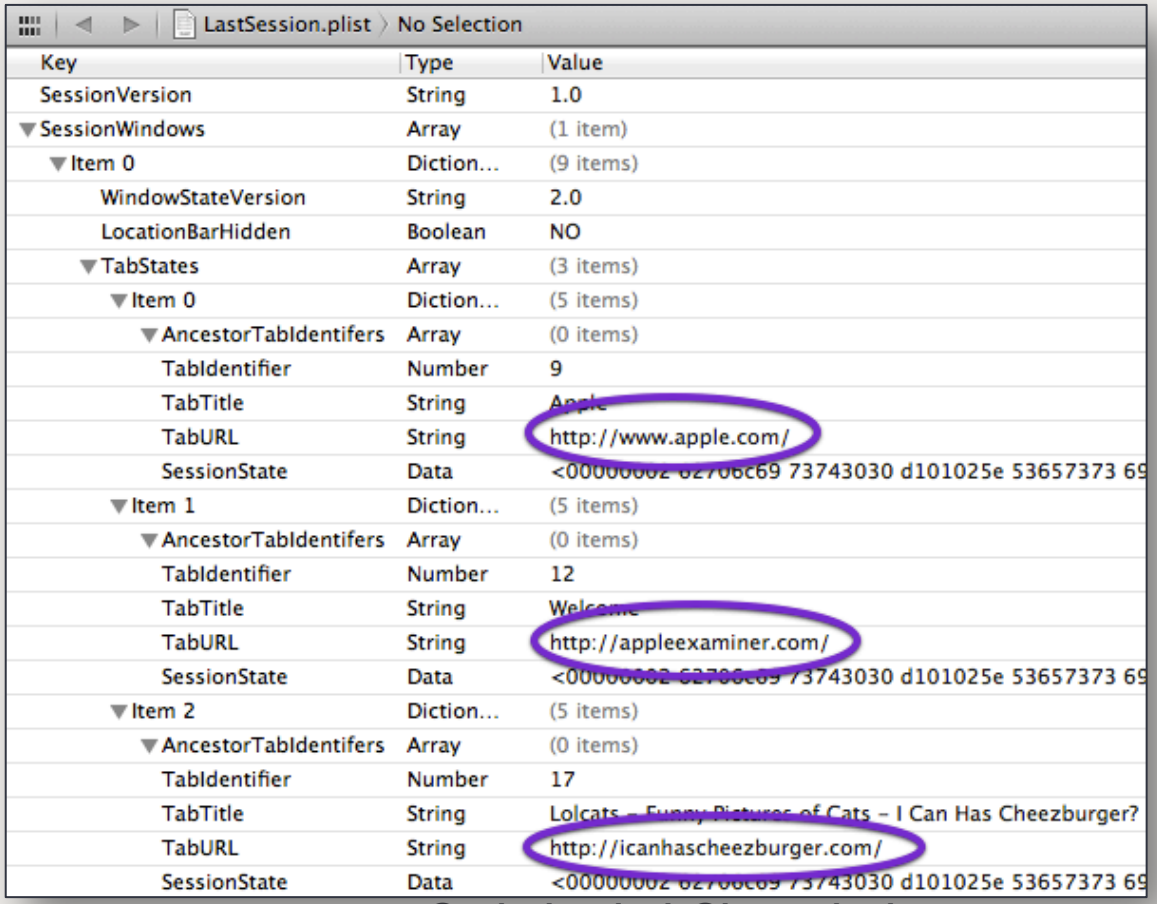
INTERNET HISTORY: SAFARI – LAST SESSION

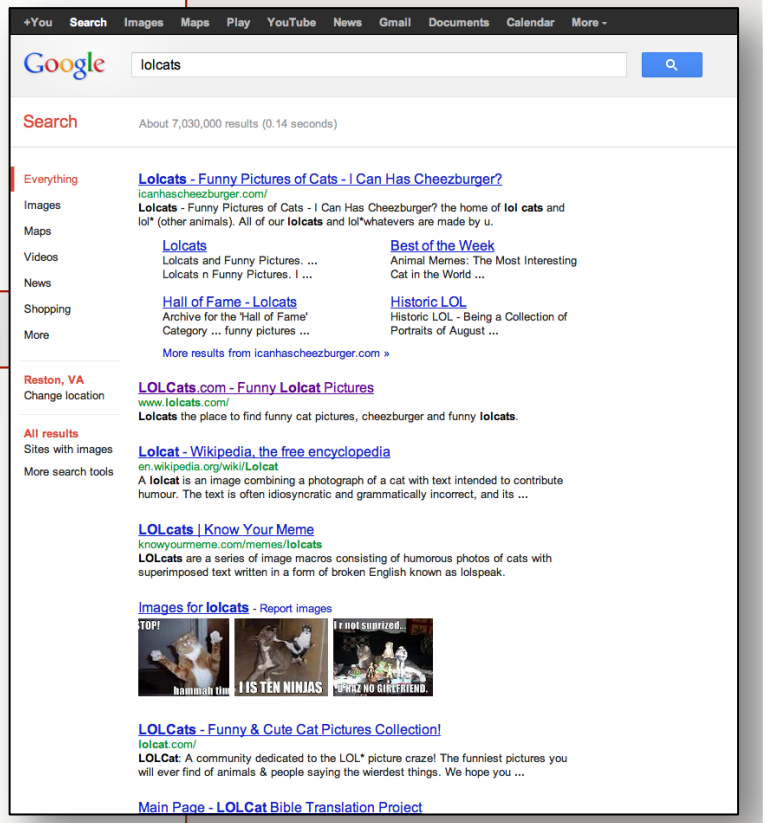
- ~/Library/Safari/LastSession.plist



INTERNET HISTORY: SAFARI - CACHE

~/Library/Caches/com.apple.Safari/Webpage Previews/

- Directory containing JPEG & PNG images of webpages.
- May be used to see a webpage taken from a snapshot in time.



~/Library/Caches/com.apple.Safari/Cache.db

- SQLite Database
- Download Cache Files
- Originating Location
- Download Date
- May contain evidence of:
  - Malicious code, redirects, phishing, etc.

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INTERNET HISTORY: CHROME – INTERNET HISTORY

~/Library/Application Support/Google/Chrome/Default/History

- SQLite Database

History

- ‘urls’ Table
- ‘visits’ Table

Downloads

- ‘downloads’ Table

Search History

- ‘keyword_search_terms’ Table

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INTERNET HISTORY: CHROME - CACHE

- ~/Library/Caches/Google/Chrome/Default/Cache/
  - “data_#” index – “Chromium Disk Cache”

```
bit:Cache oompa$ pwd
/Users/oompa/Library/Caches/Google/Chrome/Default/Cache
bit:Cache oompa$ file * | more
data_0:   data
data_1:   data
data_2:   data
data_3:   data
data_4:   data
f_00000b: gzip compressed data, was "hs.base.js", from Unix, last modified: Thu May 10 14:40:25 2012
f_00000c: gzip compressed data, was "dashboard.css", from Unix, last modified: Thu May 10 14:40:16
2012
f_00000d: gzip compressed data, was "hs.dashboard.js", from Unix, last modified: Thu May 10 14:41:14
2012
f_00000e: PNG image data, 119 x 608, 8-bit/color RGBA, non-interlaced
f_00000f: gzip compressed data, was "hs.dependencies.streams.js", from Unix, last modified: Thu May 10
14:42:20 2012
f_000010: HTML document text
f_000011: PNG image data, 214 x 224, 8-bit/color RGBA, non-interlaced
f_000012: gzip compressed data, was "staticlegacy.css", from Unix, last modified: Thu May 10 14:41:05
2012
f_000014: JPEG image data, JFIF standard 1.01
```

INTERNET HISTORY: CHROME - CACHE

- ~/Library/Caches/Google/Chrome/Default/Media Cache/
  - “data_#” index – “Chromium Disk Cache”

```
bit:Media Cache oompa$ pwd
/Users/oompa/Library/Caches/Google/Chrome/Default/Media Cache
bit:Media Cache oompa$ file * | more
data_0:   data
data_1:   data
data_2:   data
data_3:   data
f_000001: ISO Media, MPEG v4 system, version 1
f_000002: data
f_000003: data
f_000004: data
f_000005: ISO Media, MPEG v4 system, version 1
f_000006: data
f_000007: data
f_000008: data
f_000009: ISO Media, MPEG v4 system, version 1
```

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INTERNET HISTORY:
FIREFOX - INTERNET HISTORY

History

- ~/Library/Application Support/Firefox/Profiles/********.default/places.sqlite
- SQLite Database File
- 'moz_places' Table
- 'moz_historyvisits' Table

Downloads

- ~/Library/Application Support/Firefox/Profiles/********.default/downloads.sqlite
- SQLite Database – Contains one table
- 'moz_downloads' Table

Search History

- ~/Library/Application Support/Firefox/Profiles/********.default/formhistory.sqlite
- SQLite Database – Contains one table
- 'moz_formhistory' Table
- fieldname = "searchbar-history"

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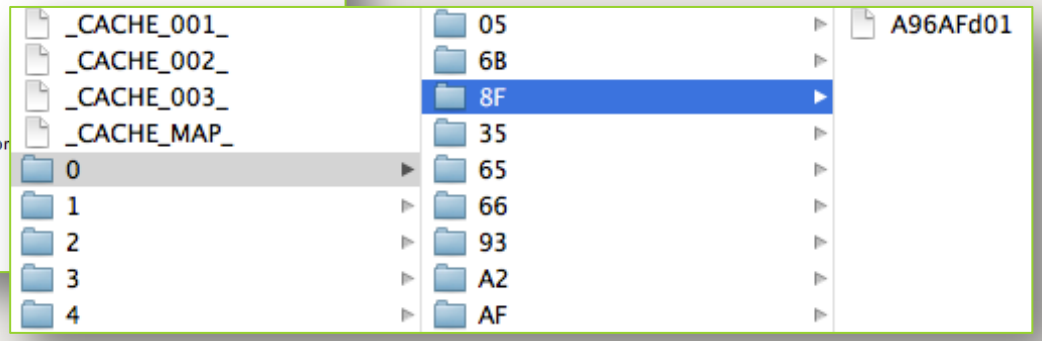
INTERNET HISTORY: FIREFOX - CACHE

- ~/Library/Caches/Firefox/Profiles/********.default/Cache
  - “CACHE MAP” format

```
bit:Cache oompa$ find . * -exec file {} \; | more
.: directory
./0: directory
./0/05: directory
./0/05/B124Bd01: JPEG image data, JFIF standard 1.01
./0/35: directory
./0/35/C4EDDd01: JPEG image data, JFIF standard 1.01
./0/65: directory
./0/65/A921Cd01: gzip compressed data, from Unix
./0/66: directory
./0/66/D444Ad01: JPEG image data, JFIF standard 1.01, comment: "CREATOR: gd-jpeg v1.0 (using IJ"
./0/6B: directory
./0/6B/CDF64d01: JPEG image data, JFIF standard 1.01
./0/8F: directory
./0/8F/A96AFd01: JPEG image data, JFIF standard 1.02
./0/93: directory
./0/93/5A4B5d01: JPEG image data, JFIF standard 1.01
./0/A2: directory
./0/A2/73A06d01: PNG image data, 558 x 465, 8-bit colormap, nor
./0/AF: directory
./0/AF/97F69d01: JPEG image data, JFIF standard 1.01
./0/C6: directory
./0/C6/4F237d01: JPEG image data, JFIF standard 1.01
./0/C8: directory
./0/C8/DB6A1d01: JPEG image data, EXIF standard
```



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EMAIL

What

- Apple Mail

Why

- Malicious Attachments
- Phishing
- Data Exfiltration

EMAIL:
APPLE MAIL

- ~/Library/Mail/V2/MailData/
  - Accounts.plist – Mail Account Information

Key	Type	Value
AccountsVersion	Number	6
▶ DeliveryAccounts	Array	(2 items)
▼ MailAccounts	Array	(4 items)
▶ Item 0	Diction…	(8 items)
▼ Item 1	Diction…	(25 items)
AccountName	String	CSH
AccountPath	String	~/Library/Mail/V2/IMAP-oompa@mail.csh.rit.edu
AccountType	String	IMAPAccount

