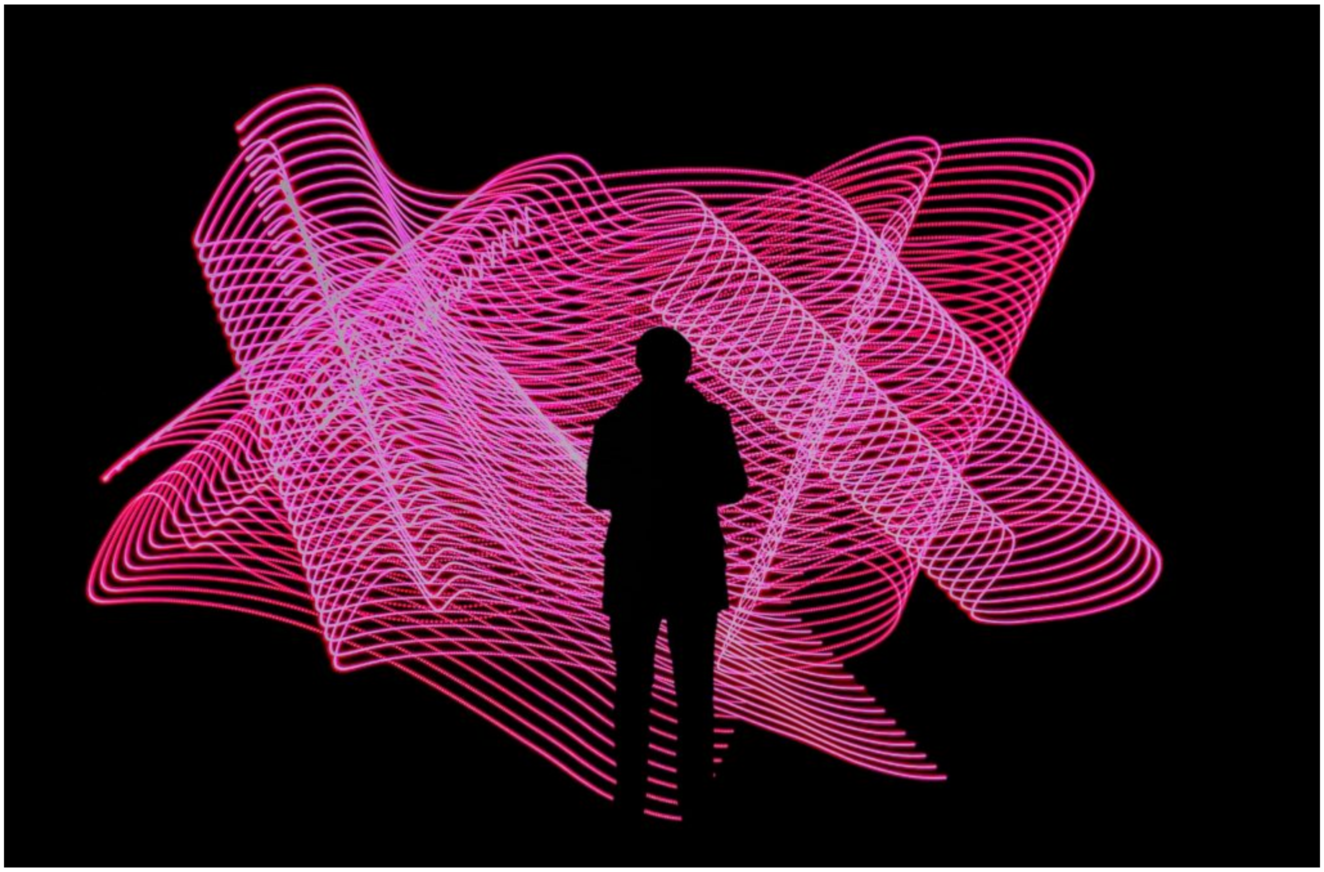
On the Trail of OSX.FairyTale | Adware Playing at Malware

sentinelone.com/blog/trail-osx-fairytale-adware-playing-malware/

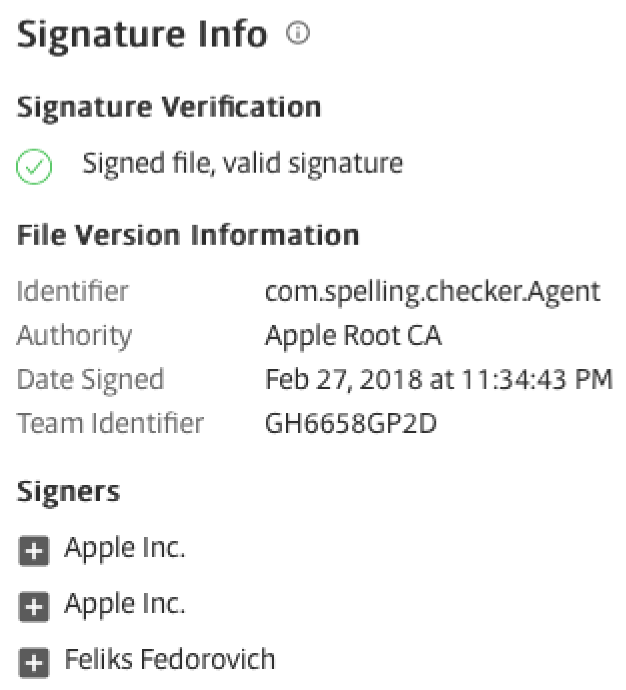
September 20, 2018



Spotted: An adware installer tries its best to avoid detection but leaves behind more clues than intended. Scroll down to find out more!

Trojan installers delivering adware and unwanted applications (PUPs) have been the most prevalent security nuisance on the macOS platform in recent years. To date, these have engaged in little more than low-level scraping of user data and browsing habits, but their potential to be far more threatening is only awaiting the right monetary incentive. A recent report on what appeared to be a run-of-the-mill adware infection set us on the trail of OSX.FairyTale, an adware variant first identified in early 2018 by Malwarebytes researcher Thomas Reed. FairyTale uses a lot of heavy obfuscation and anti-reversing technology, not unusual for malware, but overkill for simple adware. We decided to take a closer look.

