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THE ANATOMY OF A CYBER ATTACK: DISSECTING THE CYBER KILL CHAIN (CKC)

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ABSTRACT. Cyber-attacks is on continuous rise. Many organization's information systems have been compromised and their data stolen. Yet the number of Internet users is on the raise daily. The users are exposed to various cyber attacks of various types ranging from phishing, ransomware, cyber bullying, blackmailing and many more. This paper investigates in detail in to the various steps cyber attackers follow to attack and compromise a system. A theoretical review of the steps is presented and a practical demonstration of the steps presented. This paper will be very beneficial in understanding how cyber attack is conducted. This will help in planning defensive controls to curtail the attacks.

KEYWORDS: cyber attacks, cyber kill chain, hacking, vulnerability, exploit

According to Panda (n.d.), from the Cyber Kill Chain (CKC) we learn that we have the ability to stop the attacker at any step of the CKC, but the attacker has to complete all the seven steps to attain success. The CKC therefore, gives us a better understanding of the attackers and their methodology so as to have a more effective defense (Panda, n.d.). The CKC has been used for many years by the United States Department of Defence (DoD) in both cyber defence and in the battle fields (Al-Mohannadi et al., 2016). Cyber attack is any type of offensive exercise aimed at computer information systems, infrastructures, computer networks or personal computer devices (Panda, n.d.). The cyber attackers might be outsiders or insiders. Attackers classified as outsiders include terrorists, nation states, hacktivists and cyber criminals. Attackers classified as insiders are the disgruntled employees. To perform unauthorized or unintended actions, an attacker exploit a weakness referred to as a vulnerability in a computer system. The sequence of commands that takes advantage of a vulnerability to result in an unintended behaviour in a computer system is referred to as a vulnerability (Panda, n.d.).

THE CYBER KILL CHAIN

The CKC is a model aimed at illustrating cyber attacks in order to develop incident response and analysis capacity (Yadav and Rao, 2015). A mnemonic has been proposed to help easily identify the steps of the cyber kill chain: **R**eal **W**omen **D**ate **E**ngineers **I**n **C**ommando **A**rmour, with the initials representing the seven steps of the Cyber Kill Chain.

Reconnaissance

This is a stage of target selection, researching organization's details, information on technology choices, social network activity and mailing lists (Panda, n.d.). During these stage the attackers

are trying to find out which attack methods will be most effective against their target. Reconnaissance is classified into active reconnaissance and passive reconnaissance. In active reconnaissance, the attacker directly engages the network in order to find vulnerabilities that he/she could use for his/her attack. Active reconnaissance is usually done by scanning the ports of a host on the target network to discover open ports and the services that these ports are running (Active Reconnaissance, 2012).

A good firewall with a correctly configured Access Control List (ACL) that will limit the exposure of ports and services to the Internet is the simplest way to stop most port scans (Active Reconnaissance, 2012). Intrusion Prevention System (IPS) could be deployed to spot port scanning and put it off before the attacker could gather much information about the target (Chris Velazquez, 2015). Hutchins et al., (2010) have defined passive reconnaissance as an effort to gather information about a target network without actively enagaging with the target. Passive reconnaissance is usually achieved with Open Source Intelligence (OSINT) tools. These include the use of the target's website, social media and job recruitments sites. A social media profile of an employee can provides tons of information about the technologies used by target organization that could help an attacker to prepare for his/her attack against the target organization (Czumak, 2014). The information gathered during this stage becomes very much handy in designing and delivering a payload (Yadav and Rao, 2015).

Weaponization

A payload that will be delivered to meet the objectives of the attacker is obtained during this stage (Hutchins et al., 2010). The attacker tries to gather as much information as possible during the reconnaissance stage which the attacker now utilizes to prepare the right payload the attacker could deploy to attack the target (Velazquez, 2015). Weaponization could be achieved through web application exploitation, commodity or customized malware which has been prepared using an opportunistic or detailed information about the target (Panda, n.d.). A deliverable payload is prepared by pairing a Remote Access Trojan (RAT) with an exploit (Yadav and Rao, 2015). The RAT is made up of two parts: the client part and the server part. The client is the part of the RAT that is delivered to the target to executes and create a network connection with the C & C infrastructure. The client receives command from the C & C server, executes the command and returns the result. The sever aspects sits in the C & C system to display result obtained from the client part and issue command to the client (Yadav and Rao, 2015). Using the system/software vulnerabilities to deliver and executes the RAT, the exploit serves as a carrier for the RAT. RAT could be embedded in a legitimate software, delivered through social engineering, or presented as a genuine image, audio/video files.

