Crowd Security Intelligence

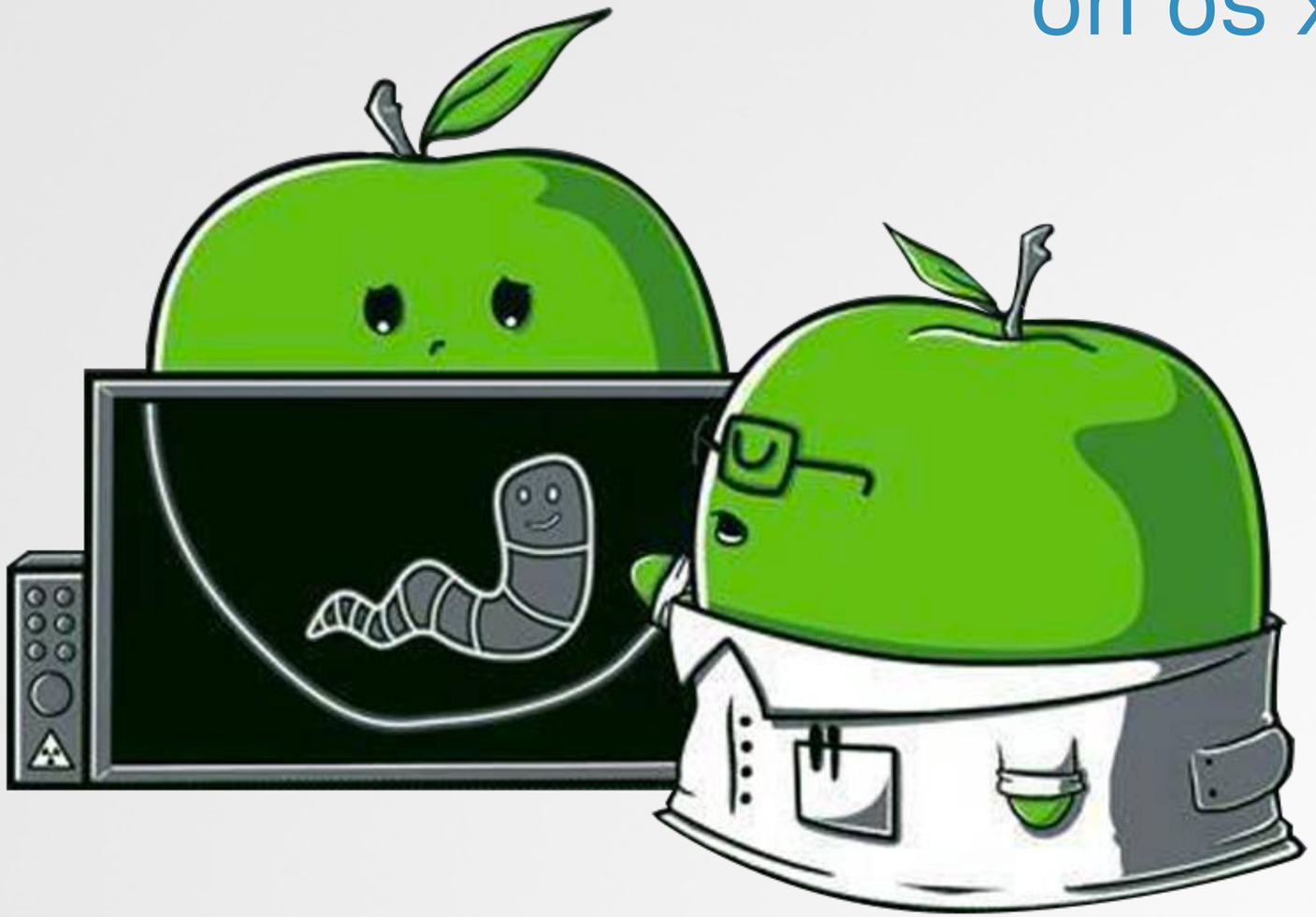
(download slides)

syn.ac/virusb2014

@patrickwardle

METHODS of MALWARE PERSISTENCE

on os x mavericks



About

"[synack] *sources a global contingent of vetted security experts worldwide and pays them on an incentivized basis to discover security vulnerabilities in our customers' web apps, mobile apps, and infrastructure endpoints.*"

`patrick wardle`

`/NASA /NSA /VRL /SYNACK`

AN OUTLINE

background, persistence, malware, & detection

background

methods of persistence

os x malware

‘autoruns’ for os x

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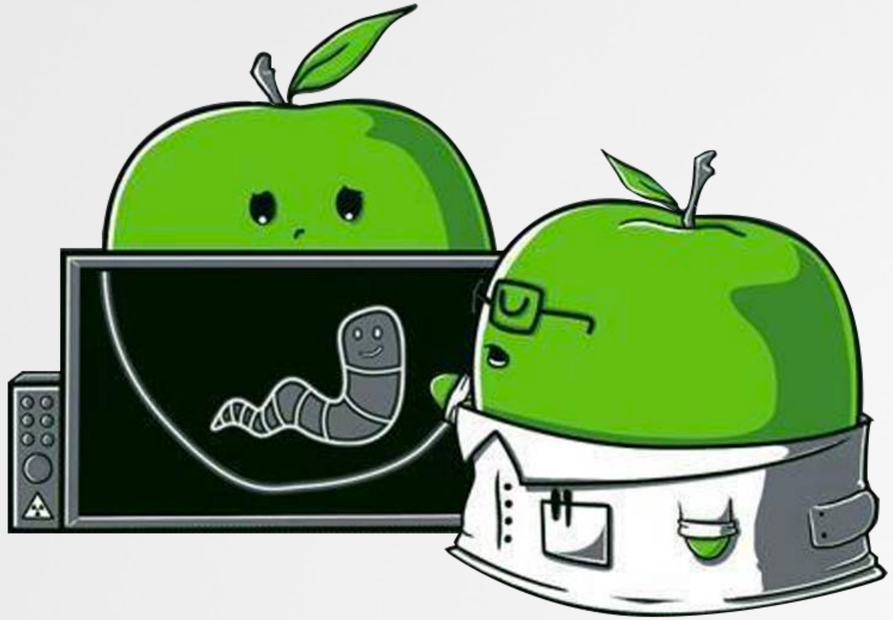
BACKGROUND