Our sample came in the guise of a trojan installer called SpellingChecker.app that was uploaded to VirusTotal in late August. The application bundle is signed with a valid Apple Developer ID:


Signature Info

Signature Verification

✓ Signed file, valid signature

File Version Information

Identifier	com.spelling.checker.Agent
Authority	Apple Root CA
Date Signed	Feb 27, 2018 at 11:34:43 PM
Team Identifier	GH6658GP2D

Signers

- Apple Inc.
- Apple Inc.
- Feliks Fedorovich

However, that has since been revoked by Apple:

```
Sentinel:$ spctl --verbose=4 --assess --type execute SpellingChecker.app
```

```
SpellingChecker.app: CSSMERR_TP_CERT_REVOKED
```

Static analysis of the installer binary reveals two things of immediate note: an attempt to escalate privileges with AppleScript, and a lot of base64 encoded strings.

```
do shell script "%@" with administrator privileges
```

```
H0VDQh9SWV4fSFFEREI=
```

```
HUJT
```

```
H0VDQh9SWV4fX0BVXg==
```

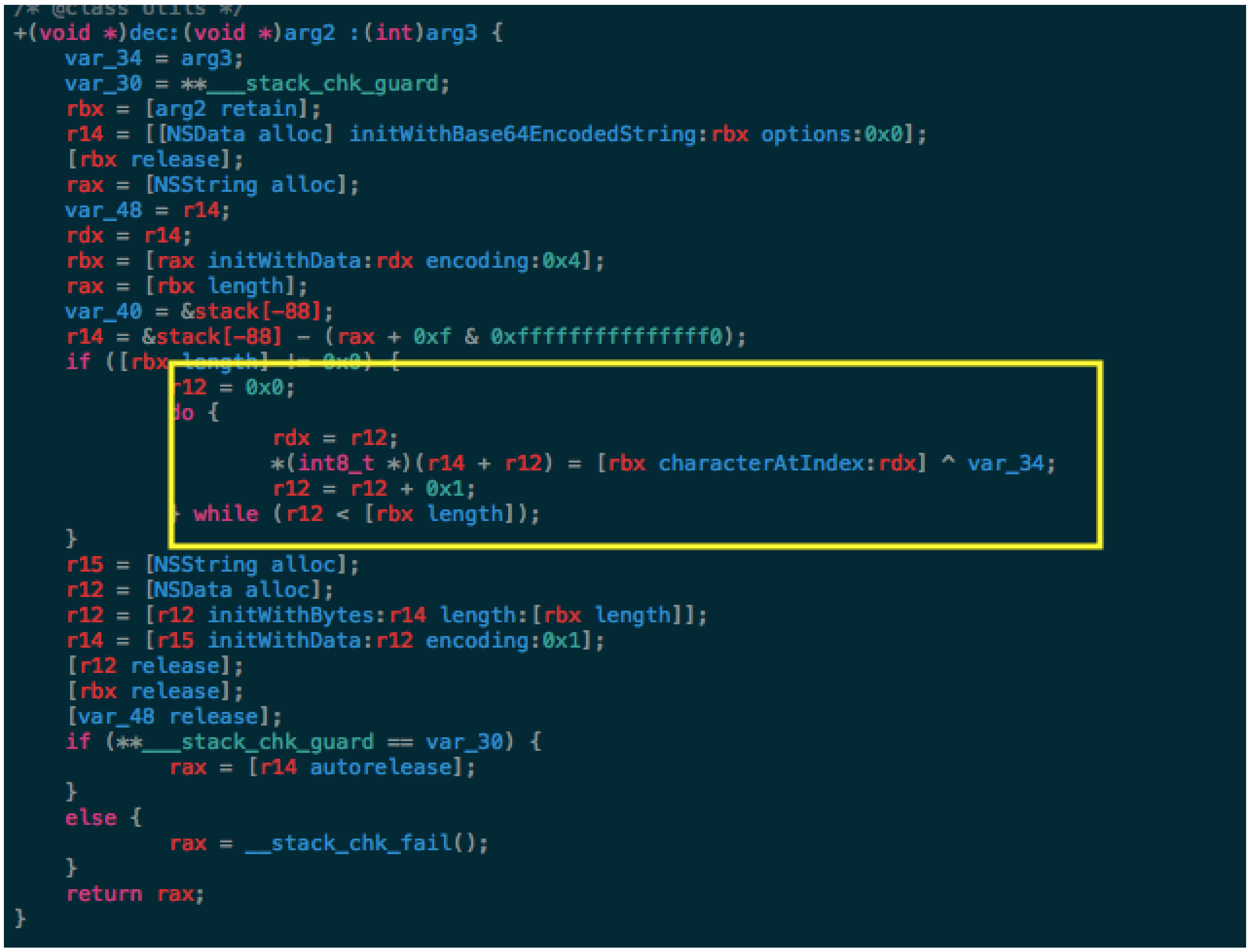
We knew things were going to get interesting when our first attempt to decode the base64 only spewed out gibberish:

```
Sentinel:$ echo H0VDQh9SWV4fSFFEREI= | base64 -D; echo
```