EMAIL: APPLE MAIL

- Directories for each email account.
  - Nested messages and attachment directories.
  - File Types: mbox & emlx
- Mailboxes
  - ~/Library/Mail/V2/

```
Attachments//435/1.2:
total 32
drwxr-xr-x  3 oompa  staff    102 May 10 16:55 .
drwxr-xr-x  5 oompa  staff    170 May 10 16:55 ..
-rw-r--r--@ 1 oompa  staff  13524 May 10 16:55 image001.jpg

Attachments//435/1.3:
total 32
drwxr-xr-x  3 oompa  staff    102 May 10 16:55 .
drwxr-xr-x  5 oompa  staff    170 May 10 16:55 ..
-rw-r--r--@ 1 oompa  staff  15868 May 10 16:55 image002.png
```

```
bit:Data oompa$ pwd
/Users/oompa/Library/Mail/V2/IMAP-oompa@mail.csh.rit.edu/INBOX.mbox/0223CBB8-8F52-487D-9F90-C87F2F6701C4/Data
bit:Data oompa$ ls -la
total 16
drwx------   11 oompa  staff    374 May 17 21:37 .
drwx------    4 oompa  staff    136 May 17 21:37 ..
-rw-r--r--@   1 oompa  staff   6148 May 17 21:38 .DS_Store
drwx------    3 oompa  staff    102 May 10 19:36 0
drwx------    5 oompa  staff    170 May 22 21:07 1
drwx------    4 oompa  staff    136 May 10 16:55 2
drwx------    4 oompa  staff    136 May 10 16:56 3
drwx------    4 oompa  staff    136 May 10 16:56 4
drwxr-xr-x    3 oompa  staff    102 May 10 17:10 6
drwxr-xr-x   54 oompa  staff   1836 May 17 21:37 Attachments
drwx------  990 oompa  staff  33660 May 28 14:46 Messages
```

EMAIL:
APPLE MAIL - ATTACHMENTS

"Saved"

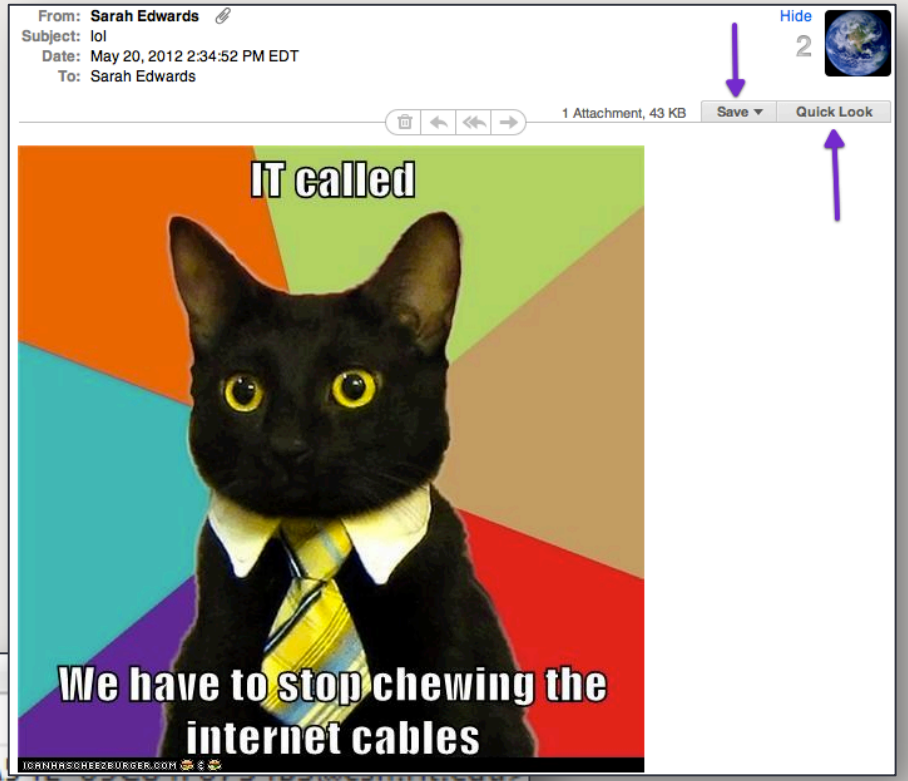
- ~/Downloads

"QuickLook"

- ~/Library/Mail Downloads/

Metadata

- ~/Library/Mail/V2/MailData/OpenAttachments.plist



Key	Type	Value
▼ Item 0	Diction...	(5 items)
MessageID	String	<F86B9649-1F9A-4779-A
ModDate	Date	May 12, 2012 5:04:13 PM
OpenedDate	Date	May 12, 2012 5:04:13 PM
PartNumber	String	2
Path	String	/Users/oompa/Library/Mail Downloads/photo.JPG

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TEMPORARY & CACHE DIRECTORIES

What

- Temporary Directories
- Java Cache

Why

- Remnants of Malicious Files
- Flashback used temp and Java Cache directories

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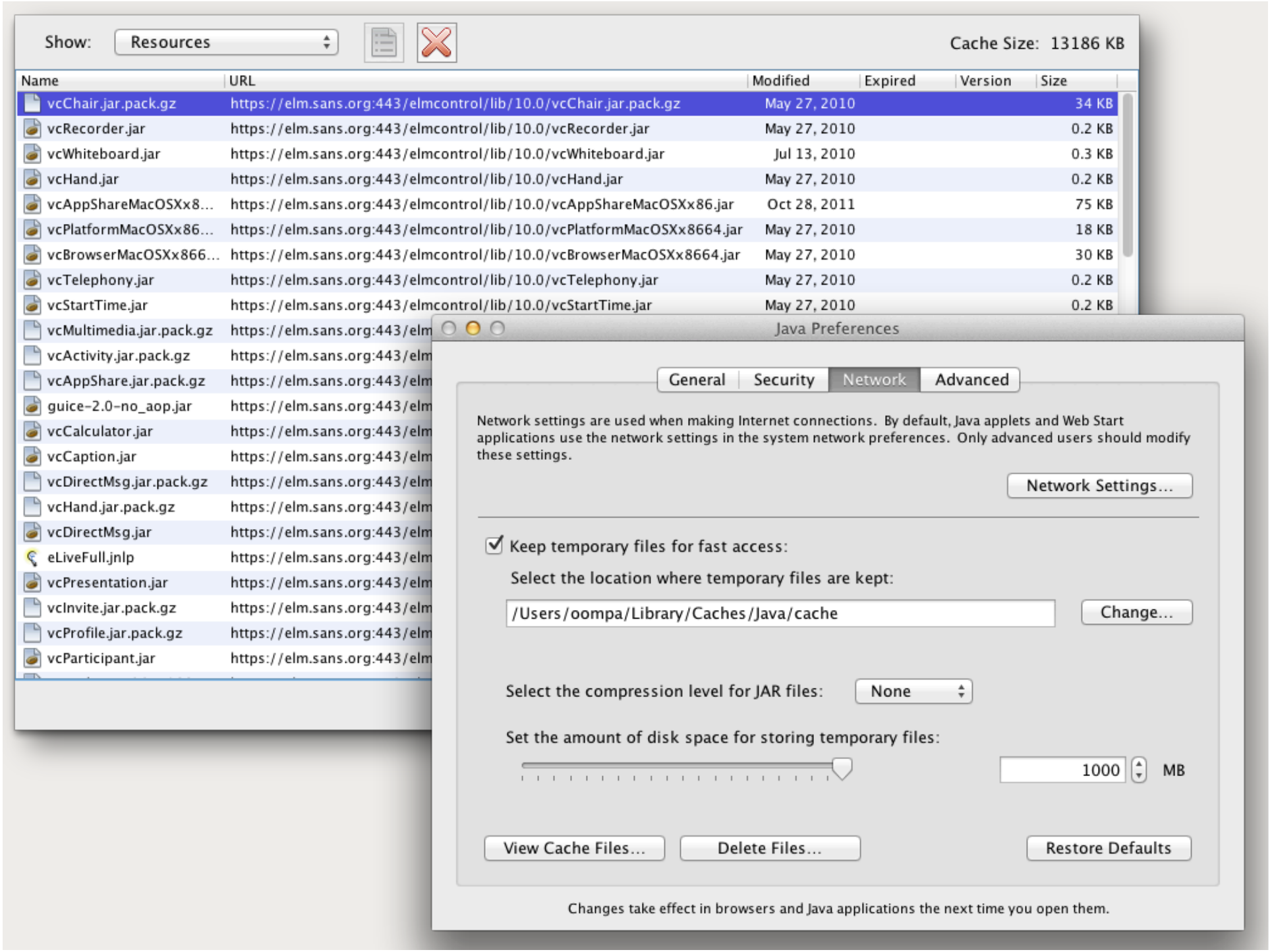
TEMP & CACHE DIRECTORIES: /TMP, JAVA TEMP & CACHE

- /tmp & /var/tmp
- /Users/<user>/Library/Caches/Java/tmp
- /Users/<user>/Library/Caches/Java/cache
  - IDX, JAR Files
  - Open Cache in /Applications/Utilities/Java Preferences.app


Show: Resources
Cache Size: 13186 KB
Name URL Modified Expired Version Size
vcChair.jar.pack.gz https://elm.sans.org:443/elmcontrol/lib/10.0/vcChair.jar.pack.gz May 27, 2010 34 KB
vcRecorder.jar https://elm.sans.org:443/elmcontrol/lib/10.0/vcRecorder.jar May 27, 2010 0.2 KB
vcWhiteboard.jar https://elm.sans.org:443/elmcontrol/lib/10.0/vcWhiteboard.jar Jul 13, 2010 0.3 KB
vcHand.jar https://elm.sans.org:443/elmcontrol/lib/10.0/vcHand.jar May 27, 2010 0.2 KB
vcAppShareMacOSXx8... https://elm.sans.org:443/elmcontrol/lib/10.0/vcAppShareMacOSXx86.jar Oct 28, 2011 75 KB
vcPlatformMacOSXx86... https://elm.sans.org:443/elmcontrol/lib/10.0/vcPlatformMacOSXx8664.jar May 27, 2010 18 KB
vcBrowserMacOSXx866... https://elm.sans.org:443/elmcontrol/lib/10.0/vcBrowserMacOSXx8664.jar May 27, 2010 30 KB
vcTelephony.jar https://elm.sans.org:443/elmcontrol/lib/10.0/vcTelephony.jar May 27, 2010 0.2 KB
vcStartTime.jar https://elm.sans.org:443/elmcontrol/lib/10.0/vcStartTime.jar May 27, 2010 0.2 KB
vcMultimedia.jar.pack.gz https://elm.sans.org:443/elm
vcActivity.jar.pack.gz https://elm.sans.org:443/elm
vcAppShare.jar.pack.gz https://elm.sans.org:443/elm
guice-2.0-no_aop.jar https://elm.sans.org:443/elm
vcCalculator.jar https://elm.sans.org:443/elm
vcCaption.jar https://elm.sans.org:443/elm
vcDirectMsg.jar.pack.gz https://elm.sans.org:443/elm
vcHand.jar.pack.gz https://elm.sans.org:443/elm
vcDirectMsg.jar https://elm.sans.org:443/elm
eLiveFull.jnlp https://elm.sans.org:443/elm
vcPresentation.jar https://elm.sans.org:443/elm
vcInvite.jar.pack.gz https://elm.sans.org:443/elm
vcProfile.jar.pack.gz https://elm.sans.org:443/elm
vcParticipant.jar https://elm.sans.org:443/elm
Java Preferences
General Security Network Advanced
Network settings are used when making Internet connections. By default, Java applets and Web Start applications use the network settings in the system network preferences. Only advanced users should modify these settings.
Network Settings...
Keep temporary files for fast access:
Select the location where temporary files are kept:
/Users/oompa/Library/Caches/Java/cache
Change...
Select the compression level for JAR files:
None
Set the amount of disk space for storing temporary files:
1000
MB
View Cache Files...
Delete Files...
Restore Defaults
Changes take effect in browsers and Java applications the next time you open them.