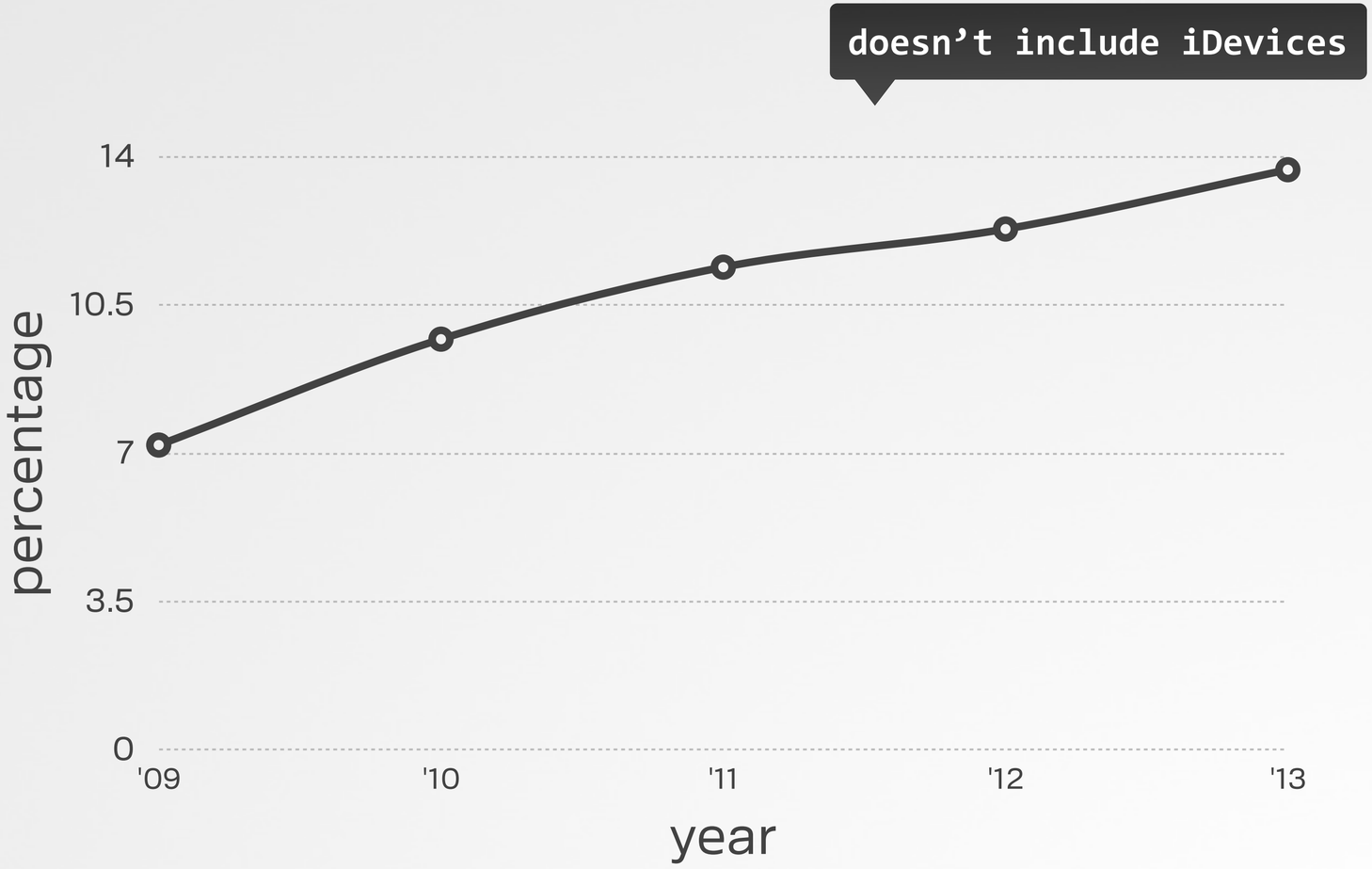
why you should care



The Rise of Macs

macs are everywhere (home & enterprise)

apple is now the #3 vendor
in usa pc shipments

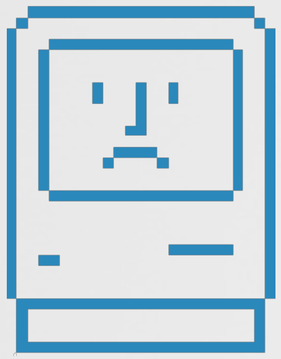


macs as % of total usa pc sales

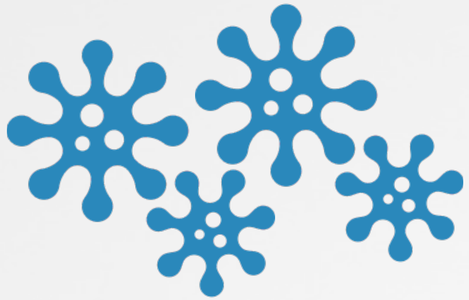
Malware on OS X?

but macs don't get malware...right?

'first' virus (elk cloner)
infected apple II's



"It doesn't get PC viruses. A Mac isn't susceptible to the thousands of viruses plaguing Windows-based computers." -apple.com (2012)



last year, 33 new os x
malware families

Apple's Response

OS X now contains many anti-malware features

so we're all safe now, right?!?

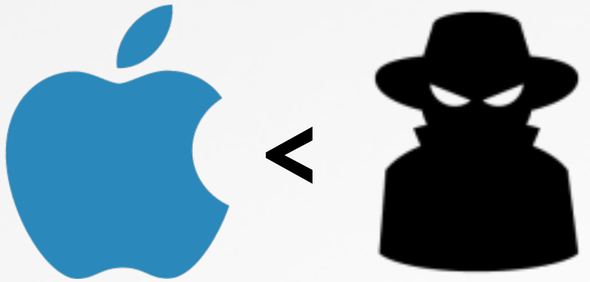
xprotect

gatekeeper

os x sandbox

code-signing

nope!



'wins'

The Current Situation

the apple juice is sour...