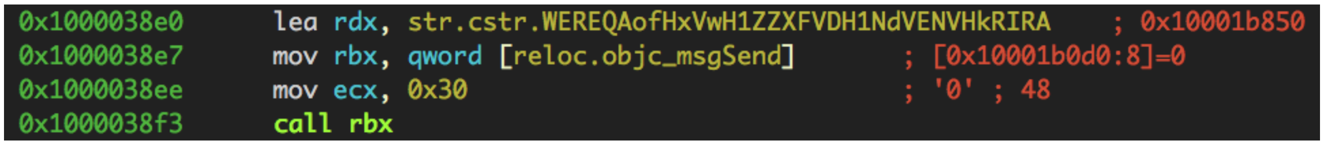
```
ECBRY^HQDDB
```

```
Sentinel:$
```

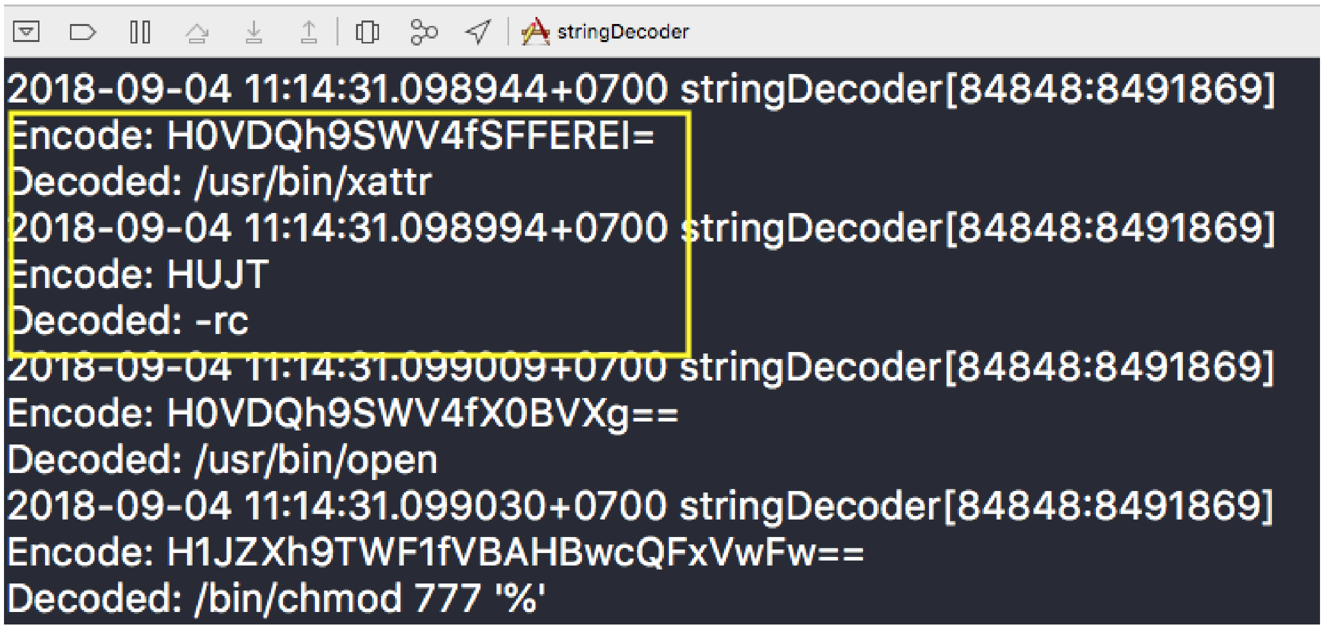
A quick trip to Hopper showed us the pseudo-code for the decryption method:


```
/* @class Utils */
+(void *)dec:(void *)arg2 :(int)arg3 {
    var_34 = arg3;
    var_30 = **___stack_chk_guard;
    rbx = [arg2 retain];
    r14 = [[NSData alloc] initWithBase64EncodedString:rbx options:0x0];
    [rbx release];
    rax = [NSString alloc];
    var_48 = r14;
    rdx = r14;
    rbx = [rax initWithData:rdx encoding:0x4];
    rax = [rbx length];
    var_40 = &stack[-88];
    r14 = &stack[-88] - (rax + 0xf & 0xfffffffffffffff0);
    if ([rbx length] != 0x0) {
            r12 = 0x0;
            do {
                    rdx = r12;
                    *(int8_t *)(r14 + r12) = [rbx characterAtIndex:rdx] ^ var_34;
                    r12 = r12 + 0x1;
            } while (r12 < [rbx length]);
    }
    r15 = [NSString alloc];
    r12 = [NSData alloc];
    r12 = [r12 initWithBytes:r14 length:[rbx length]];
    r14 = [r15 initWithData:r12 encoding:0x1];
    [r12 release];
    [rbx release];
    [var_48 release];
    if (**___stack_chk_guard == var_30) {
            rax = [r14 autorelease];
    }
    else {
            rax = __stack_chk_fail();
    }
    return rax;
}
```

A fairly-straightforward XOR, which we re-implemented in Objective-C. Looking at the arguments passed into the method, the base64 was XOR'd with 0x30 (48 in decimal):


```
0x1000038e0      lea rdx, str.cstr.WEREQAofHxVwH1ZZXFVDH1NdVENVHkRIRA    ; 0x10001b850
0x1000038e7      mov rbx, qword [reloc.objc_msgSend]        ; [0x10001b0d0:8]=0
0x1000038ee      mov ecx, 0x30                              ; '0' ; 48
0x1000038f3      call rbx
```

Using our decoder, we were now able to see what the installer was up to: an XProtect bypass:



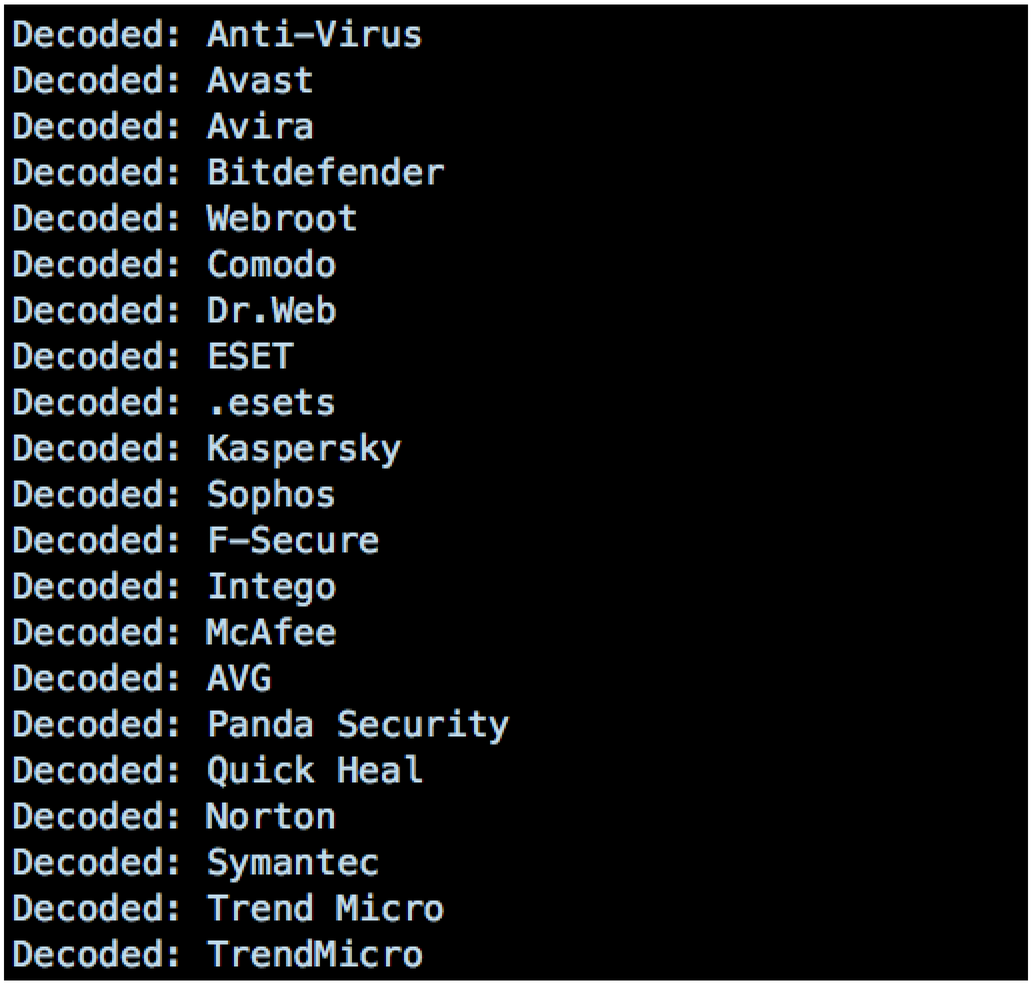
```
2018-09-04 11:14:31.098944+0700 stringDecoder[84848:8491869]
Encode: H0VDQh9SWV4fSFFEREI=
Decoded: /usr/bin/xattr
2018-09-04 11:14:31.098994+0700 stringDecoder[84848:8491869]
Encode: HUJT
Decoded: -rc
2018-09-04 11:14:31.099009+0700 stringDecoder[84848:8491869]
Encode: H0VDQh9SWV4fX0BVXg==
Decoded: /usr/bin/open
2018-09-04 11:14:31.099030+0700 stringDecoder[84848:8491869]
Encode: H1JZXh9TWF1fVBAHBwcQFxVwFw==
Decoded: /bin/chmod 777 '%'
```

Using `xattr` to remove Apple's quarantine bit is a common technique used by researchers. It makes it possible to run and examine malware on a Mac even after it has been blocked by Apple. Clearly, this trick hasn't gone unnoticed among malware authors, either.

FairyTale's installer had another surprise for us, too. For both safety and convenience, malware researchers make use of virtual machines to analyse samples, but FairyTale's authors didn't want anyone looking at their code in a virtual machine:

```
Decoded: ioreg -l | grep -e 'VirtualBox' -e 'Oracle' -e 'VMware' -e
'Parallels' | wc -l
```

And they didn't want to get caught by Legacy AntiVirus software either, as this list of de-obfuscated base64 strings makes clear:



```
Decoded: Anti-Virus
Decoded: Avast
Decoded: Avira
Decoded: Bitdefender
Decoded: Webroot
Decoded: Comodo
Decoded: Dr.Web
Decoded: ESET
Decoded: .esets
Decoded: Kaspersky
Decoded: Sophos
Decoded: F-Secure
Decoded: Intego
Decoded: McAfee
Decoded: AVG
Decoded: Panda Security
Decoded: Quick Heal
Decoded: Norton
Decoded: Symantec
Decoded: Trend Micro
Decoded: TrendMicro
```

On execution, the Installer takes a trip to Temp folder where it drops the following compressed file:

`/tmp/ot3497.zip`

After unpacking the zip file, FairyTale then writes and loads a persistence agent and its executable to the following paths:

`~/Library/LaunchAgents/com.sysd.launchserviced.plist`

`~/Library/Application Support/com.sysd.launchserviced/launchserviced`

The installer uses the `xattr` to both remove the quarantine bit and the `kMDItemWhereFroms` bit, which is used by Spotlight and MDQuery to keep track of where a file has come from. Typically, for downloads, that will be the URL from which the file was sourced. Fortunately, macOS has other ways of spilling secrets; namely, in this case, in `~/Library/Caches/com.spelling.checker.Agent` sql database:

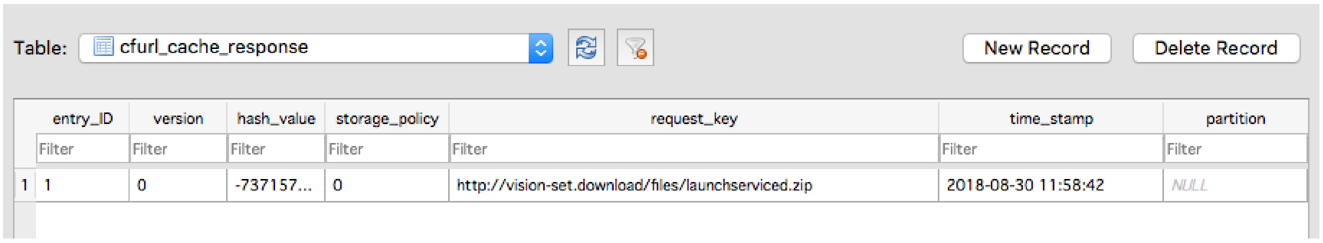


Table: cfurl_cache_response

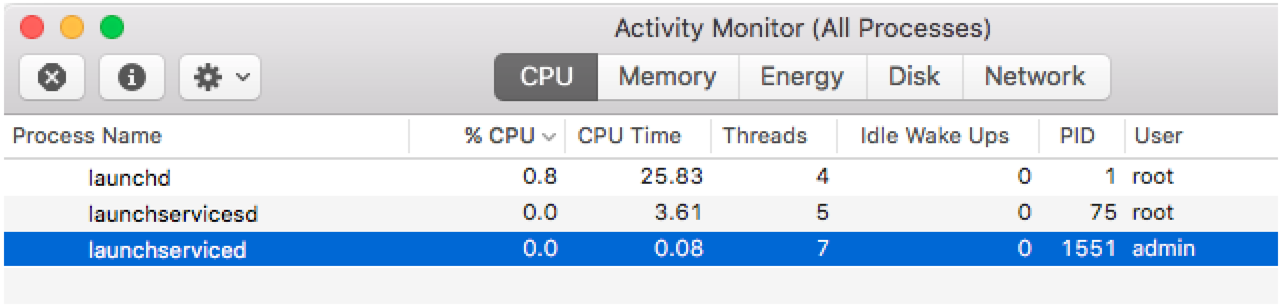
New Record | Delete Record

	entry_ID	version	hash_value	storage_policy	request_key	time_stamp	partition
1	1	0	-737157...	0	http://vision-set.download/files/launchserviced.zip	2018-08-30 11:58:42	NULL

From this, we can see that the installer grabbed the launchserviced.zip from

`http://vision-set.download/files/launchserviced.zip`

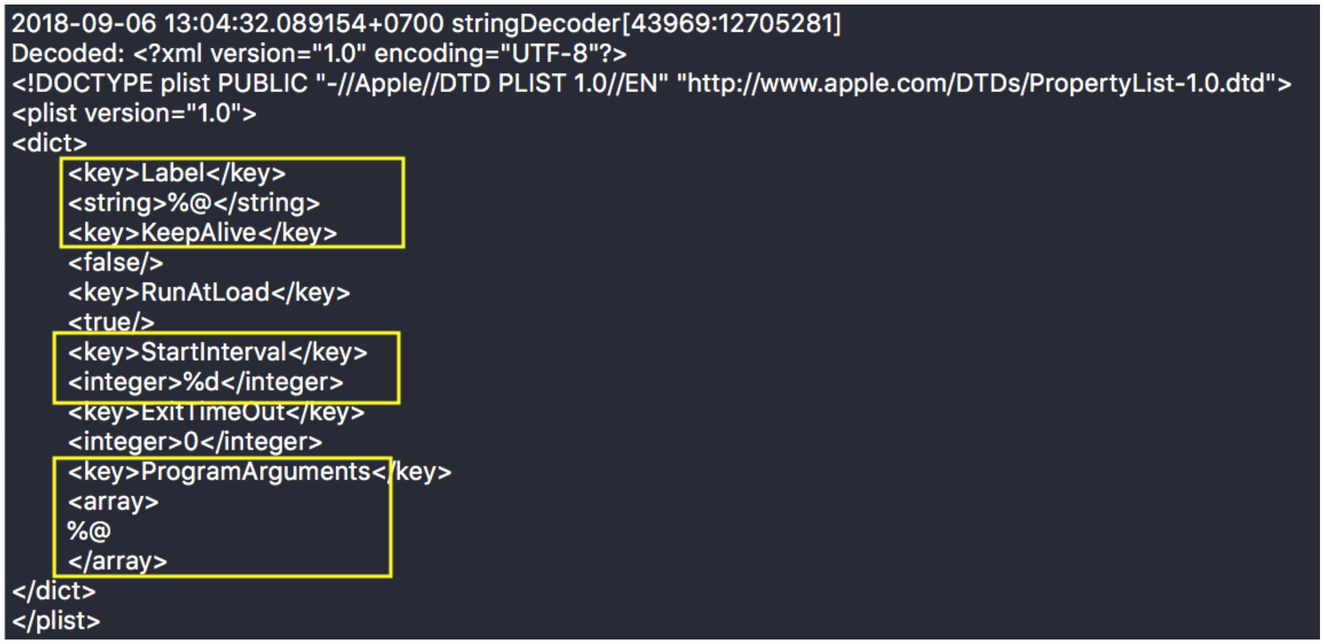
Stealth was undoubtedly on the author's mind. The name of the executable, launchserviced, is just one letter different from the name of a real Apple process that runs on every user's Mac. The highlighted item below is OSX.FairyTale trying to blend in with legitimate Apple processes:



Process Name	% CPU	CPU Time	Threads	Idle Wake Ups	PID	User
launchd	0.8	25.83	4	0	1	root
launchservicesd	0.0	3.61	5	0	75	root
launchserviced	0.0	0.08	7	0	1551	admin

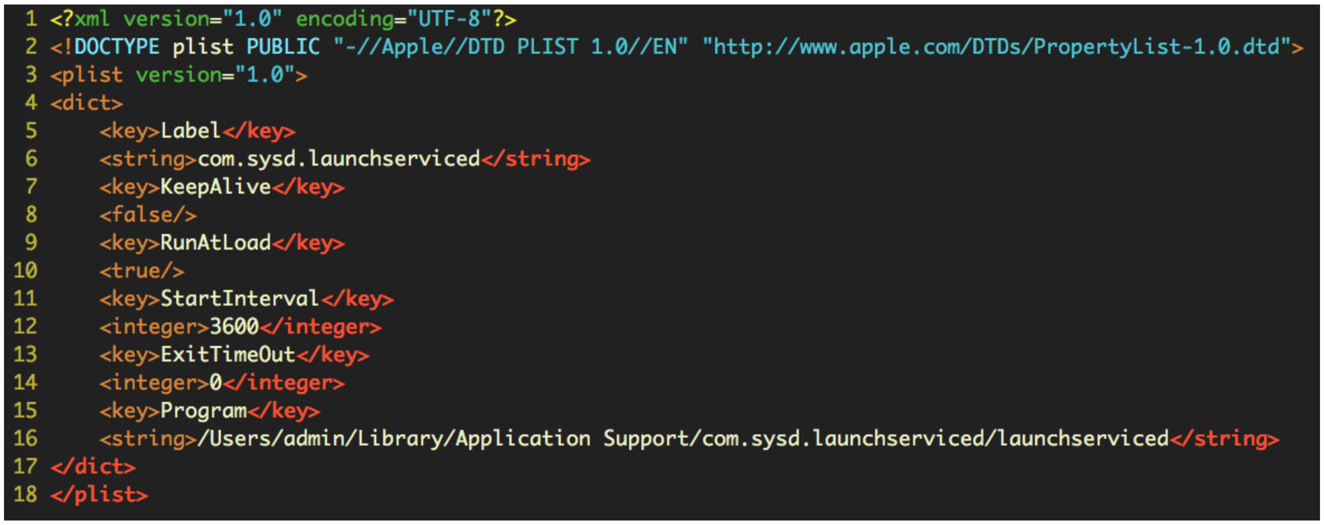
Clearly, FairyTale aims to go unnoticed or to be taken for something legitimate.