JAVA TEMP & CACHE: IDX FILE CONTENTS

```
0000000: 0000 0000 025b 0000 0000 0000 0000 0001  .....[..........
0000010: 28d8 2ea8 4000 0000 0000 0000 0000 0000  (...@...........
0000020: 0000 0000 0000 0000 00ac 0000 0000 0000  ................
0000030: 0000 0000 0000 0000 0136 9959 1234 0000  .........6.Y.4..
0000040: 0000 0000 0000 0000 0000 0000 0000 0000  ................
0000050: 0000 0000 0000 0000 0000 0000 0136 9959  .............6.Y
0000060: 1234 0000 0000 0000 0000 0000 0000 0000  .4..............
0000070: 0000 0000 0000 0000 0000 0000 0000 0000  ................
0000080: 0000 003a 6874 7470 733a 2f2f 656c 6d2e  ...:https://elm.
0000090: 7361 6e73 2e6f 7267 3a34 3433 2f65 6c6d  sans.org:443/elm
00000a0: 636f 6e74 726f 6c2f 6c69 622f 3130 2e30  control/lib/10.0
00000b0: 2f76 6343 6170 7469 6f6e 2e6a 6172 0000  /vcCaption.jar..
00000c0: 000b 3636 2e33 352e 3435 2e35 3000 0000  ..66.35.45.50...
00000d0: 0200 063c 6e75 6c6c 3e00 0333 3032 0008  ...<null>..302..
00000e0: 4c6f 6361 7469 6f6e 0042 6874 7470 733a  Location.Bhttps:
00000f0: 2f2f 656c 6d2e 7361 6e73 2e6f 7267 3a34  //elm.sans.org:4
0000100: 3433 2f65 6c6d 636f 6e74 726f 6c2f 6c69  43/elmcontrol/li
0000110: 622f 3130 2e30 2f76 6343 6170 7469 6f6e  b/10.0/vcCaption
0000120: 2e6a 6172 2e70 6163 6b2e 677a            .jar.pack.gz
```

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BRIAN BASKIN'S (@BBASKIN) IDX PARSER

- https://github.com/Rurik/Java_IDX_Parser
- Windows Executable
- or…
- Python Script!

```
nibble:CEIC2013 sledwards$ python idx_parser.py 68b1b3cd-5249d485.idx
Java IDX Parser -- version 1.3 -- by @bbaskin

IDX file: 68b1b3cd-5249d485.idx (IDX File Version 6.03)

[*] Section 2 (Download History) found:
URL: http://192.168.1.134/adobe.jar
IP: 192.168.1.134
<null>: HTTP/1.1 200 OK
content-length: 1124562
last-modified: Fri, 07 Dec 2012 05:21:22 GMT
content-type: application/java-archive
date: Wed, 06 Mar 2013 21:23:11 GMT
server: Apache/2.2.22 (Unix) DAV/2 mod_ssl/2.2.22 OpenSSL/0.9.8r
deploy-request-content-type: application/x-java-archive

[*] Section 3 (Jar Manifest) found:
Manifest-Version: 1.0
Created-By: 1.6.0_24 (Sun Microsystems Inc.)

Name: WebEnhancer.class
SHA1-Digest: 55gPOWmd1lIgDYdOF2EXCTPRpyU=

Name: mac
SHA1-Digest: fvpEryer0UCRvrcUIOyvQTWj4Vs=

Name: win
SHA1-Digest: f6fErxOtG88SsYClqc8kYTSFYIw=
```

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TEMP & CACHE FILES: EXAMPLES

Flashback

- Mach-O Binary – /tmp/.sysenter
- Java Cache Files
  - rh-3.jar
  - cl-3.jar

Imuler

- /tmp/.mdworker
- /tmp/CurlUpload

MacControl

- /tmp/launch-hs – Bash Script
- /tmp/launch-hse - Malware
- /tmp/file.doc – Decoy Word Doc

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LOG ANALYSIS

What

- Apple System Logs
- Audit Logs
- Firewall Logs
- Install Logs

Why

- Suspicious Use
- Account Creation
- Super User Access
- External Volumes

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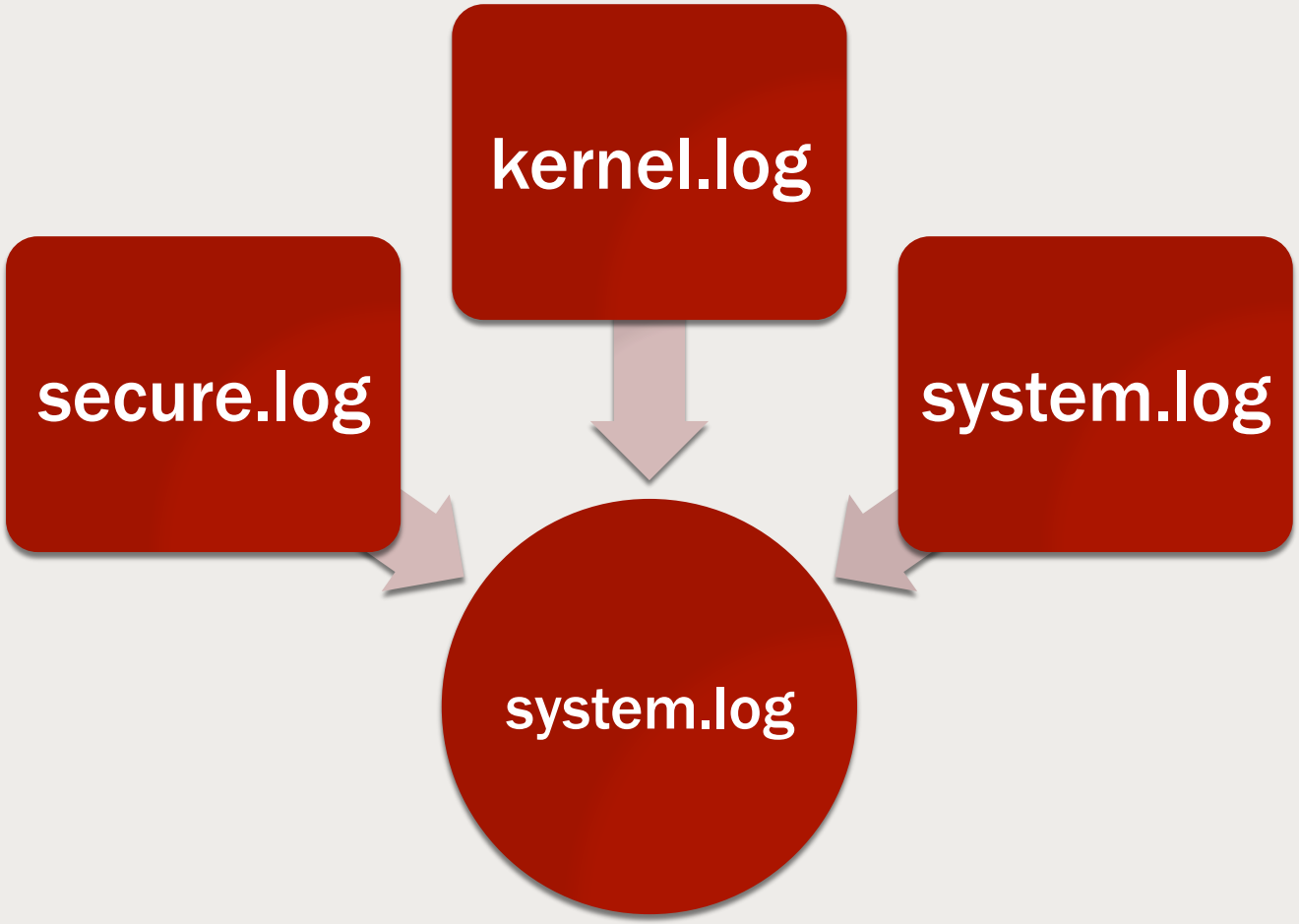
MAJOR LOG CHANGES IN 10.8



LOG ANALYSIS: APPLE SYSTEM LOGS

- Location: /private/var/log/asl/ (>10.5.6)
- syslog “replacement”
- View using Console.app or `syslog` command
- Filename Format: YYYY.MM.DD.[UID].[GID].asl

```
-rw-------+ 1 root  wheel  93522 May 22 23:45 2012.05.22.G80.asl
-rw-------+ 1 root  wheel   8696 May 22 23:45 2012.05.22.U0.G80.asl
-rw-------+ 1 root  wheel  24612 May 22 23:45 2012.05.22.U501.asl
-rw-------+ 1 root  wheel   3720 May 22 22:45 2012.05.22.U89.asl
-rw-------+ 1 root  wheel  87101 May 23 23:45 2012.05.23.G80.asl
-rw-------+ 1 root  wheel   9245 May 23 23:45 2012.05.23.U0.G80.asl
-rw-------  1 root  wheel    864 May 23 21:57 2012.05.23.U0.asl
-rw-------+ 1 root  wheel  18556 May 23 23:35 2012.05.23.U501.asl
-rw-------+ 1 root  wheel   5680 May 23 23:45 2012.05.23.U89.asl
-rw-------+ 1 root  wheel  92582 May 24 23:45 2012.05.24.G80.asl
-rw-------+ 1 root  wheel   9122 May 24 23:45 2012.05.24.U0.G80.asl
-rw-------+ 1 root  wheel  17707 May 24 23:28 2012.05.24.U501.asl
-rw-------+ 1 root  wheel   5680 May 24 23:45 2012.05.24.U89.asl
-rw-------+ 1 root  wheel  92416 May 25 23:45 2012.05.25.G80.asl
```

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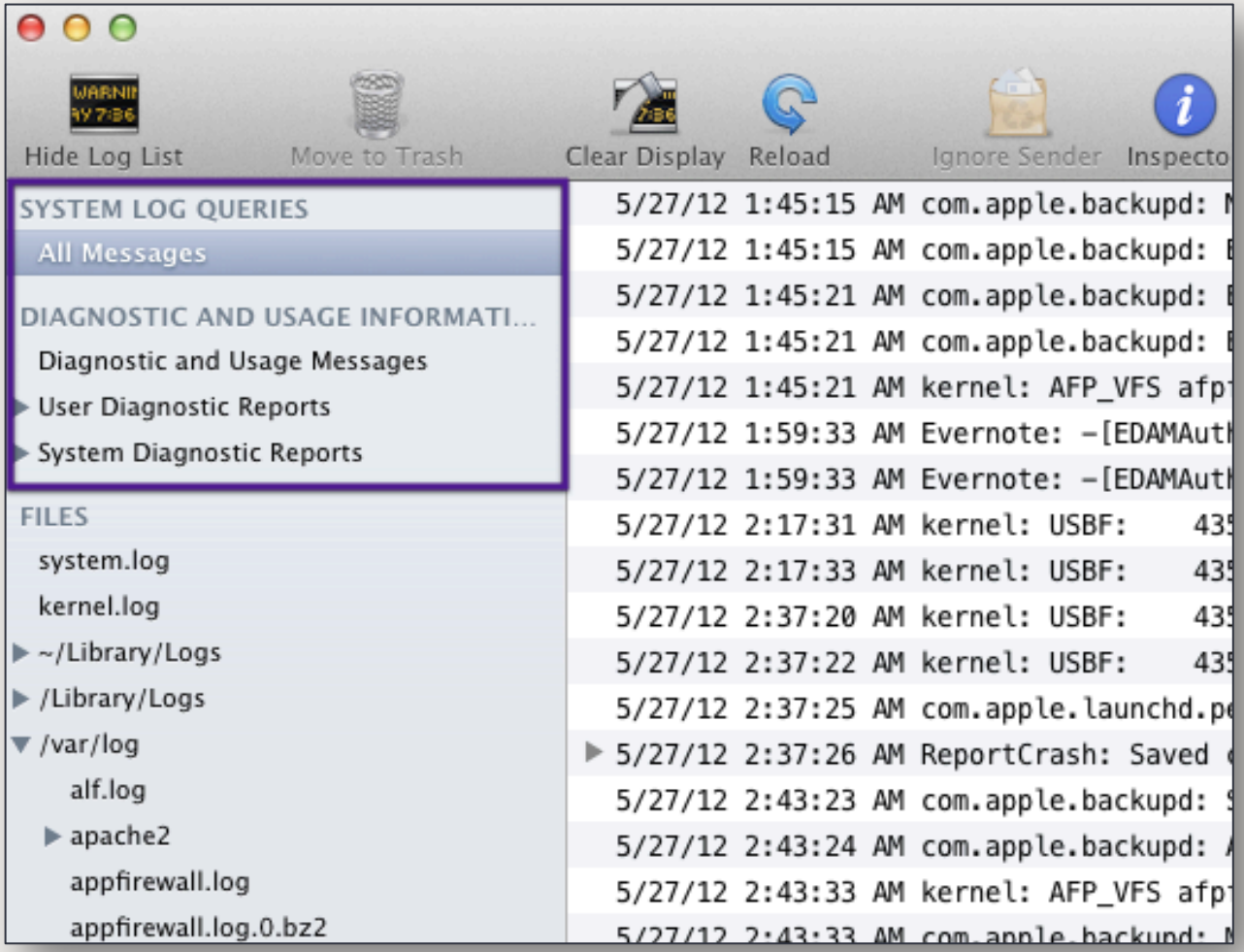
LOG ANALYSIS: CONSOLE.APP