+

+

+

lots of macs

feeble anti-malware protections

os x malware

limited os x malware analysis tools

“by identifying persistence mechanisms in os x and studying malware that abuses these, we can (better) protect ourselves”

....and a new analysis tool can help as well

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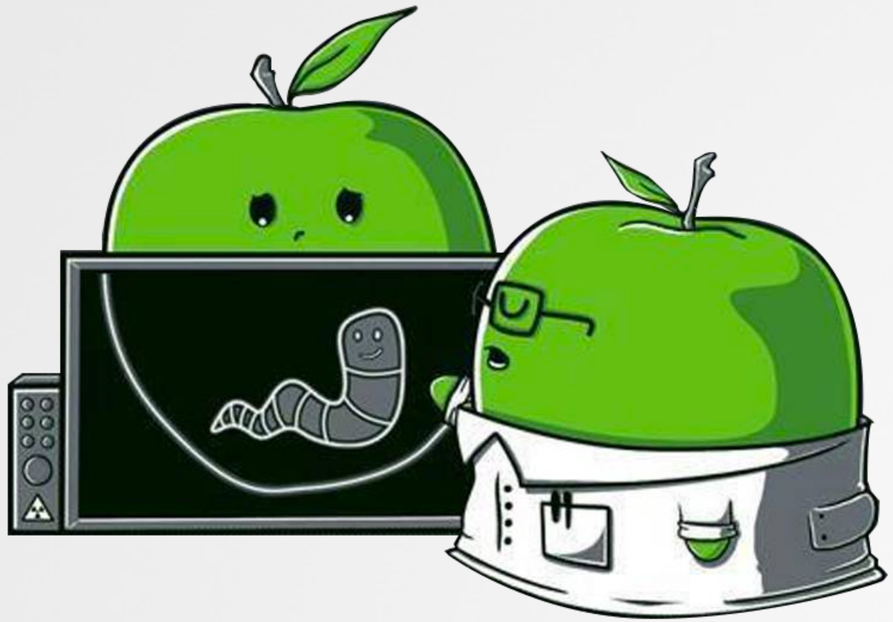
METHODS OF PERSISTENCE

where malware may live



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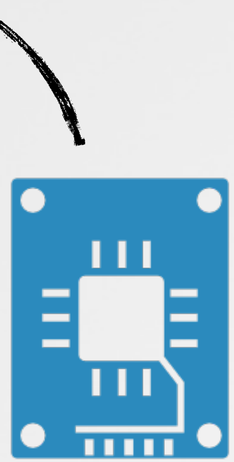
Low Level

the boot process affords several opportunities for persistence

often highly complex, though very insidious and difficult to detect

install malicious EFI components?



replace/patch the **`boot.efi`**?

re-flash the bootROM?

infecting the boot process

‘mac efi rootkits’
by loukas k (snare)

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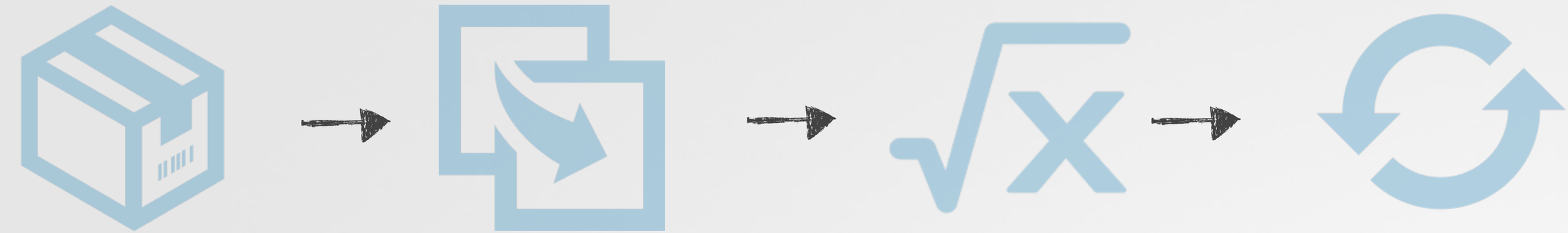
KERNEL EXTENSIONS

loaded automatically into ring-0



write a KEXT

copy to KEXT directory

set ownership to root

rebuild kernel cache

also: /System/Library/Extensions

```
# cp -R persist.kext /Library/Extensions

# chown -R root:wheel /Library/Extensions/persist.kext

# kextcache -system-prelinked-kernel
# kextcache -system-caches
```

installing a kext

Launch Daemons & Agents

similar to windows services

daemons and agents are started by **launchD**

daemons

non interactive, launched pre-login

```
/System/Library/LaunchDaemons
/Library/LaunchDaemons
```

agents

interactive, launched post-login

```
/System/Library/LaunchAgents
/Library/LaunchAgents
~/Library/LaunchAgents
```

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Launch Daemons & Agents

registered ('installed') via a property list

plist instructs **launchD** how/when to load the item

label/identifier

binary image

auto launch

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist PUBLIC ...>
<plist version="1.0">
<dict>
    <key>Label</key>
    <string>com.example.persist</string>
    <key>ProgramArguments</key>
    <array>
        <string>/path/to/persist</string>
        <string>args?</string>
    </array>
    <key>RunAtLoad</key>
    <true/>
</dict>
</plist>
```

daemon/agent plist

Cron Jobs

used to automatically run scrips/commands

popular with malware writers coming from *nix based backgrounds

can use @reboot, @daily, etc.

```
$ echo "* * * * * echo \"I'm persisting\""
       > /tmp/persistJob

$ crontab /tmp/persistJob

$ crontab -l
* * * * * echo "I'm persisting"
```

create

creating & installing a cron job

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Login & Logout Hooks

allow a script to be automatically executed at login and/or logout

```
# defaults write com.apple.loginwindow LoginHook /usr/bin/hook.sh
```

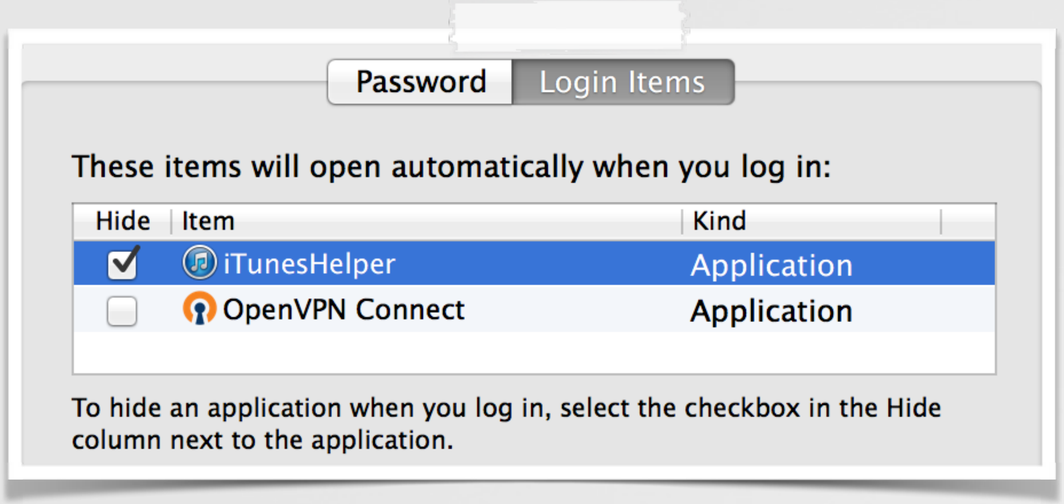
```
# ~/Library/Preferences/com.apple.loginwindow.plist
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist ...>
<plist version="1.0">
<dict>
    <key>LoginHook</key>
    <string>/usr/bin/hook.sh</string>
</dict>
</plist>
```

script

login hook

Login Items

‘legitimate’ method to ensure apps are executed at login



System Preferences -> Users & Groups -> Login Items

~/Library/Preferences/com.apple.loginitems.plist