Among the installer's obfuscated base64 is the template for a property list file:


```
2018-09-06 13:04:32.089154+0700 stringDecoder[43969:12705281]
Decoded: <?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist PUBLIC "-//Apple//DTD PLIST 1.0//EN" "http://www.apple.com/DTDs/PropertyList-1.0.dtd">
<plist version="1.0">
<dict>
    <key>Label</key>
    <string>%@</string>
    <key>KeepAlive</key>
    <false/>
    <key>RunAtLoad</key>
    <true/>
    <key>StartInterval</key>
    <integer>%d</integer>
    <key>ExitTimeOut</key>
    <integer>0</integer>
    <key>ProgramArguments</key>
    <array>
    %@
    </array>
</dict>
</plist>
```

Notice that it uses placeholders for some of the keys: *label* – the name that is typically used for the property list's filename and also the name it gives to *launchd* when it's loaded; *StartInterval* – which tells *launchd* how often to run the job; and *ProgramArguments* – an array of commands to pass to the job when it runs.

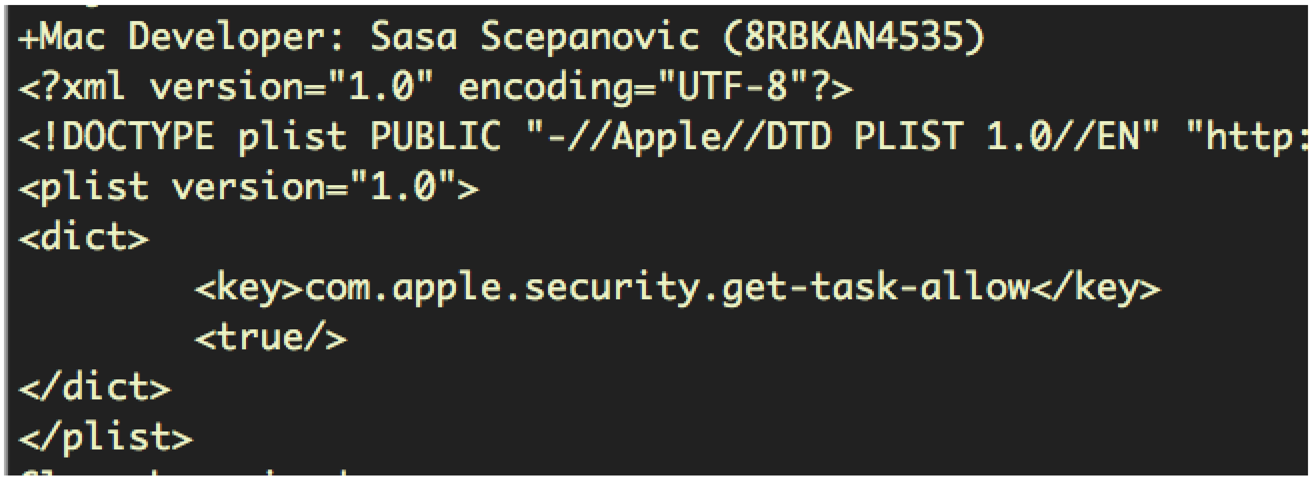
Again, the intent is clear: this isn't a one-off package, but a re-usable installer for any payload the author chooses. Here's the actual property list dropped for Spelling.Checker, with a start interval of 3600 seconds, i.e., every hour:



```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist PUBLIC "-//Apple//DTD PLIST 1.0//EN" "http://www.apple.com/DTDs/PropertyList-1.0.dtd">
<plist version="1.0">
<dict>
    <key>Label</key>
    <string>com.sysd.launchserviced</string>
    <key>KeepAlive</key>
    <false/>
    <key>RunAtLoad</key>
    <true/>
    <key>StartInterval</key>
    <integer>3600</integer>
    <key>ExitTimeOut</key>
    <integer>0</integer>
    <key>Program</key>
    <string>/Users/admin/Library/Application Support/com.sysd.launchserviced/launchserviced</string>
</dict>
</plist>
```

The dropped version used the *Program* key rather than *ProgramArguments* key, which tells us that no commands are passed to the executable on launch in this case. Although the property list structure is correct, it's an unnecessary change, as the same effect is achieved by simply passing in the program path as the first argument to the *ProgramArguments* key.

It seems the coder is a careful programmer who pays attention to details. Alas, like all villains in a FairyTale, it's the bad guys' own actions that lead to their downfall, and this story is no different when we look at the launchserviced binary.