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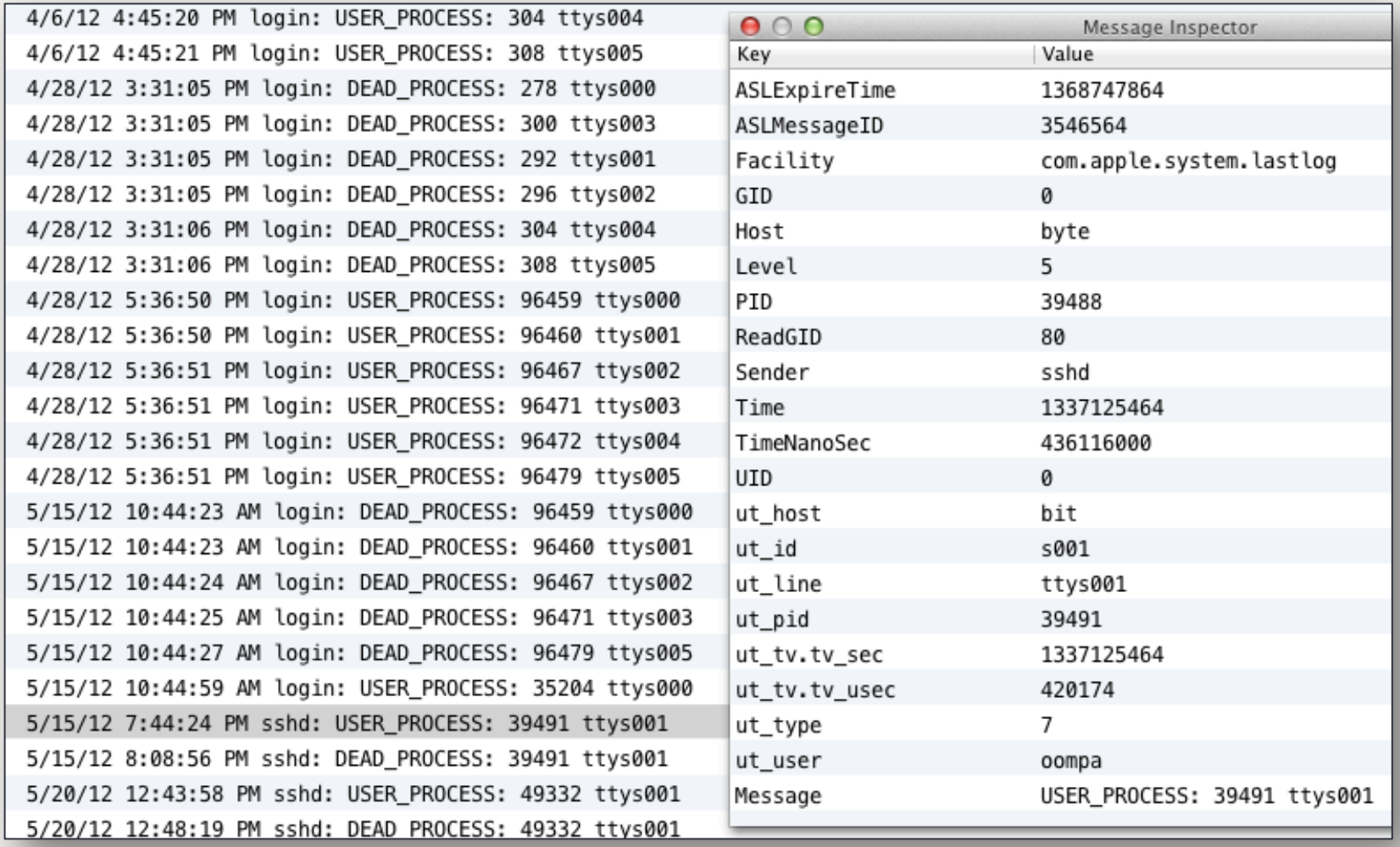
LOG ANALYSIS: CONSOLE.APP



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LOG ANALYSIS: SYSLOG COMMAND

- `syslog –d asl/`

```
sh-3.2# syslog -d asl/ | more
Mar 12 17:15:01 byte login[63585] <Notice>: USER_PROCESS: 63585 ttys003
Mar 15 01:41:32 byte login[48848] <Notice>: USER_PROCESS: 48848 ttys004
Mar 15 01:44:22 byte login[48905] <Notice>: USER_PROCESS: 48905 ttys005
Mar 15 01:52:19 byte login[48848] <Notice>: DEAD_PROCESS: 48848 ttys004
Mar 15 01:52:19 byte login[48905] <Notice>: DEAD_PROCESS: 48905 ttys005
Mar 15 01:52:21 byte login[48960] <Notice>: USER_PROCESS: 48960 ttys004
Mar 15 01:53:16 byte login[48960] <Notice>: DEAD_PROCESS: 48960 ttys004
Mar 15 01:53:18 byte login[50861] <Notice>: USER_PROCESS: 50861 ttys004
Mar 15 01:53:52 byte login[50861] <Notice>: DEAD_PROCESS: 50861 ttys004
Mar 15 01:53:53 byte login[52753] <Notice>: USER_PROCESS: 52753 ttys004
Mar 15 01:54:19 byte login[53625] <Notice>: USER_PROCESS: 53625 ttys005
```

LOG ANALYSIS:
SYSLOG —T UTC —F RAW —D /ASL

- [ASLMessageID 3555356]
- [Time 2012.05.28 19:39:32 UTC]
- [TimeNanoSec 887175000]
- [Level 5]
- [PID 908]
- [UID 0]
- [GID 20]
- [ReadGID 80]
- [Host byte]
- [Sender login]
- [Facility com.apple.system.utmpx]
- [Message DEAD_PROCESS: 908 ttys002]
- [ut_user oompa]
- [ut_id s002]
- [ut_line ttys002]
- [ut_pid 908]
- [ut_type 8]
- [ut_tv.tv_sec 1338233972]
- [ut_tv.tv_usec 886961]
- [ASLExpireTime 1369856372]

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LOG ANALYSIS: AUDIT LOGS

- Location: /private/var/audit/
- BSM Audit Logs
- StartTime.EndTime
- YYYYMMDDHHMMSS.YYYYMMDDHHMMSS

```
drwx------   8 root  wheel    272 May 28 15:22 .
drwxr-xr-x  29 root  wheel    986 May  9 21:39 ..
-r--r-----   1 root  wheel  48987 May 10 00:46 20120509232853.20120510044637
-r--r-----   1 root  wheel  57158 May 12 11:31 20120510204054.20120512153135
-r--r-----   1 root  wheel  92166 May 27 20:02 20120512153220.20120528000216
-r--r-----   1 root  wheel  20805 May 28 15:20 20120528000250.20120528192006
-r--r-----   1 root  wheel   4619 May 28 21:07 20120528192235.not_terminated
lrwxr-xr-x   1 root  wheel     40 May 28 15:22 current -> /var/audit/20120528192235.not_terminated
```

LOG ANALYSIS: PRAUDIT –XN /VAR/AUDIT/*

- su Example:

```
<record version="11" event="user authentication" modifier="0"
time="Mon May 28 21:12:51 2012" msec=" + 41 msec" >
<subject audit-uid="501" uid="0" gid="20" ruid="501" rgid="20"
pid="552" sid="100004" tid="552 0.0.0.0" />
<text>Verify password for record type Users &apos;root&apos; node
&apos;/Local/Default&apos;</text>
<return errval="success" retval="0" />
</record>

<record version="11" event="user authentication" modifier="0"
time="Mon May 28 21:12:55 2012" msec=" + 449 msec" >
<subject audit-uid="501" uid="0" gid="20" ruid="501" rgid="20"
pid="554" sid="100004" tid="554 0.0.0.0" />
<text>Verify password for record type Users &apos;root&apos; node
&apos;/Local/Default&apos;</text>
<return errval="failure: Unknown error: 255" retval="5000" />
</record>
```

LOG ANALYSIS: USER LOGINS / LOGOUTS

Local Terminal

```
•May 28 14:48:04 byte login[693]: USER_PROCESS: 693 ttys000
•May 28 14:48:07 byte login[698]: USER_PROCESS: 698 ttys001
•May 28 15:07:29 byte login[812]: USER_PROCESS: 812 ttys002
•May 28 15:07:51 byte login[812]: DEAD_PROCESS: 812 ttys002
```

Login Window

```
•May 28 12:42:23 byte loginwindow[66]: DEAD_PROCESS: 74 console
•May 28 14:28:04 byte loginwindow[66]: USER_PROCESS: 60 console
```

SSH

```
•May 28 15:15:38 byte sshd[831]: USER_PROCESS: 842 ttys002
•May 28 15:15:52 byte sshd[831]: DEAD_PROCESS: 842 ttys002
```

Screen Sharing

```
•5/28/12 3:31:33.675 PM screensharingd: Authentication:
 SUCCEEDED :: User Name: Sarah Edwards :: Viewer Address:
 192.168.1.101 :: Type: DH
```

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LOG ANALYSIS MONTHLY.OUT

- Account Audit
- Monthly
- Uses `ac -p` command to calculate account time on system.
- "Accumulated connected time in decimal hours"

```
-- End of monthly output --

Wed Apr  4 09:15:54 EDT 2012

Rotating fax log files:

Doing login accounting:
     total     3678.85
     sledwards  3678.76
     root         0.09

-- End of monthly output --

Tue May  1 05:30:00 PDT 2012

Rotating fax log files:

Doing login accounting:
     total     4301.95
     sledwards  4301.77
     root         0.18

-- End of monthly output --

Fri Jun  1 06:46:13 PDT 2012

Rotating fax log files:

Doing login accounting:
     total     5047.22
     sledwards  5047.04
     root         0.18

-- End of monthly output --
```

LOG ANALYSIS: PRIVILEGE ESCALATION

su

- `5/27/12 8:54:21.646 PM su: BAD SU oompa to root on /dev/ttys001`
- `5/28/12 8:57:44.032 PM su: oompa to root on /dev/ttys000`

sudo

- `5/27/12 8:48:15.790 PM sudo: oompa : TTY=ttys000 ; PWD=/Users/oompa/Documents ; USER=root ; COMMAND=/usr/bin/iosnoop`

LOG ANALYSIS: ACCOUNT CREATION

Audit Logs

- <record version="11" event="create user" modifier="0" time="Mon May 28 21:25:49 2012" msec=" + 677 msec" >
  <subject audit-uid="501" uid="501" gid="20" ruid="501" rgid="20" pid="585" sid="100004" tid="585 0.0.0.0" />
  <text>Create record type Users 'supersecretuser' node '/Local/Default'</text>
  <return errval="success" retval="0" />
  </record>

secure.log

- May 28 21:25:22 bit com.apple.SecurityServer[24]: UID 501 authenticated as user oompa (UID 501) for right 'system.preferences.accounts'

LOG ANALYSIS: FIREWALL LOGS

- Location: /private/var/log/appfirewall.log

```
May 28 21:58:22 bit Firewall[81]: Stealth Mode connection attempt to
UDP 192.168.1.101:31365 from 192.168.1.100:57188
May 28 21:58:22 bit Firewall[81]: Stealth Mode connection attempt to
UDP 192.168.1.101:3702 from 192.168.1.100:57188
May 28 21:58:22 bit Firewall[81]: Stealth Mode connection attempt to
UDP 192.168.1.101:48189 from 192.168.1.100:57188
May 28 21:58:22 bit Firewall[81]: Stealth Mode connection attempt to
UDP 192.168.1.101:27899 from 192.168.1.100:57188
May 28 21:58:22 bit Firewall[81]: Stealth Mode connection attempt to
UDP 192.168.1.101:1804 from 192.168.1.100:57188
May 28 21:58:22 bit Firewall[81]: Stealth Mode connection attempt to
UDP 192.168.1.101:59846 from 192.168.1.100:57188
May 28 21:58:22 bit Firewall[81]: Stealth Mode connection attempt to
UDP 192.168.1.101:31335 from 192.168.1.100:57188
May 28 21:58:22 bit Firewall[81]: Stealth Mode connection attempt to
UDP 192.168.1.101:20817 from 192.168.1.100:57188
May 28 21:58:22 bit Firewall[81]: Stealth Mode connection attempt to
UDP 192.168.1.101:16974
```

LOG ANALYSIS: INSTALL.LOG

```
May 27 11:59:03 MBP Installer[470]: logKext  Installation Log
May 27 11:59:03 MBP Installer[470]: Opened from: /Users/oompa/
Downloads/logKext-2.3.pkg
May 27 11:59:03 MBP Installer[470]: Product archive /Users/oompa/
Downloads/logKext-2.3.pkg trustLevel=100
May 27 11:59:17 MBP Installer[470]: InstallerStatusNotifications
plugin loaded
May 27 11:59:26 MBP runner[477]: Administrator authorization
granted.
May 27 11:59:26 MBP Installer[470]:
================================================================
May 27 11:59:26 MBP Installer[470]: User picked Standard Install
May 27 11:59:26 MBP Installer[470]: Choices selected for
installation:
…
May 27 12:01:34 MBP installd[481]: Installed "logKext" ()
May 27 12:01:35 MBP installd[481]: PackageKit: ----- End install
-----
```

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LOG ANALYSIS: LOG RECOVERY

- Logs get “removed” or “turned over”
- GREP or keyword search for specific date/log formats.
  - “May 18 23:17:15”
  - “Thu May 31 19:35:35 EDT 2012”
  - “ASL DB”
  - “launchctl::Audit startup”
  - “BZh91AY&SY”