```
<dict>
 <key>com.apple.LSSharedFileList.Binding</key>
 <data>
 ZG5pYgAAAACAAAAAAAAAAAAAAAAAAAAA...
 </data>
 <key>com.apple.LSSharedFileList.ItemIsHidden</key>
 <true/>
 <key>com.apple.loginitem.HideOnLaunch</key>
 <true/>
 <key>Name</key>
 <string>iTunesHelper</string>
</dict>
```

base64 data (path, etc.)

login item

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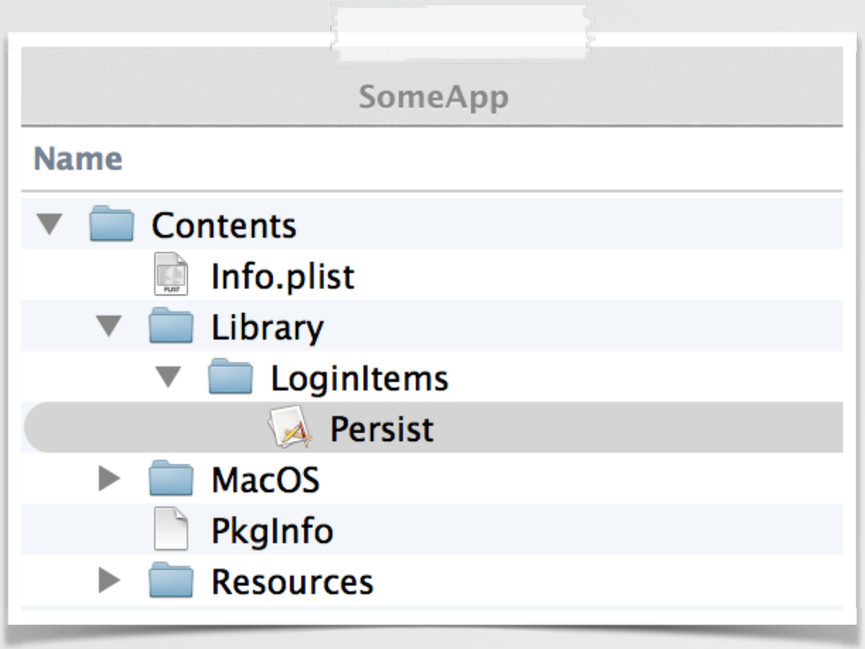
Login Items (sandboxed)

ensure sandboxed apps are executed at each login, ‘legitimately’



copy persistent app to **`<main>.app/Contents/Library/LoginItems/`**

does not show up in (any) GUI

invoke **`SMLoginItemSetEnableD()`** in the main app, with the persistent app’s id

```
/private/var/db/launchd.db/
 ->com.apple.launchd.peruser.501/overrides.plist
```

```
//enable auto launch
SMLoginItemSetEnabled((__bridge CFStringRef) @"com.company.persistMe", YES);
```

sandboxed login item

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Startup Items

allow a script to be automatically executed at each reboot

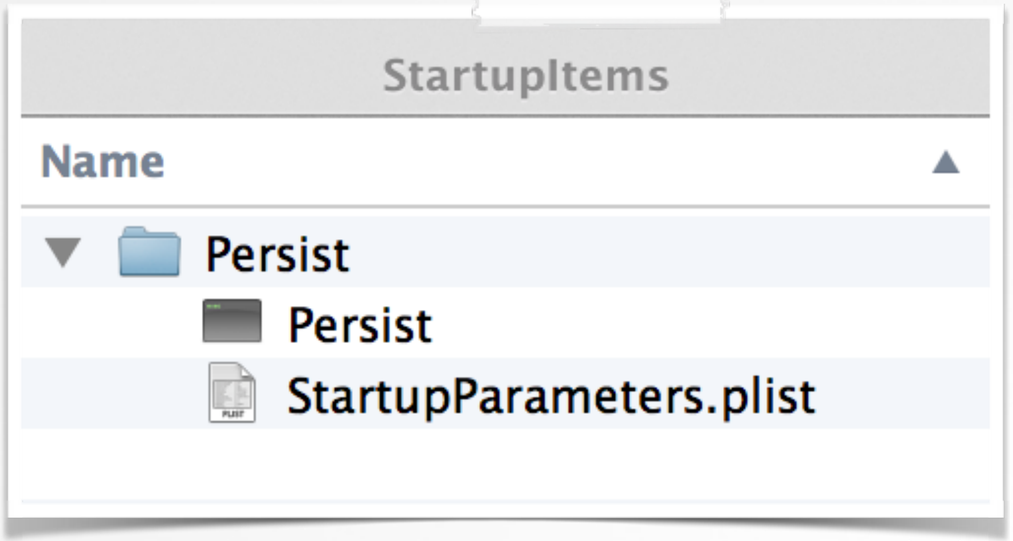
match script's name

```
#!/bin/sh
. /etc/rc.common

StartService()
{
  #anything here
}

RunService "$1"
```

persistent script

```
{
  Description = "anything";
  Provides = ("<name>");
}
```

StartupParameters.plist



/System/Library/StartupItems

/Library/StartupItems

RC.COMMON

allows scripts or commands to automatically execute

another linux'y-based technique

how easy is this?