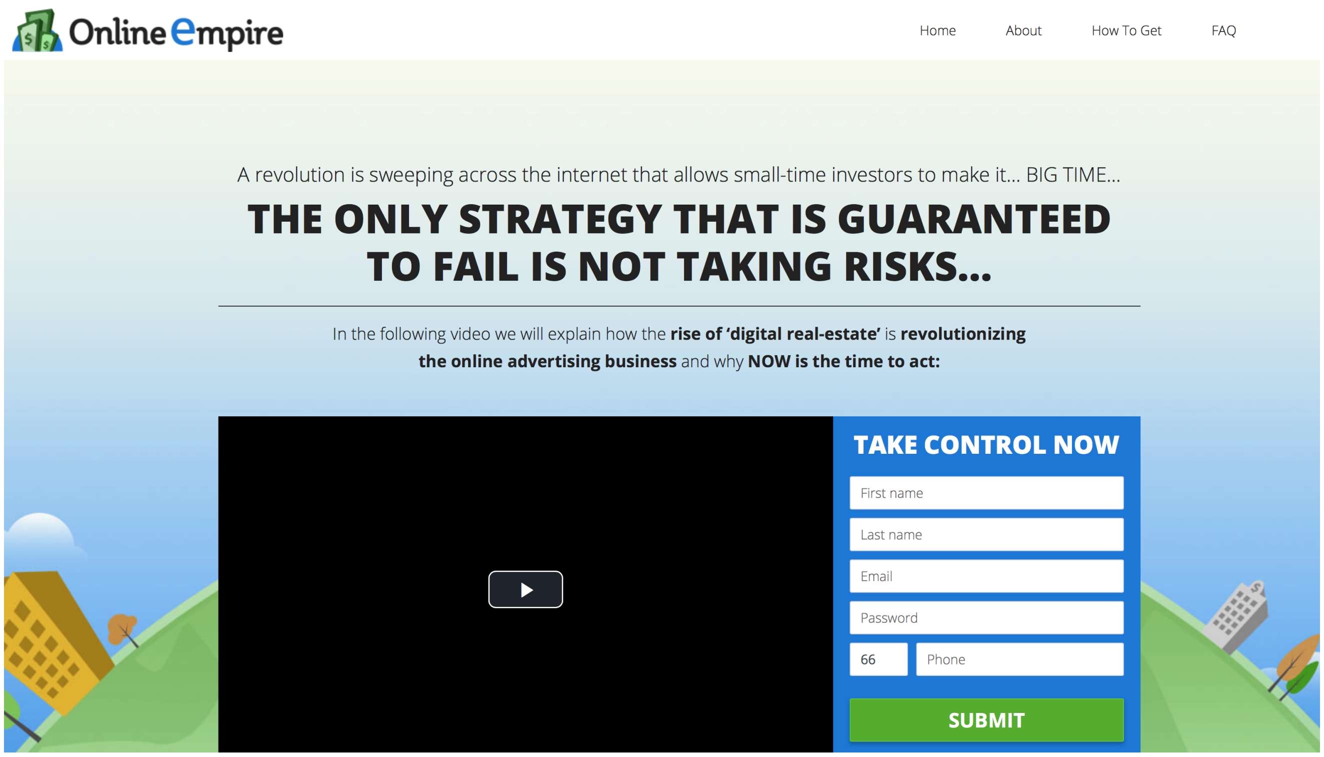
```
+Mac Developer: Sasa Scepanovic (8RBKAN4535)
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist PUBLIC "-//Apple//DTD PLIST 1.0//EN" "http:
<plist version="1.0">
<dict>
        <key>com.apple.security.get-task-allow</key>
        <true/>
</dict>
</plist>
```

After all the effort put into avoiding detection and reverse engineering, the author of launchserviced made an error, and appears to have accidentally allowed debug entitlements in the binary:

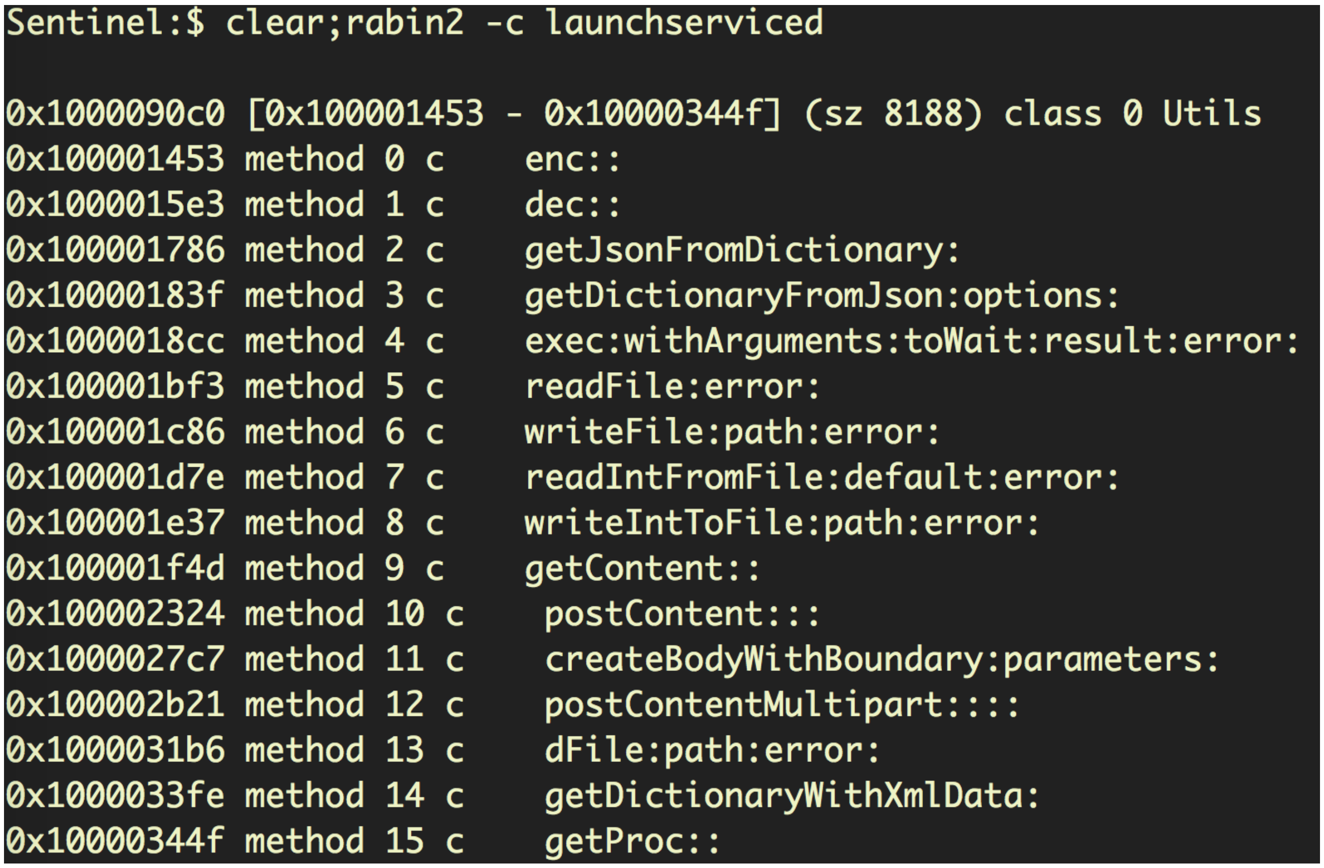
Although not currently enforced by Apple, the `com.apple.security.get-task-allow` entitlement is intended to allow a debugger to attach to a sandboxed app when it's running. This is necessary during development to allow Xcode or the low-level debugger (lldb) to launch and inspect the running code. However, the entitlement is stripped automatically when code is exported for distribution through Xcode's Organizer. The presence of it here suggests that the developer copied the target from the project after building it, or perhaps exported the binary using 'debug' rather than 'release' settings.