VOLUME ANALYSIS

What

- Log Files
- MRU Files
- Property List Files

Why

- Insider Threat
- Data Exfiltration
- Distribute Malware

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VOLUME ANALYSIS: SYSTEM.LOG & DAILY.LOG

```
May 19 08:58:23 bit fseventsd[20]: log dir: /Volumes/Time Machine Backups/.fseventsd getting new uuid: 5420A642-DE8C-4B90-B2B4-B948288F5E3F
May 19 16:52:30 bit fseventsd[20]: log dir: /Volumes/NO NAME/.fseventsd getting new uuid: DD64986D-F58C-407B-901B-5BD27104F062
May 23 20:10:35 bit fseventsd[20]: log dir: /Volumes/NO NAME/.fseventsd getting new uuid: 0D8CB03B-0691-4381-ACEF-8F7F421D12DF
May 26 14:01:03 bit fseventsd[20]: log dir: /Volumes/WDPassport/.fseventsd getting new uuid: CDCE4339-A254-4925-A909-97B4553BDAC1
May 26 15:40:38 bit fseventsd[20]: log dir: /Volumes/WDPassport/.fseventsd getting new uuid: D4FFFBA2-16A8-4CB3-88DE-327CDE1551EC
```

```
Fri May 11 17:12:29 EDT 2012

Removing old temporary files:

Cleaning out old system announcements:

Removing stale files from /var/rwho:

Removing scratch fax files

Disk status:
Filesystem                        Size   Used  Avail Capacity  Mounted on
/dev/disk0s2                     698Gi   22Gi  675Gi     4%    /
localhost:/35wJAmjuh-MSBDh6mJulon 698Gi  698Gi    0Bi   100%    /Volumes/MobileBackups
/dev/disk6s2                     107Mi  107Mi    0Bi   100%    /Volumes/Google Chrome
```

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VOLUME ANALYSIS: KERNEL.LOG (10.8 - SYSTEM.LOG)

- Search for “USBMSC”
- Serial Number, Vendor ID, Product ID, Version

```
Apr 25 12:27:11 Pro kernel[0]: USBMSC Identifier (non-unique): 58A8120830AC8C5C 0x1e1d 0x1101 0x100
Apr 25 12:32:31 Pro kernel[0]: USBMSC Identifier (non-unique): 58A8120830AC8C5C 0x1e1d 0x1101 0x100
Apr 25 12:47:29 Pro kernel[0]: USBMSC Identifier (non-unique): 58A8120830AC8C5C 0x1e1d 0x1101 0x100
Apr 25 12:49:43 Pro kernel[0]: USBMSC Identifier (non-unique): 58A8120830AC8C5C 0x1e1d 0x1101 0x100
Apr 25 12:52:46 Pro kernel[0]: USBMSC Identifier (non-unique): FBF1011220504638 0x90c 0x1000 0x1100
Apr 25 12:53:37 Pro kernel[0]: USBMSC Identifier (non-unique): ABCDEF0123456789 0xe90 0x5 0x0
Apr 25 13:04:21 Pro kernel[0]: USBMSC Identifier (non-unique): 58A8120830AC8C5C 0x1e1d 0x1101 0x100
Apr 25 13:04:29 Pro kernel[0]: USBMSC Identifier (non-unique): FBF1011220504638 0x90c 0x1000 0x1100
Apr 26 12:36:05 Pro kernel[0]: USBMSC Identifier (non-unique): 58A8120830AC8C5C 0x1e1d 0x1101 0x100
Apr 27 09:02:59 Pro kernel[0]: USBMSC Identifier (non-unique): FBF1011220504638 0x90c 0x1000 0x1100
Apr 30 09:07:14 Pro kernel[0]: USBMSC Identifier (non-unique): FBF1011220504638 0x90c 0x1000 0x1100
May  3 05:43:05 Pro kernel[0]: USBMSC Identifier (non-unique): 58A8120830AC8C5C 0x1e1d 0x1101 0x100
May  3 06:24:05 Pro kernel[0]: USBMSC Identifier (non-unique): SWOC22905731 0x1199 0xfff 0x323
May 24 11:22:43 Pro kernel[0]: USBMSC Identifier (non-unique): 000000009833 0x5ac 0x8403 0x9833
May 24 11:53:25 Pro kernel[0]: USBMSC Identifier (non-unique): 0911201415f7f3 0x1e1d 0x165 0x100
May 25 12:48:38 Pro kernel[0]: USBMSC Identifier (non-unique): 0911201415f7f3 0x1e1d 0x165 0x100
May 30 06:50:01 Pro kernel[0]: USBMSC Identifier (non-unique): 0911201415f7f3 0x1e1d 0x165 0x100
May 31 13:10:09 Pro kernel[0]: USBMSC Identifier (non-unique): 0911201415f7f3 0x1e1d 0x165 0x100
Jun  1 07:16:03 Pro kernel[0]: USBMSC Identifier (non-unique): 0911201415f7f3 0x1e1d 0x165 0x100
```

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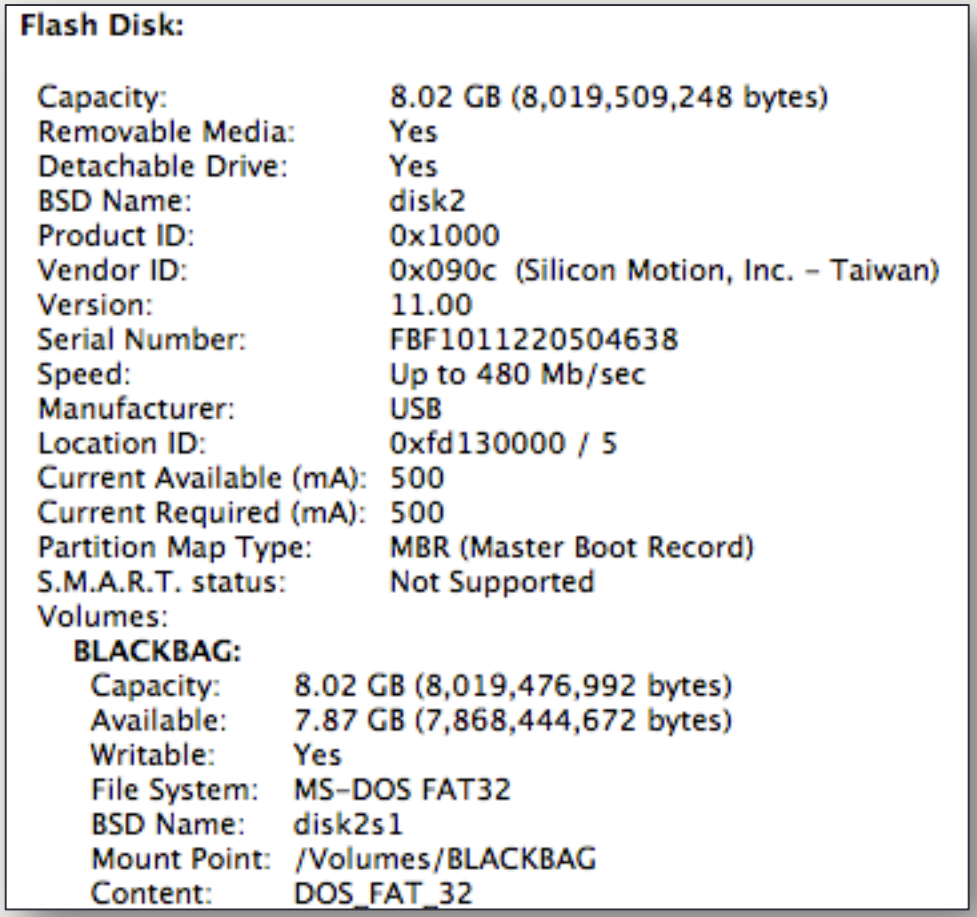
VOLUME ANALYSIS: KERNEL.LOG (10.8 - SYSTEM.LOG)

```
Jun  3 11:11:53 bit kernel[0]: USBMSC Identifier
(non-unique): FBF1011220504638 0x90c 0x1000 0x1100
```

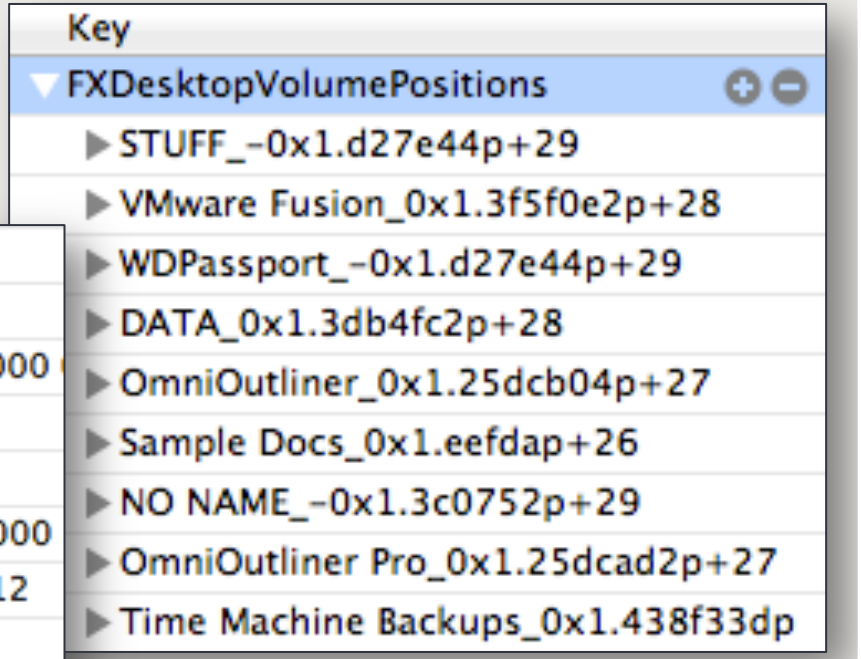


Flash Disk:

Capacity:	8.02 GB (8,019,509,248 bytes)
Removable Media:	Yes
Detachable Drive:	Yes
BSD Name:	disk2
Product ID:	0x1000
Vendor ID:	0x090c (Silicon Motion, Inc. - Taiwan)
Version:	11.00
Serial Number:	FBF1011220504638
Speed:	Up to 480 Mb/sec
Manufacturer:	USB
Location ID:	0xfd130000 / 5
Current Available (mA):	500
Current Required (mA):	500
Partition Map Type:	MBR (Master Boot Record)
S.M.A.R.T. status:	Not Supported
Volumes:	
BLACKBAG:	
Capacity:	8.02 GB (8,019,476,992 bytes)
Available:	7.87 GB (7,868,444,672 bytes)
Writable:	Yes
File System:	MS-DOS FAT32
BSD Name:	disk2s1
Mount Point:	/Volumes/BLACKBAG
Content:	DOS_FAT_32

VOLUME ANALYSIS: COM.APPLE.FINDER.PLIST

- FXDesktopVolumePositions
- FXRecentFolders (10 most recent)



FXRecentFolders	Array	(10 items)
Item 0	Diction…	(2 items)
file-bookmark	Data	<626f6f6b ac030000
name	String	STUFF
Item 1	Diction…	(2 items)
file-bookmark	Data	<626f6f6b 3c030000
name	String	TechnoSecurity2012
Item 2	Diction…	(2 items)
file-bookmark	Data	<626f6f6b 8c020000
name	String	oompa
Item 3	Diction…	(2 items)
file-bookmark	Data	<626f6f6b c0020000
name	String	Dropbox

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ANTIVIRUS

What

- Extended Attributes
- File Quarantine
- Xprotect
- GateKeeper
- Third-party Vendors

Why

- File Metadata
- Logs
- Quarantine Directories
- Weaknesses & Limitations

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ANTIVIRUS: FILE QUARANTINE

- Introduced in 10.5
- Quarantines downloaded files
- Applications (Browsers, Email, etc)
- Weaknesses
  - Files on USB drives
  - Applications that do not implement File Quarantine

ANTIVIRUS: FILE QUARANTINE

- Application's Info.plist
  - LSFileQuarantineEnabled Key set to True

```
<key>KSProductID</key>
<string>com.google.Chrome</string>
<key>KSUpdateURL</key>
<string>https://tools.google.com/service/update2</string>
<key>KSVersion</key>
<string>19.0.1084.46</string>
<key>LSFileQuarantineEnabled</key>
<true/>
<key>LSHasLocalizedDisplayName</key>
<string>1</string>
<key>LSMinimumSystem
<string>10.5.0</stri
<key>NSAppleScriptEn
<true/>
```

KSProductID	String	com.google.Chrome
KSUpdateURL	String	https://tools.google.com/service/update2
KSVersion	String	19.0.1084.46
File quarantine enabled	Boolean	YES
Application has localized display name	String	YES
Minimum system version	String	10.5.0
Scriptable	Boolean	YES

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ANTIVIRUS:
FILE QUARANTINE EVENTS