```
# vim /etc/rc.common

...

add any commands (at end)
```

modifying rc.common

LAUNCHD.CONF

allows **`launchCtl`** commands to be automatically executed

file does not exist by default

```
# echo bsexec 1 /bin/bash <anything.script> > /etc/launchd.conf
```

`launchd.conf`

'**`bsexec`**' is a **`launchCtl`** command that executes other commands...perfect!

can also set environment variables via the **`setenv`** command (e.g. **`DYLD_INSERT_LIBRARIES`**)

DYLD_INSERT_LIBRARIES

allows a library to be automatically loaded/executed

application

```
$ less /Applications/Safari.app/Contents/Info.plist
...
<key>LSEnvironment</key>
<dict>
  <key>DYLD_INSERT_LIBRARIES</key>
   <string>/usr/bin/evil.dylib</string>
</dict>
```

unsign the target binary

launch item

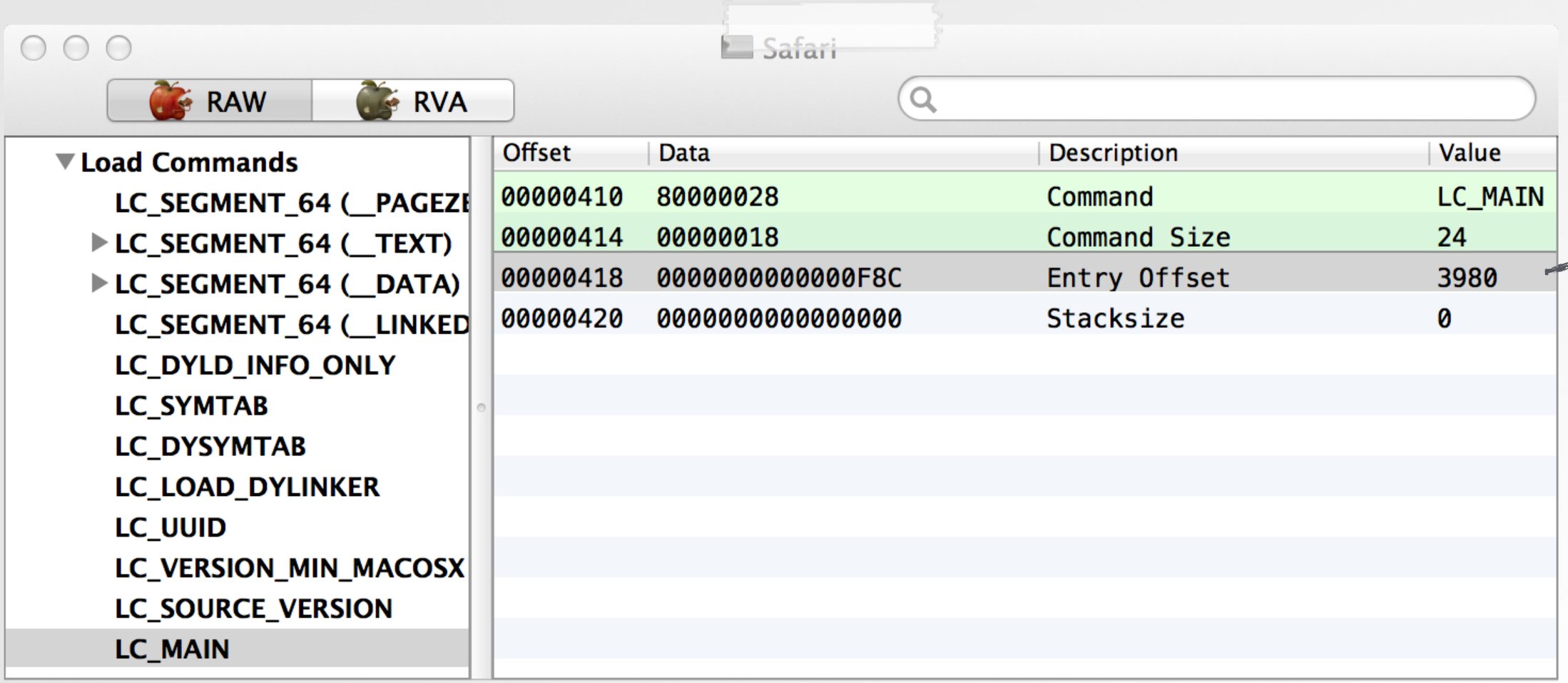
```
$ less /System/Library/LaunchDaemons/com.apple.mDNSResponder.plist
...
<key>EnvironmentVariables</key>
<dict>
  <key>DYLD_INSERT_LIBRARIES</key>
  <string>/usr/bin/evil.dylib</string>
</dict>
```

dyld_insert_libraries (app & launch item)

Mach-O Infection

ensures (injected) code is executed when host is run

read, “infecting mach-o files”
(roy g biv)



entry point

mach-o structure

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Application Specific

plugins or extensions can provide automatic code execution

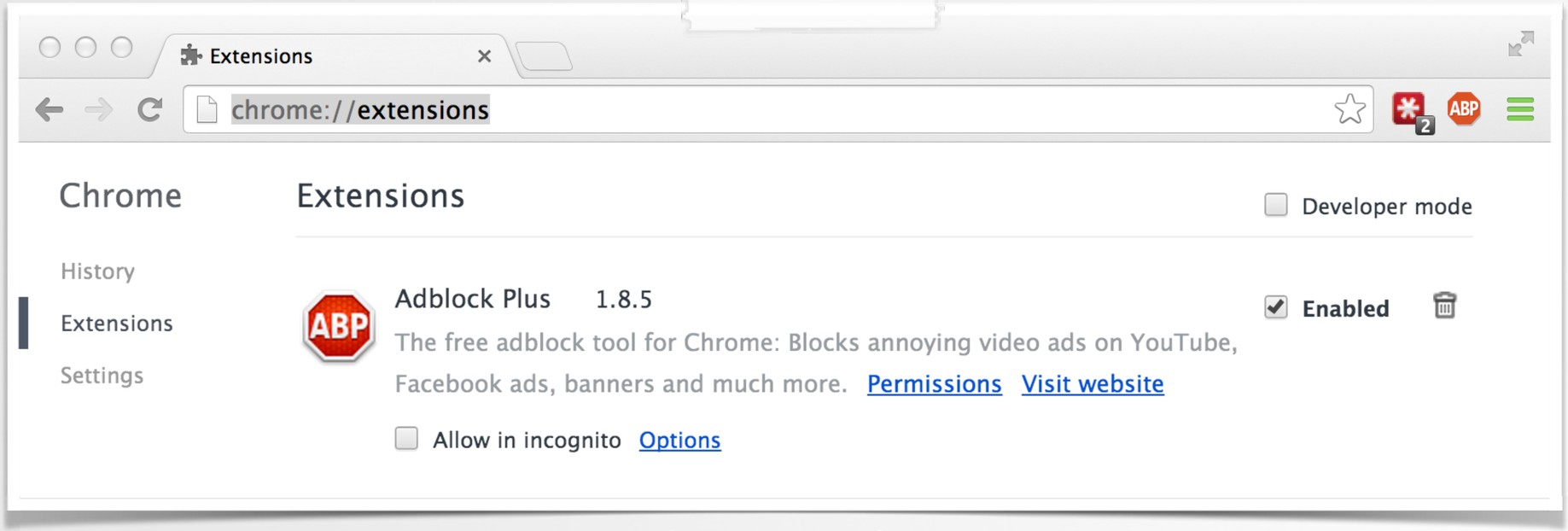
‘evil plugin’ (fG!)

safari

firefox

chrome

iTunes



browser (chrome) extensions

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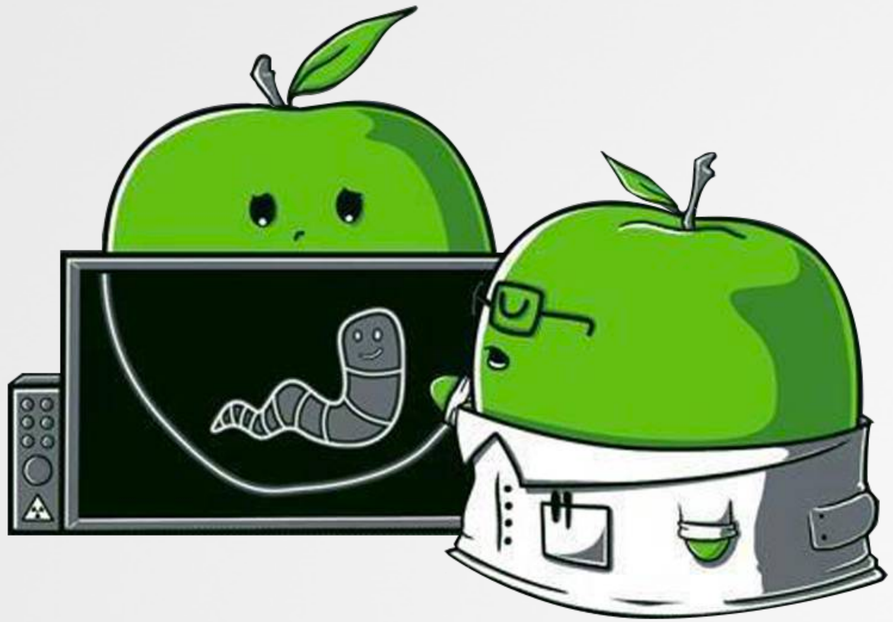
PERSISTENCE OS X MALWARE

how the bad guys do it



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OSX/CallMe (launch Daemon)

allows for infil/exfil & remote execution of commands

fs_usage is like fileMon