We also see this binary is signed with a different developer ID than the revoked one used for the installer. Although it's not possible to tell whether this signature is revoked, we have reported it to Apple and assume they are investigating.

When executed, the launchserviced appears to have relatively benign behaviour. If Safari is open, it is redirected through several sites and finally lands on `online-empire.co`:


Online Empire
Home
About
How To Get
FAQ
A revolution is sweeping across the internet that allows small-time investors to make it... BIG TIME...
THE ONLY STRATEGY THAT IS GUARANTEED TO FAIL IS NOT TAKING RISKS...
In the following video we will explain how the rise of 'digital real-estate' is revolutionizing the online advertising business and why NOW is the time to act:
TAKE CONTROL NOW
First name
Last name
Email
Password
66
Phone
SUBMIT

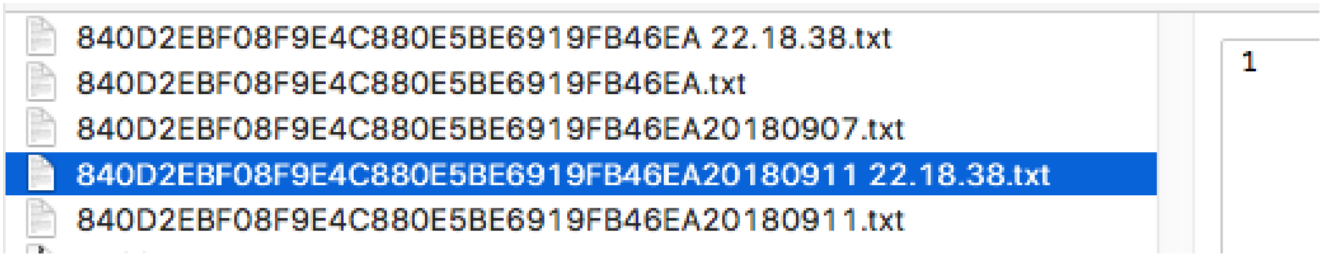
Other addresses loaded include `rdtrck2.com` and `bizprofits.go2cloud.org`, `rdtrck2.com`, `bizprofits.go2cloud.org` and `tracklik.com`.
Further static analysis of the code reveals methods that we'd expect to see in browser redirection:



```
Sentinel:$ clear;rabin2 -c launchserviced

0x1000090c0 [0x100001453 - 0x10000344f] (sz 8188) class 0 Utils
0x100001453 method 0 c    enc::
0x1000015e3 method 1 c    dec::
0x100001786 method 2 c    getJsonFromDictionary:
0x10000183f method 3 c    getDictionaryFromJson:options:
0x1000018cc method 4 c    exec:withArguments:toWait:result:error:
0x100001bf3 method 5 c    readFile:error:
0x100001c86 method 6 c    writeFile:path:error:
0x100001d7e method 7 c    readIntFromFile:default:error:
0x100001e37 method 8 c    writeIntToFile:path:error:
0x100001f4d method 9 c    getContent::
0x100002324 method 10 c    postContent:::
0x1000027c7 method 11 c    createBodyWithBoundary:parameters:
0x100002b21 method 12 c    postContentMultipart::::
0x1000031b6 method 13 c    dFile:path:error:
0x1000033fe method 14 c    getDictionaryWithXmlData:
0x10000344f method 15 c    getProc::
```

Two data files are written to the executable’s parent folder with a hard-coded file name prefix `840D2EBF08F9E4C880E5BE6919FB46EA`. The files contain a single byte, which in our tests was either ‘1’ or ‘2’.

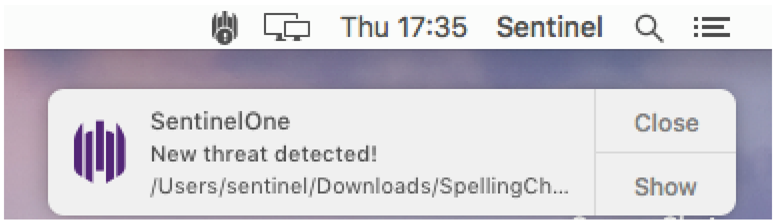


840D2EBF08F9E4C880E5BE6919FB46EA 22.18.38.txt
840D2EBF08F9E4C880E5BE6919FB46EA.txt
840D2EBF08F9E4C880E5BE6919FB46EA20180907.txt
840D2EBF08F9E4C880E5BE6919FB46EA20180911 22.18.38.txt
840D2EBF08F9E4C880E5BE6919FB46EA20180911.txt

1

A Happy Ending?

OSX.FairyTale is an interesting adware variant not because of what it does, but because of the techniques used to prevent detection and analysis. Considerable effort has been expended in hardening the installer code to prevent reversal, and launchserviced was clearly named for stealth. Given the rather unadventurous behaviour of the launchserviced code, we can only assume that these efforts were either a proof-of-concept or part of a larger project still in development.



SentinelOne
New threat detected!
/Users/sentinel/Downloads/SpellingCh...

The developer signatures and code are now on the radar, but like many a real-life FairyTale, we won’t be surprised to see this one get retold and adapted for other purposes in the future.