10.7 & 10.8

- ~/Library/Preferences/
  com.apple.LaunchServices.QuarantineEvents.V2

10.6

- ~/Library/Preferences/
  com.apple.LaunchServices.QuarantineEvents

ANTIVIRUS: FILE QUARANTINE

- Quarantine Events – LSQuarantineEvent Table

Key	Example Data
LSQuarantineEventIdentifier	68F08939-EF7F-4326-BDA3-810542E43579
LSQuarantineTimeStamp	358820762.0
LSQuarantineAgentBundleIdentifier	com.google.Chrome
LSQuarantineAgentName	Google Chrome
LSQuarantineDataURLString	http://ash.barebones.com/TextWrangler_4.0.dmg
LSQuarantineSenderName	*NULL*
LSQuarantineSenderAddress	*NULL*
LSQuarantineTypeNumber	0
LSQuarantineOriginTitle	*NULL*
LSQuarantineOriginURLString	http://www.barebones.com/products/textwrangler/
LSQuarantineOriginAlias	*NULL*

ANTIVIRUS: EXTENDED ATTRIBUTES

- Command: `xattr`
- Quarantine
- Metadata:
  - kMDItemWhereFroms
- Disk Images
- FinderInfo
- TextEncoding
- Preview UI State
- Resource Fork
- DropBox
- Etc.

```
bit:Downloads oompa$ xattr -xl TextWrangler_4.0.dmg
com.apple.diskimages.fsck:
00000000  A1 52 D4 F1 FC 10 76 E8 A6 EB E3 EB 73 3F 8F A1  |.R....v.....s?..|
00000010  46 83 68 3C                                      |F.h<|
00000014
com.apple.diskimages.recentcksum:
00000000  69 3A 31 34 39 33 37 34 39 20 6F 6E 20 33 39 38  |i:1493749 on 398|
00000010  31 45 32 45 36 2D 30 43 41 43 2D 33 41 33 45 2D  |1E2E6-0CAC-3A3E-|
00000020  42 45 31 44 2D 39 30 44 35 38 33 46 38 39 41 35  |BE1D-90D583F89A5|
00000030  44 20 40 20 31 33 33 37 31 32 37 39 36 34 20 2D  |D @ 1337127964 -|
00000040  20 43 52 43 33 32 3A 24 45 36 41 31 34 31 31 34  | CRC32:$E6A14114|
00000050
com.apple.metadata:kMDItemWhereFroms:
00000000  62 70 6C 69 73 74 30 30 A2 01 02 5F 10 2D 68 74  |bplist00..._.-ht|
00000010  74 70 3A 2F 2F 61 73 68 2E 62 61 72 65 62 6F 6E  |tp://ash.barebon|
00000020  65 73 2E 63 6F 6D 2F 54 65 78 74 57 72 61 6E 67  |es.com/TextWrang|
00000030  6C 65 72 5F 34 2E 30 2E 64 6D 67 5F 10 2F 68 74  |ler_4.0.dmg_./ht|
00000040  74 70 3A 2F 2F 77 77 77 2E 62 61 72 65 62 6F 6E  |tp://www.barebon|
00000050  65 73 2E 63 6F 6D 2F 70 72 6F 64 75 63 74 73 2F  |es.com/products/|
00000060  74 65 78 74 77 72 61 6E 67 6C 65 72 2F 08 0B 3B  |textwrangler/..;|
00000070  00 00 00 00 00 00 01 01 00 00 00 00 00 00 00 03  |................|
00000080  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 6D  |...............m|
00000090
com.apple.quarantine:
00000000  30 30 30 31 3B 34 66 62 32 66 34 31 64 3B 47 6F  |0001;4fb2f41d;Go|
00000010  6F 67 6C 65 20 43 68 72 6F 6D 65 3B 36 38 46 30  |ogle Chrome;68F0|
                                                          |8939-EF7F-4326-B|
                                                          |DA3-810542E43579|
                                                          ||com.google.Chro|
                                                          |me|
00000052
```

```
-rw-r--r--@  1 oompa  staff   18041097 May 11 20:01 Rdio.dmg
-rw-r--r--@  1 oompa  staff    5416932 May 15 20:26 TextWrangler_4.0.dmg
-rw-r--r--@  1 oompa  staff  188900306 May 11 19:22 VMware-Fusion-4.1.2-683185-light.dmg
-rw-r--r--@  1 oompa  staff   39937338 Apr 30 15:30 googlechrome.dmg
```

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ANTIVIRUS: EXTENDED ATTRIBUTES

com.apple.quarantine	Related Key in QuarantineEvents Database
4fb2f41d	LSQuarantineTimeStamp
Google Chrome	LSQuarantineAgentName
68F08939-EF7F-4326-BDA3-810542E43579	LSQuarantineEventIdentifier
com.google.Chrome	LSQuarantineAgentBundleIdentifier
com.apple.metadata:kMDItemWereFroms	
http://ash.barebones.com/TextWrangler_4.0.dmg	LSQuarantineDataURLString
http://www.barebones.com/products/textwrangler/	LSQuarantineOriginURLString

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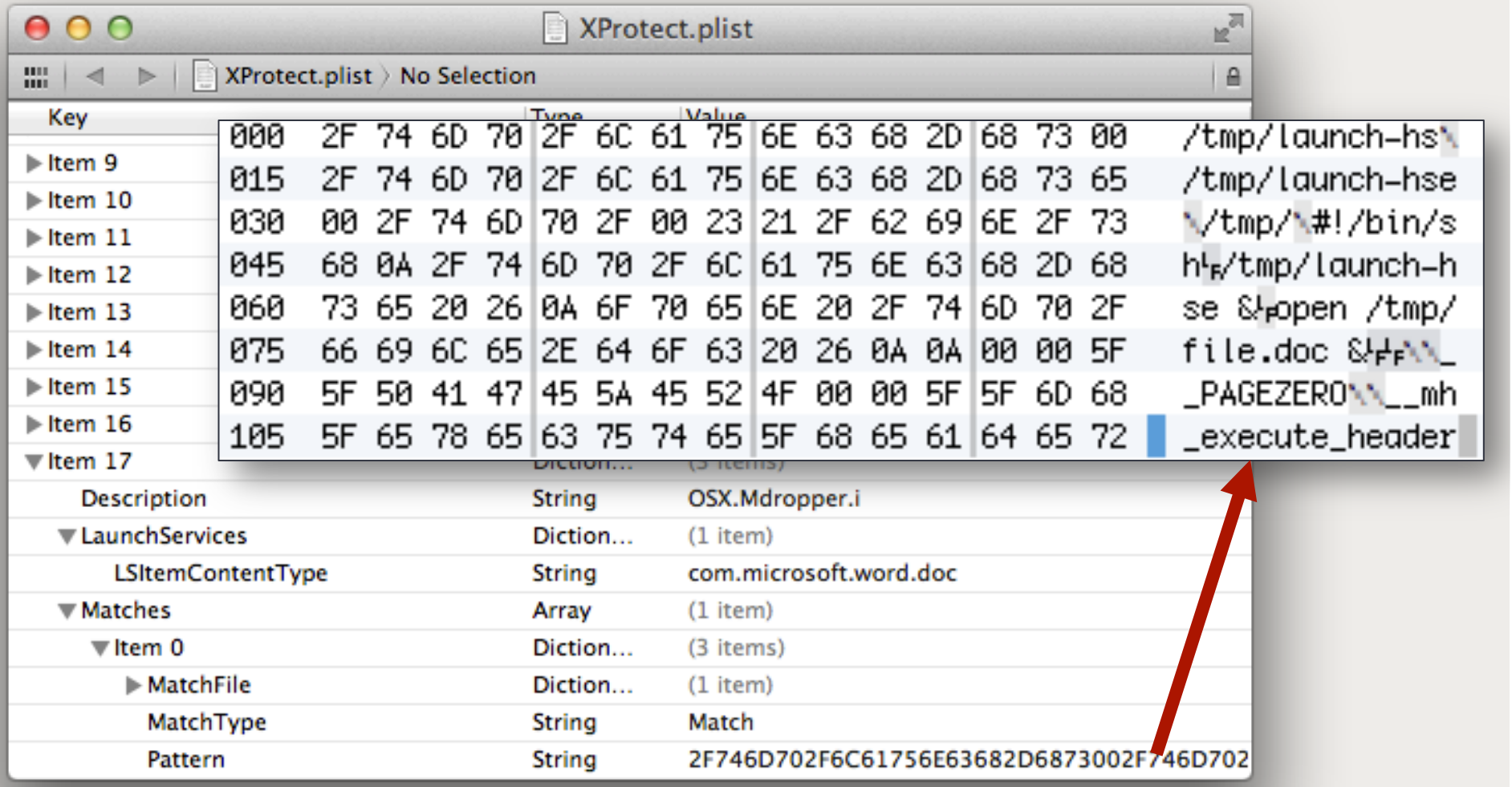
ANTIVIRUS: XPROTECT

- /System/Library/CoreServices/CoreTypes.bundle/Contents/Resources
  - XProtect.meta.plist
    - Last Update Date & Version
  - XProtect.plist
    - AV Signatures
- Weaknesses
  - Apple updates it, sometimes.
  - Very few signatures on blacklist
  - No Heuristics
  - Only checks “quarantined” files

ANTIVIRUS: XPROTECT



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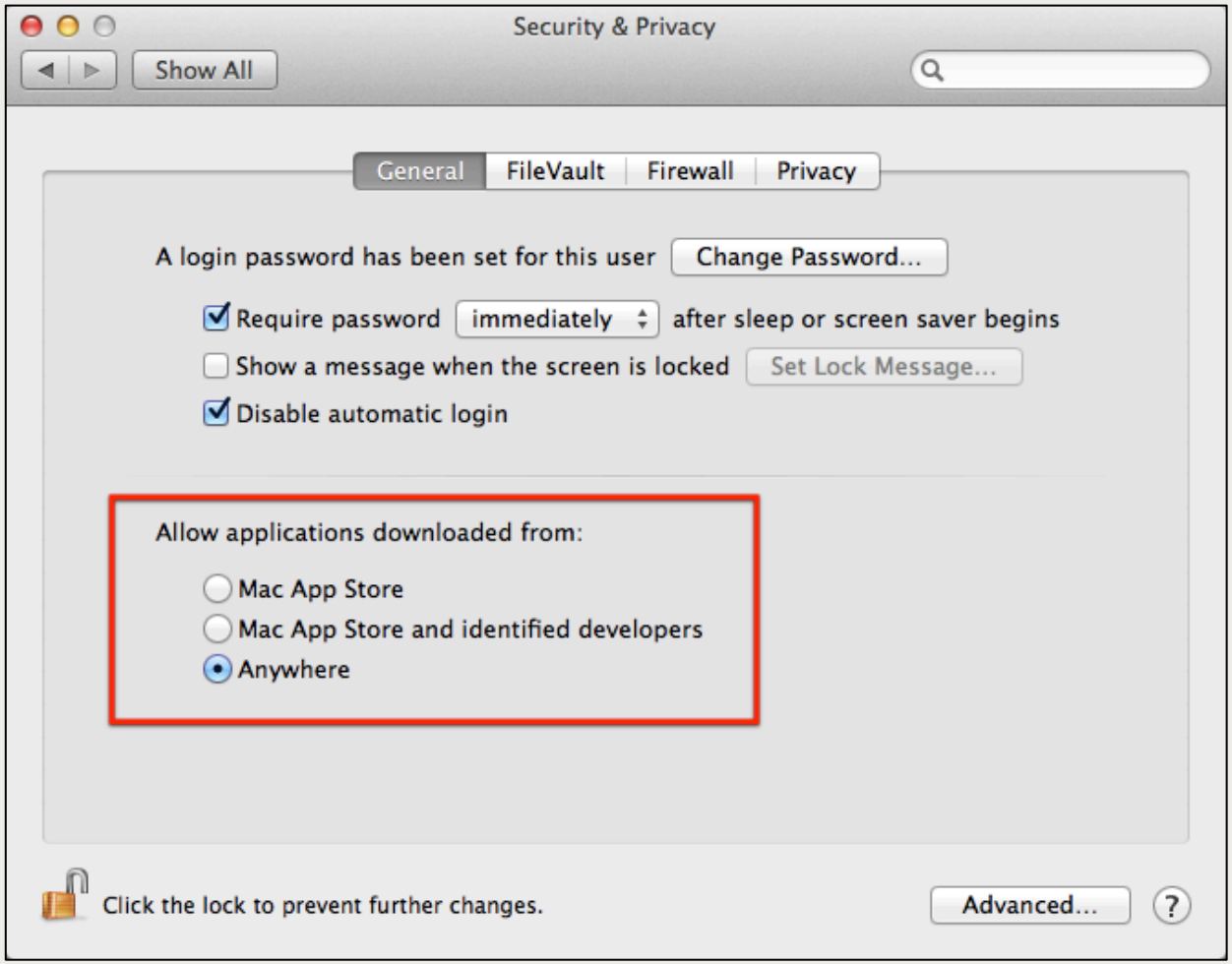
ANTIVIRUS: GATEKEEPER