```
# fs_usage -w -filesystem | grep OSX_CallMe

open       /library/LaunchDaemons/.dat035f.000
WrData[A]  /library/LaunchDaemons/.dat035f.000
rename     /library/LaunchDaemons/.dat035f.000
           -> /library/LaunchDaemons/realPlayerUpdate.plist
```

```
$ ls /Library/LaunchDaemons/real*
realPlayerUpdate.plist

$ ps aux | grep -i real
root 0:00.06 /Library/Application Support/.realPlayerUpdate
```

the malware

launch daemon persistence

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OSX/FlashBack (LaunchAgent)

injects ads into users' http/https streams

```
$ less ~/Library/LaunchAgents/com.java.update.plist
<?xml version="1.0" encoding="UTF-8"?>
…
<dict>
  <key>Label</key>
  <string>com.java.update.plist</string>
  <key>ProgramArguments</key>
  <array>
    <string> /Users/user/.jupdate </string>
  </array>
  <key>RunAtLoad</key>
  <true/>
```

malware's binary

persist

(user) launch agent persistence

OSX/Crisis (LauchAgent)

collects audio, images, screenshots and

IDA (pseudo) disassembly

method name

```
;build path for malware's launch agent plist
-[RCSMUtils createLaunchAgentPlist:forBinary:]

call   NSHomeDirectory
mov    [esp+0Ch], eax
lea    edx, @"Library/LaunchAgents/com.apple.mdworker.plist"
mov    [esp+10h], edx
lea    edx, "%@/%@"
mov    [esp+8], edx
mov    [esp+4], stringWithFormat_message_refs
mov    [esp], NSString_clsRef
call   _objc_msgSend
```

(user) launch agent persistence

```
[NSString stringWithFormat:@"%@%@",
  NSHomeDirectory(), @"Library/LaunchAgents/com.apple.mdworker.plist"];
```

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OSX/XSLCmd (launch Agent)

provides reverse shell, infil/exfil, installation of other tools

persistence

```
__cstring:0000E910
 clipboardd db 'clipboardd',0
 com_apple_serv db 'com
 libraryLaunch db '/Lib
 db '<?xml version="1.0
 db '<plist version="1.
 db '<dict>',0Ah
 db '<key>RunAtLoad</ke
 db '<false/>',0Ah
 db '<key>KeepAlive</ke
 db '<true/>',0Ah
 db '<key>Label</key>',
 db '<string>com.apple.
 db '<key>Program</key>
 db '<string>%s</string
 db '</dict>',0Ah
 db '</plist>',0Ah,0
```

```
$ less ~/Library/LaunchAgents/com.apple.service.clipboardd.plist
<?xml version="1.0" encoding="UTF-8"?>
<plist version="1.0">
<dict>
 <key>RunAtLoad</key>
 <false/>
 <key>KeepAlive</key>
 <true/>
 <key>Label</key>
 <string>com.apple.service.clipboardd</string>
 <key>Program</key>
 <string>~/Library/LaunchAgents/clipboardd</string>
</dict>
</plist>
```

launch daemon persistence

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OSX/JANICAB (CRONJOB)

collects audio and screenshots

janicab's installer.py

```
""" add to crontab """

#add the script to crontab
subprocess.call("echo \"* * * * *
   python ~/.t/runner.pyc \" >>/tmp/dump",shell=True)

#import the new crontab
subprocess.call("crontab /tmp/dump",shell=True)
subprocess.call("rm -f /tmp/dump",shell=True)
```

```
$ crontab -l
* * * * * python
~/.t/runner.pyc
```

cron job persistence

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OSX/KITMOS (LOGIN ITEM)

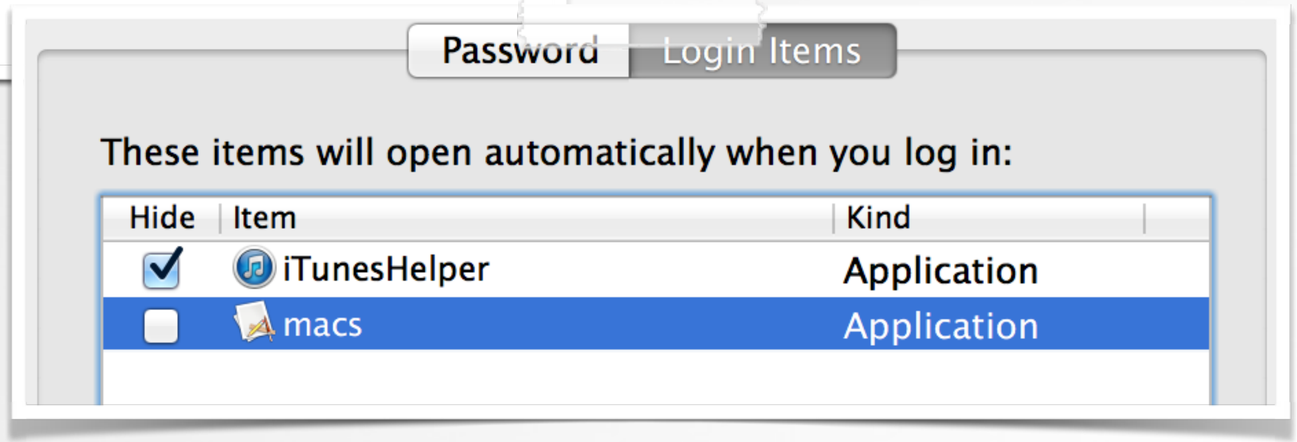
uploads screen shots to a remote c&c server