- Introduced in 10.8 - Mountain Lion
- Similar Functionality to File Quarantine/XProtect
- Security Settings
  - Mac App Store
    - Users can only run apps from the store.
  - Mac App Store & Identified Developers
    - Default Setting
    - Users can only run software signed using Apple Developer ID
  - Anywhere
    - Users can run anything from anywhere

ANTIVIRUS: GATEKEEPER SETTINGS



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ANTIVIRUS: THIRD-PARTY SOFTWARE

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ANTI-FORENSICS

What

- Encryption
- Optimization Software
- Secure Erase

Why

- Suspicious Use
- Data Removal

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ANTI-FORENSICS: FILEVAULT ENCRYPTION

FileVault (Legacy)

- Home Directory
- Introduced in 10.3
- Password
- Sparse Disk Image <10.4
- Sparse Bundle >10.5

FileVault 2

- Full Disk Encryption
- Introduced in 10.7
- Password or Recovery Key

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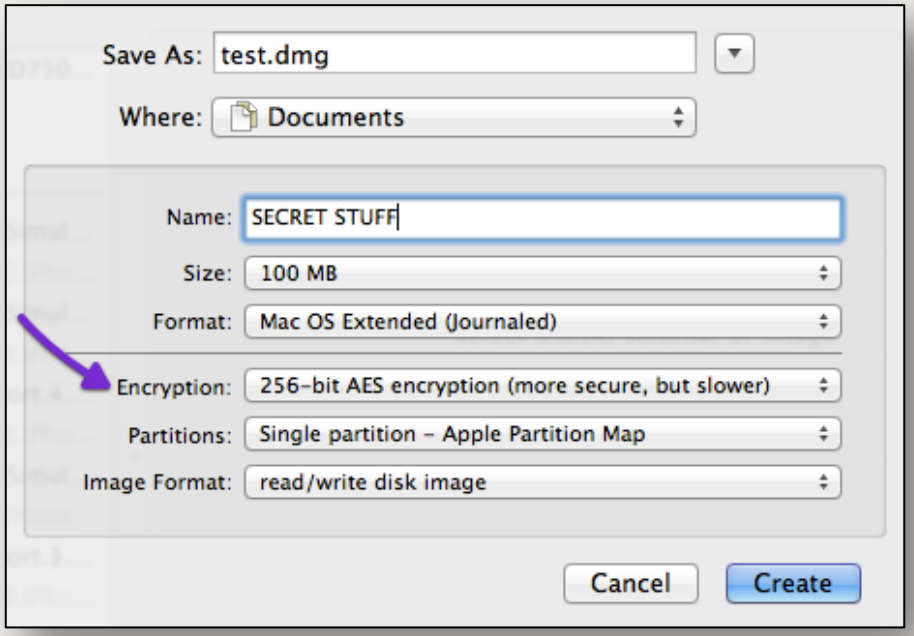
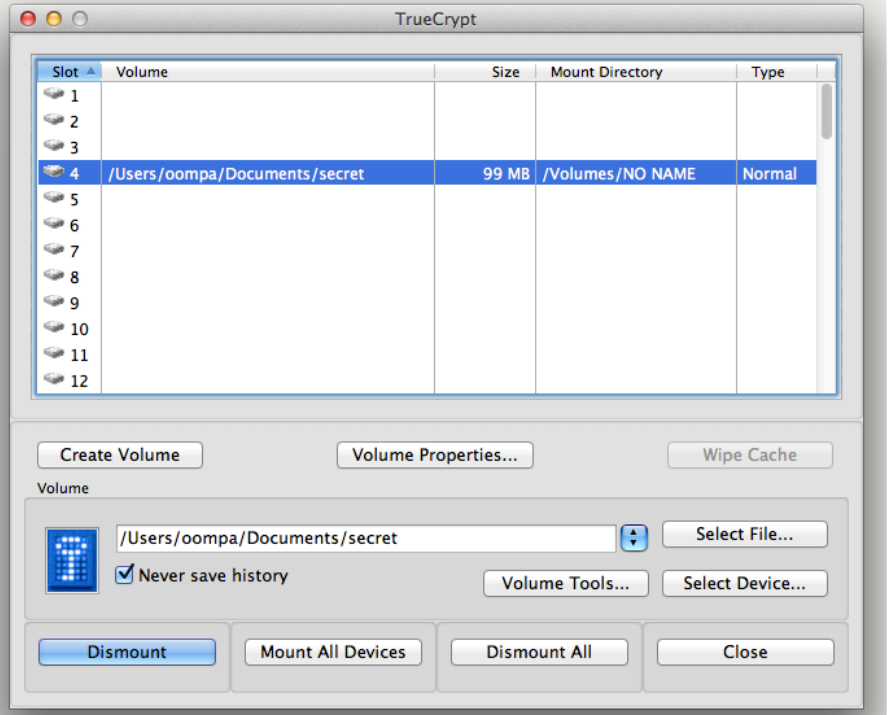
ANTI-FORENSICS: OTHER ENCRYPTION

- Apple Encrypted Disk Images
- TrueCrypt
- Check Point FDE
- McAfee Endpoint Encryption





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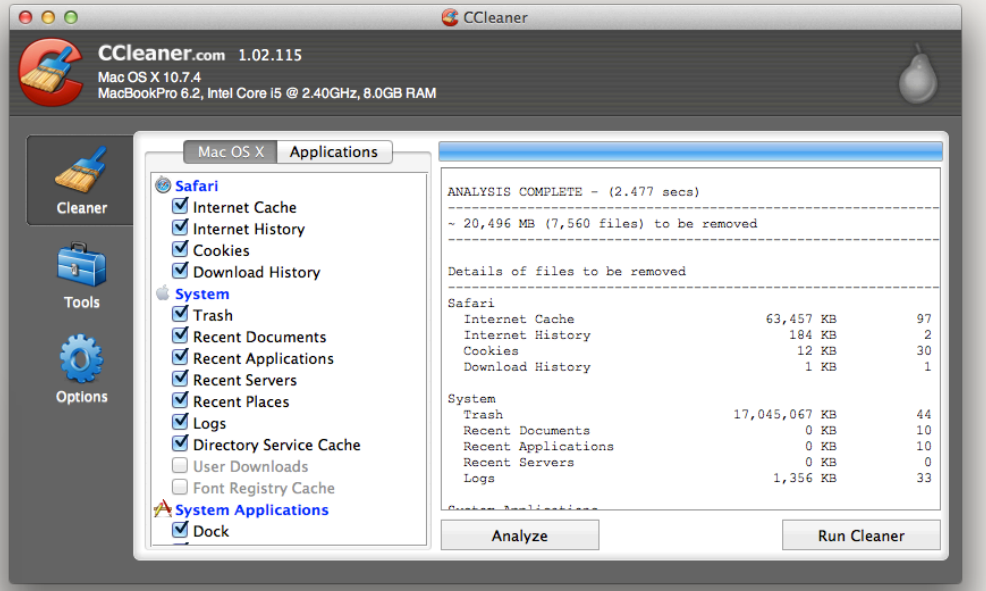
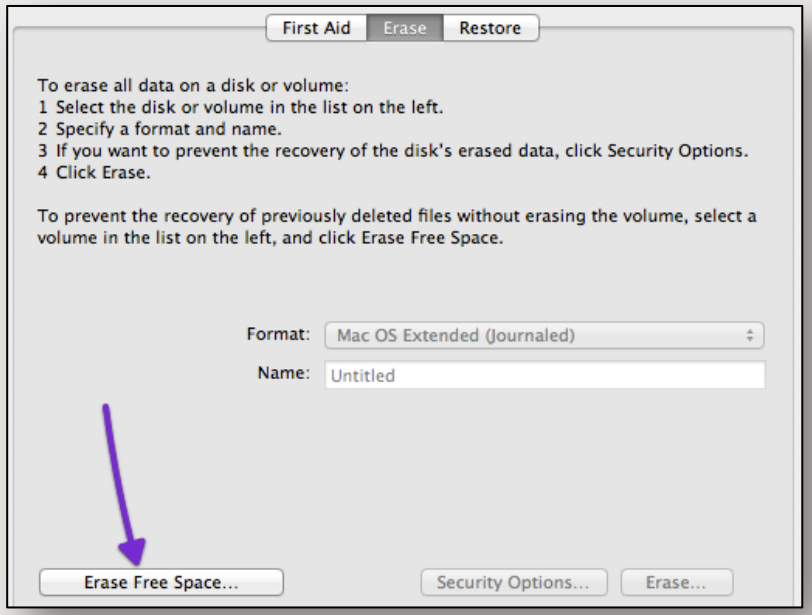
ANTI-FORENSICS: OPTIMIZATION SOFTWARE & SECURE ERASE

- Piriform CCleaner
- Intego Washing Machine 2
- Disk Utility
  - Disk Wipe
  - Erase Free Space





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OTHER FILES

What

- Kernel Extensions
- Bash History
- User Accounts
- Applications
- Shared Directory

Why

- Suspicious Use
- Hidden Files
- Unknown Accounts
- Suspicious Software
- Application Misuse

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OTHER FILES: KERNEL EXTENSIONS

- Dynamically loaded executable code in kernel space
  - Low Level Device Drivers
  - Network Filters
  - File Systems
  - …keyloggers?

```
MBP:Extensions oompa$ pwd
/System/Library/Extensions
MBP:Extensions oompa$ ls -la | grep "logKext"
drwxr-xr-x    3 root  wheel   102 Nov 19  2009 logKext.kext
```

```
76    0 0xffffff7f81340000 0xa000     0xa000     com.apple.driver.AppleMCCSControl (1.0.24) <55 9 7 5 4 3 1>
77    0 0xffffff7f81214000 0x5000     0x5000     com.apple.driver.AppleUpstreamUserClient (3.5.9) <55 9 8 7 5 4 3 1>
78    1 0xffffff7f813e5000 0xa4000    0xa4000    com.apple.driver.DspFuncLib (2.1.1f12) <67 66 5 4 3 1>
79    0 0xffffff7f81489000 0xaf000    0xaf000    com.apple.driver.AppleHDA (2.1.1f12) <78 67 65 64 57 55 6 5 4 3 1>
81    1 0xffffff7f80f67000 0x5000     0x5000     com.apple.kext.triggers (1.0) <7 6 5 4 3 1>
82    0 0xffffff7f80f6c000 0x9000     0x9000     com.apple.filesystems.autofs (3.0) <81 7 6 5 4 3 1>
83    0 0xffffff7f81631000 0x5000     0x5000     com.vmware.kext.vmmemctl (0068.29.96) <7 5 4 3 1>
85    0 0xffffff7f81637000 0xa000     0xa000     com.vmware.kext.vmhgfs (0068.29.96) <5 4 3 1>
88    0 0xffffff7f80802000 0x4000     0x4000     com.fsb.kext.logKext (2.3) <25 4 3>
```

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OTHER FILES: BASH HISTORY

- ~/.bash_history
- File not written until session logout
  - Each terminal window is a login session
- 500 Entries by default
- Incident Response Tip:
  - Run the ‘history’ command for the logged in user.

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OTHER FILES: USER ACCOUNTS

- /private/var/db/dslocal/nodes/Default/users/
- Password Shadow – ShadowHashData Key (Lion & Mountain Lion)
- Password Shadow - /private/var/db/shadow/<User GUID>

```
sh-3.2# ls -lat
total 224
drwx------  77 root  wheel    2618 May 15 03:05 .
-rw-------   1 root  wheel    1525 May 15 03:05 root.plist
-rw-------   1 root  wheel  103449 May 12 19:21 user.plist
drw-------  12 root  wheel     408 May 10 16:41 ..
-rw-------   1 root  wheel     250 May 10 00:36 _taskgated.plist
-rw-------   1 root  wheel     666 May  9 19:29 _krbtgt.plist
-rw-------   1 root  wheel     260 May  9 19:20 _amavisd.plist
-rw-------   1 root  wheel     261 May  9 19:20 _appowner.plist
-rw-------   1 root  wheel     276 May  9 19:20 _appserver.plist
-rw-------   1 root  wheel     248 May  9 19:20 _ard.plist
-rw-------   1 root  wheel     254 May  9 19:20 _atsserver.plist
-rw-------   1 root  wheel     266 May  9 19:20 _avbdeviced.plist
-rw-------   1 root  wheel     250 May  9 19:20 _calendar.plist
```

OTHER FILES: APPLICATION HOOKING

Flashback Example: DYLD_INSERT_LIBRARIES

Credentials Given

- Inserts the key “LSEnvironment” in subkey DYLD_INSERT_LIBRARIES in /Applications/Safari.app/Contents/Info.plist
- References *.xsl and/or *.png files in:
  - /Applications/Safari.app/Contents/Resources/

No Credentials Given

- Inserts DYLD_INSERT_LIBRARIES into ~/.MacOSX/environment.plist
- References: /Users/Shared/.libgmalloc.dylib file
  - References: Hidden .tmp file in /Users/<user>/Application Support/

OTHER FILES: SHARED DIRECTORY

/Users/Shared/

- Writable to all users

Flashback – Mach-O binaries

- Hidden *.so files
- .libgmalloc.dylib (Previous Slide)
- .tdem

BASIC REVERSE ENGINEERING

What

- Basic Reverse Engineering tools & techniques

Why

- Deeper look at the malware internals.

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BASIC REVERSE ENGINEERING: STATIC: FILE & XXD

```
MBP:~ oompa$ file /Users/oompa/Downloads/logKext-2.3.pkg
/Users/oompa/Downloads/logKext-2.3.pkg: xar archive - version 1
MBP:~ oompa$ xxd /Users/oompa/Downloads/logKext-2.3.pkg | more
0000000: 7861 7221 001c 0001 0000 0000 0000 0b91  xar!............
0000010: 0000 0000 0000 63e7 0000 0001 78da ec97  ......c.....x...
0000020: 4b8f db36 1080 eff9 1582 ef8e f87e 045c  K..6.........~.\
0000030: 056d 81a0 bd15 e8f6 d21b 450e 6dc1 b264  .m........E.m..d
0000040: 48da ad9d 5f5f 4a96 1fbb 6b79 dd2e d2a4  H..__J...ky....
0000050: 454e 1a0e 4743 8a33 1f67 643e 6ed7 65f2  EN..GC.3.gd>n.e.
0000060: 084d 5bd4 d5dd 0cbf 47b3 042a 57fb a25a  .M[.....G..*W..Z
```

BASIC REVERSE ENGINEERING: STATIC: LIPO

- Architecture Information

```
MBP:logKext oompa$ file logKextDaemon
logKextDaemon: Mach-O universal binary with 3 architectures
logKextDaemon (for architecture x86_64):        Mach-O 64-bit executable x86_64
logKextDaemon (for architecture i386):  Mach-O executable i386
logKextDaemon (for architecture ppc7400):       Mach-O executable ppc
MBP:logKext oompa$ lipo -detailed_info logKextDaemon
Fat header in: logKextDaemon
fat_magic 0xcafebabe
nfat_arch 3
architecture x86_64
    cputype CPU_TYPE_X86_64
    cpusubtype CPU_SUBTYPE_X86_64_ALL
    offset 4096
    size 24352
    align 2^12 (4096)
architecture i386
    cputype CPU_TYPE_I386
    cpusubtype CPU_SUBTYPE_I386_ALL
    offset 28672
    size 23896
    align 2^12 (4096)
architecture ppc7400
    cputype CPU_TYPE_POWERPC
    cpusubtype CPU_SUBTYPE_POWERPC_7400
    offset 53248
    size 21300
    align 2^12 (4096)
```

BASIC REVERSE ENGINEERING: STATIC: NM

- Display symbols
- Capabilities of program
- Xcode Required

```
bit:VMSHARE oompa$ nm -arch x86_64 logKextDaemon |  more
000000010000229e s  stub helpers
                 U _BF_ecb_encrypt
                 U _BF_set_key
                 U _CFArrayAppendValue
                 U _CFArrayCreateMutable
                 U _CFBooleanGetValue
                 U _CFDataAppendBytes
                 U _CFDataCreate
                 U _CFDataCreateMutable
                 U _CFDataDeleteBytes
                 U _CFDataGetBytePtr
                 U _CFDataGetBytes
                 U _CFDataGetLength
                 U _CFDictionaryGetValue
                 U _CFLocaleCopyCurrent
                 U _CFNumberCreate
                 U _CFNumberFormatterCreate
                 U _CFNumberFormatterCreateStringWithValue
                 U _CFPreferencesAppSynchronize
                 U _CFPreferencesCopyAppValue
                 U _CFPreferencesGetAppBooleanValue
                 U _CFPreferencesGetAppIntegerValue
                 U _CFPreferencesSetAppValue
                 U _CFPropertyListCreateFromStream
                 U _CFReadStreamClose
                 U _CFReadStreamCreateWithFile
                 U _CFReadStreamOpen
                 U _CFRelease
```

BASIC REVERSE ENGINEERING: STATIC: OTOOL

- Shared Libraries
- Xcode Required

```
bit:VMSHARE oompa$ otool -L logKextDaemon | more
logKextDaemon:
        /System/Library/Frameworks/IOKit.framework/Versions/A/IOKit (compatibility version 1.0.0, current version 275.
0.0)
        /usr/lib/libcrypto.0.9.7.dylib (compatibility version 0.9.7, current version 0.9.7)
        /System/Library/Frameworks/Security.framework/Versions/A/Security (compatibility version 1.0.0, current versio
n 36371.0.0)
        /System/Library/Frameworks/CoreFoundation.framework/Versions/A/CoreFoundation (compatibility version 150.0.0,
current version 476.18.0)
        /System/Library/Frameworks/SystemConfiguration.framework/Versions/A/SystemConfiguration (compatibility version
 1.0.0, current version 212.2.0)
        /usr/lib/libstdc++.6.dylib (compatibility version 7.0.0, current version 7.4.0)
        /usr/lib/libgcc_s.1.dylib (compatibility version 1.0.0, current version 1.0.0)
        /usr/lib/libSystem.B.dylib (compatibility version 1.0.0, current version 111.1.4)
```

BASIC REVERSE ENGINEERING: DYNAMIC: VMMAP

- Display virtual memory regions for a process.

```
MBP:~ oompa$ sudo vmmap 296 | more
Virtual Memory Map of process 296 (logKextDaemon)
Output report format:  2.2  -- 64-bit process

==== Non-writable regions for process 296
__TEXT                 0000000100000000-0000000100003000 [   12K] r-x/rwx SM=COW  /Library/Application Support/logKext/logKextDaemon
__LINKEDIT             0000000100005000-0000000100007000 [    8K] r--/rwx SM=COW  /Library/Application Support/logKext/logKextDaemon
__TEXT                 0000000100007000-00000001000eb000 [  912K] r-x/rwx SM=COW  /usr/lib/libcrypto.0.9.7.dylib
__LINKEDIT             00000001001a000-0000000100140000 [  216K] r--/rwx SM=COW  /usr/lib/libcrypto.0.9.7.dylib
MALLOC metadata        0000000100140000-0000000100141000 [    4K] r--/rwx SM=COW
```

BASIC REVERSE ENGINEERING: DYNAMIC: LSOF

- com.fsb.logKext <- Keylog file!

```
MBP:~ oompa$ sudo lsof -p 53
COMMAND    PID USER   FD     TYPE             DEVICE  SIZE/OFF   NODE NAME
logKextDa   53 root  cwd      DIR               14,2      1156      2 /
logKextDa   53 root  txt      REG               14,2     74548 426352 /Library/Application Support/logKext/logKextDaemon
logKextDa   53 root  txt      REG               14,2   2251584   5803 /usr/lib/libcrypto.0.9.7.dylib
logKextDa   53 root  txt      REG               14,2     51288 427680 /private/var/db/mds/system/mdsDirectory.db
logKextDa   53 root  txt      REG               14,2     35640 426371 /Library/Keychains/System.keychain
logKextDa   53 root  txt      REG               14,2  16285968  34732 /usr/share/icu/icudt46l.dat
logKextDa   53 root  txt      REG               14,2    599232   8982 /usr/lib/dyld
logKextDa   53 root  txt      REG               14,2 288935936 282671 /private/var/db/dyld/dyld_shared_cache_x86_64
logKextDa   53 root    0r     CHR                3,2       0t0    302 /dev/null
logKextDa   53 root    1     PIPE 0xffffff80066784d0     16384        ->0xffffff8006678580
logKextDa   53 root    2     PIPE 0xffffff80066784d0     16384        ->0xffffff8006678580
logKextDa   53 root    3w     REG               14,2      3912 426390 /Library/Preferences/com.fsb.logKext
logKextDa   53 root    4u  KQUEUE                                     count=1, state=0x2
```

BASIC REVERSE ENGINEERING: DYNAMIC: IOSNOOP

- Track IO events

```
MBP:~ oompa$ cat lk_install.txt | grep -i logkext
    0   397 W 16955040  36864   installd ??/Boms/com.fsb.logkext.logkextReadme.pkg.bom
    0   397 W 16955144   8192   installd ??/Root/LogKext Readme.html
    0   397 W 16956112  36864   installd ??/Boms/com.fsb.logkext.logkextuninstall.pkg.bom
    0   397 W 16956184   4096   installd ??/Root/LogKextUninstall.command
    0   397 W 16956192  36864   installd ??/Boms/com.fsb.logkext.logkext.pkg.bom
    0   397 W 16956264   4096   installd ??/LaunchDaemons/logKext.plist
    0   397 W 16956272  36864   installd ??/Boms/com.fsb.logkext.logkextkeymap.pkg.bom
    0   397 W 16956344   8192   installd ??/logKext/logKextKeymap.plist
    0   397 W 16956448  36864   installd ??/Boms/com.fsb.logkext.logkextExt.pkg.bom
    0   397 W 16956520   4096   installd ??/com.fsb.logkext.logkextExt.pkg.Gjplwp/postflight
    0   397 W 16956528   4096   installd ??/com.fsb.logkext.logkextExt.pkg.Gjplwp/postinstall
    0   397 W 17100768  12288   installd ??/MacOS/logKext
    0   397 W 17100800  36864   installd ??/Boms/com.fsb.logkext.logkextdaemon.pkg.bom
    0   397 W 17100872  73728   installd ??/logKext/.BC.jZOcU5
    0   397 W 17101016   4096   installd ??/logKext/logKextDaemon
    0   397 W 17101024  36864   installd ??/Boms/com.fsb.logkext.logkextclient.pkg.bom
    0   397 W 17102792   4096   installd ??/bin/logKextClient
    0   397 W 17247288  36864   installd ??/Boms/com.fsb.logkext.logkextkeygen.pkg.bom
    0   397 W 18349472  40960   installd ??/logKext/.BC.tBOfse
    0   397 W 18349552   4096   installd ??/logKext/logKextKeyGen
   89   343 R 16955144   4096   mdworker ??/Macintosh HD/LogKext Readme.html
   89   343 R 16955144   8192   mdworker ??/Macintosh HD/LogKext Readme.html
   89   343 R 16956184   4096   mdworker ??/Macintosh HD/LogKextUninstall.command
    0    10 R 17068304   4096      kextd ??/MacOS/logKext
    0    10 R 17068312  28672      kextd ??/MacOS/logKext
    0    10 R 17068368  20480      kextd ??/MacOS/logKext
    0   414 R 16956528   4096   installd ??/com.fsb.logkext.logkextExt.pkg.Gjplwp/postinstall
    0   426 R 18349472   4096         sh ??/logKext/logKextKeyGen
```

REVERSE ENGINEERING: DYNAMIC: EXECSNOOP

- Track process execution events.

```
MBP:~ oompa$ cat lk_install.txt
  UID     PID    PPID ARGS
    0     394       1 diskmanagementd
    0     395       1 sandboxd
  501     396     391 runner
   92     397       1 SecurityAgent
    0     398       1 authorizationhos
    0     399       1 kcm
    0     400       1 installd
    0     401       1 authorizationhos
    0     402       1 authorizationhos
    0     403       1 authorizationhos
    0     404     400 update_dyld_shar
  501     405      55 SFLSharedPrefsTo
  501     406      55 SFLSharedPrefsTo
  501     407     140 PubSubAgent
    0     408     400 xpchelper
    0     409     400 shove
    0     410     400 kextcache
    0     411       1 launchdadd
    0     412     400 kextcache
    0     412     400 kextcache
    0      10       1 kextd
    0      10       1 kextd
    0     416     400 sh
    0     417     416 find
    0     418     417 chmod
    0     419     417 chmod
    0     420     417 chmod
    0     421     417 chmod
    0     422     417 chmod
    0     423     417 chmod
    0     424     417 chmod
    0     425     417 chmod
    0     426     416 kextunload
    0     427     416 kextload
    0     429       1 taskgated
    0     428     416 logKextKeyGen
    0     430     416 launchctl
    0     431       1 logKextDaemon
    0     432     416 open
    0     433      55 SFLIconTool
  501     346     140 Safari
    0     435       1 launchdadd
    0     436     400 efw_cache_update
    0     437      55 SFLSharedPrefsTo
```

oompa@csh.rit.edu | @i

BASIC REVERSE ENGINEERING: OTHER TOOLS

- `opensnoop` – File Opens
- `rwsnoop` – File Read/Writes
- IDA – Disassembler (hex-rays.com)
- GDB – GNU Debugger
- Instruments (Xcode Developer Tools)
- fseventer - fernlightning.com

WHEN MACS GET HACKED

Sarah Edwards
@iamevltwin
oompa@csh.rit.edu