```
;build path for malware's launch agent plist
-[FileBackupAppDelegate checkAutorun]

mov     dword ptr [esp+18h], 0
mov     dword ptr [esp+14h], 0
mov     [esp+10h], ebx
mov     dword ptr [esp+0Ch], 0
mov     dword ptr [esp+8], 0
mov     [esp+4], eax ; _kLSSharedFileListItemLast_ptr
mov     [esp], edi  ; _LSSharedFileListCreate
call    LSSharedFileListInsertItemURL
```

persistence api

user's login items



login item persistence

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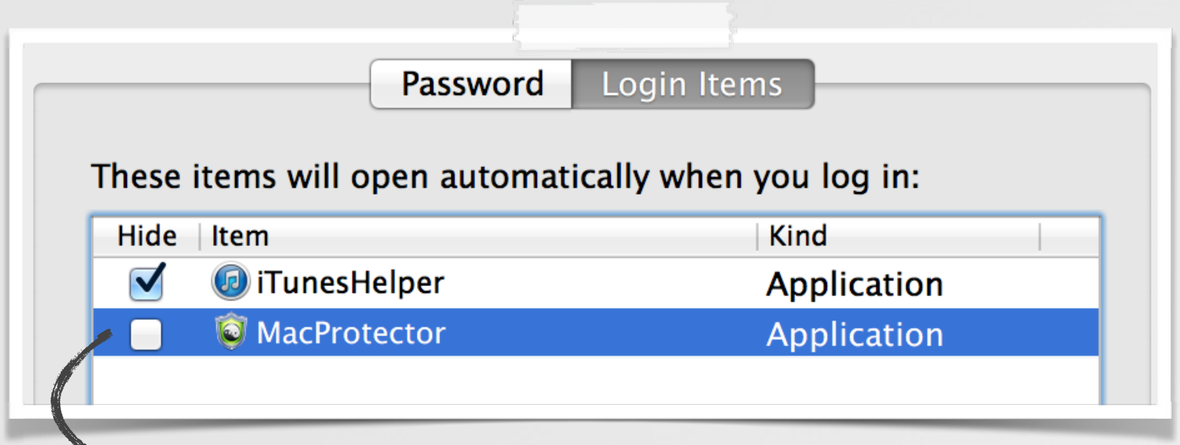
OSX/MacProtector (Login Item)

fake (rogue) anti-virus product that coerces user into paying up



~/Library/Preferences/com.apple.loginitems.plist

```
<dict>
  <key>Alias</key>
  <data>
  ZG5pYgAAAAACAAAAAAAAAAAAAAAAAAAAA...
  </data>
  <key>Name</key>
  <string>MacProtector</string>
</dict>
```

base64 encoded path, etc

login item persistence

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OSX/YONTOO (BROWSER EXTENSION)

injects adds into users' browser sessions

extracted from IDA disassembly

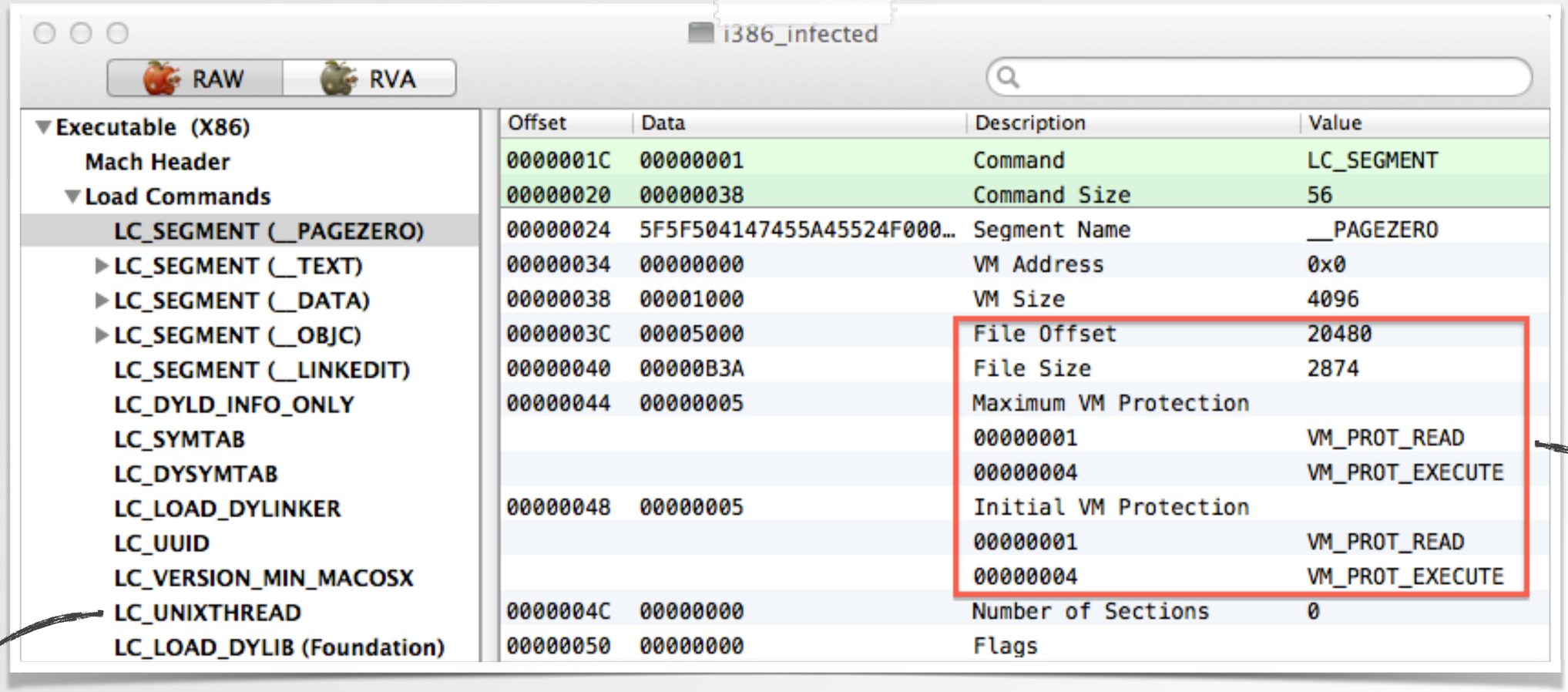
```
;create paths for malicious plugins

lea   edi, cfstr_InstallingExte; "Installing extensions"
lea   ebx, cfstr_Ok            ; "Ok"
...

+[ExtensionsInstaller installSafariExtension:]
"~/Library/Safari/Extensions/Extensions.plist"

+[ExtensionsInstaller installFirefoxExtension:]
"~/Library/Application Support/Mozilla/Extensions"

+[ExtensionsInstaller installChromeExtension:]
"~/Library/Application Support/Google/Chrome/External Extensions"
```

browser extension persistence

OSX/CLAPZOK (VIRAL INFECTION)

researcher released proof-of-concept

image src: http://reverse.put.as/ (fG!)



entry point
load command

binary infection persistence

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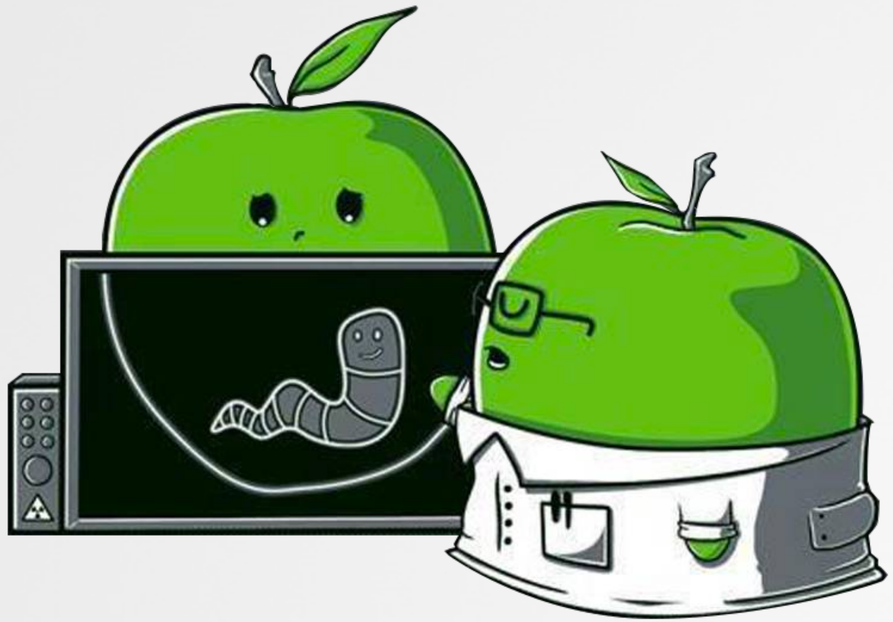
KNOCK KNOCK

‘autoruns’ for OS X



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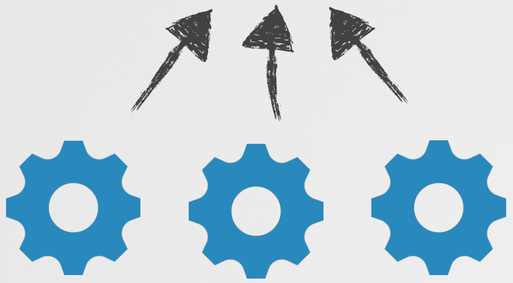
KNOCK KNOCK'S DESIGN & GOALS

finds stuff that will automatically execute during startup

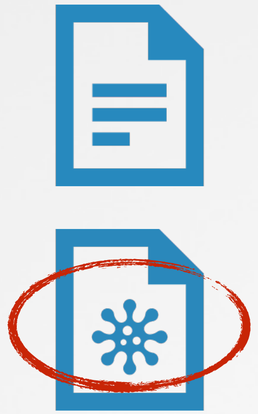
scan

core engine

"open-source, plugin-oriented, design aims to encourage collaboration & evolution"



plugins



malware

auto run binaries
& commands

github.com/synack/knockknock

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KnockKnock's Plugins

one for each particular persistence technique

```
#launch daemon directories
LAUNCH_DAEMON_DIRS = ['/System/Library/LaunchDaemons/', '/Library/LaunchDaemons/']

#init results
results['launchAgents'] = []

#get all files in launch daemon directories
for directory in LAUNCH_DAEMON_DIRS:
   launchItems.extend(glob.glob(directory + '*'))

#iterate over launch daemon files (plists)
# ->find/save ones that are set to auto run
for item in launchItems:
   plistData = utils.loadPlist(item)

   if plistData[‘RunAtLoad'] or plistData['KeepAlive']:
      results.append(file.File(plistData['ProgramArguments'][0]))
```

persistence?

(simplified) launch daemon plugin

KnockKnock Output

(currently) command-line

SHA256: 1db30d5b2bb24bcc4b68d647c6a2e96d984a13a28cc5f17596b3bfe316cca342

File name: clipboardd

Detection ratio: 0 / 51

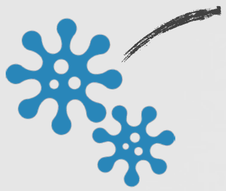
Analysis date: 2014-08-12 16:34:34 UTC (1 week, 2 days ago)


```
$ python knockknock.py -p launchDandA
WHO'S THERE:

[Launch Agents]

clipboardd
 path: /Users/user/Library/LaunchAgents/clipboardd
 plist: /Users/user/Library/LaunchAgents/com.apple.service.clipboardd.plist
 hash: 60242ad3e1b6c4d417d4dfeb8fb464a1

TOTAL ITEMS FOUND: 1
```



OSX/XSLCmd detection

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Some Conclusions

with tonnes of persistence methods

insecure macs

+

os x malware

=

but knowledge is power
& **knockknock** can help!

Questions & Answers

...feel free to contact me any time!

patrick@synack.com

@patrickwardle

syn.ac/virusb2014

try it out!

github.com/synack/knockknock

Synack

credits

thezooom.com
deviantart.com (FreshFarhan)

iconmonstr.com
flaticon.com