Delivery

The most realistic and efficient way, example e-mail, USB device or watering hole is utilized to send the selected payload (Velazquez, 2015). The delivery of the payload can either be target-initiated example the target opening a malicious PDF file or attacker-initiated for example the attacker using SQL injection attack or compromising a network service (Panda, n.d.). The delivery stage provides the first opportunity defenders could use technology to mitigate attacks

(Velazquez, 2015). Using Network Intrusion Detection like Surricata (NIDS) and Host Intrusion Detection (HIDS). According to Clarke (2017), the most thriving technique of sending payload into an organization is with the use of e-mail. E-mail URL scanners could be use to protect from links that could lead to malicious websites (Velazquez, 2015). Another common method used by attackers to gain entry into an organization is through drive-by-downloads. Instead of being completely self-contained, most drive-by-downloads attacks uses malware distribution networks. The exploit code is hosted on a separate web server achieved using a compromised web page using a method like inserting a URL in malicious script code. User interactions like downloading and executing malicious files or visiting malicious web pages on the Internet is necessarily in most cyber attacks. Exploiting network devices or services like CVE-2014-3306 and CVE-2014-9583 are some attacks that could occur without user interactions. Using paid anonymous services, compromised websites, and compromised email accounts many attacks occurred anonymously (Yadav and Rao, 2015).

Exploitation

In the exploitation stage, the attacker's payload is triggered on the target system (Yadav and Rao, 2015). The malicious payload compromises the computer device in order to gain a foothold in the environment (Panda, n.d.). According to Yadav and Rao, (2015), the exploit must match the operating system/software version and upgrade status and it must be able to evade any form of antivirus or any security control. Upon successful execution, the payload will reconnect to the C & C part and awaits further instructions. Prepared using vulnerabilities in software known as CVE, exploit is the most significant part of the CKC (Yadav and Rao, 2015).

Installation

In the installation stage, a malware is installed on the victim's computer. Prior to infecting the victim's computer, the payload will either be executed by the victim or the payload may automatically executes itself (Al-Mohannadi, et al., 2016). The malicious payload is installed and persistence is maintained (Yadav and Rao, 2015). Modern malware utilizes droppers and downloaders to deliver the malware modules in a complicated manner. A program that installs and run the malware on target system is known as a dropper. Downloaders on the otherhand, does not contain the central malicious components but instead connects to a remote repository to download the core components (Yadav and Rao, 2015).

Command & Control

The attacker creates a C & C channel as an entrance to the internal assets of the victim using the installed malware. The attacker is now in control of the victim's machine at this stage (Al-Mohannadi, et al., 2016). The attacker uses the C & C channel to tell the compromised machine what to do next and what information to gather (Panda, n.d.). The C & C channel can be centralized or peer-to-peer decentralized structure. In the centralized structure, a central server is used to command and control compromised machines. In peer-to-peer decentralized architecture infected machines are used as nodes and each node is responsible for only a subset of the of the total bots in the botnets. Some of the techniques used by malware to achieve unobservable

anonymous communication channel include the use of Internet Relay Chat (IRC), use of TCP/HTTP/FTP protocols, steganography and the use of The Onion Router (TOR) (Yadav and Rao, 2015). The use of DNS fast flux, DNS as a medium and Domain Generation Algorithm (DGA) are some of the ways malware authors use to hide their C & C server from detection.

Act on Objectives

The objective of the attack might be mass attack or targeted attack. The aim of mass attack is to attack as many targets as possible with the aim of recruiting them into a botnet for DDoS attack or credentials harvesting (Yadav and Rao, 2015). In targetted attacks, data exfiltration or credentials harvesting are usually the motive. If the motive is destructive in however, the attackers may crash the system drive, device drivers or make the CPU uses its maximum capacity for extended period of time to damage the processor hardware (Yadav and Rao, 2015). Using screen captures, key stroke monitoring, password cracking, monitoring network traffic for credentials, gathering sensitive contents and documents are some of the methods deployed to gather data (Panda, n.d.).

THE PRACTICAL DEMONSTRATIONS

Reconnaissance

For illustration purpose we are going to make use of a tool called Maltego to conduct a passive reconnaissance on our target. Our target is Cyberforce Pentest Ltd, which is a company I and my friends formed. Going to the Cyberforce Pentest Ltd, we were able to grab an e-mail: contact@cyberforcepentest.com. Starting from that single email, we were able to grab a lot of information.

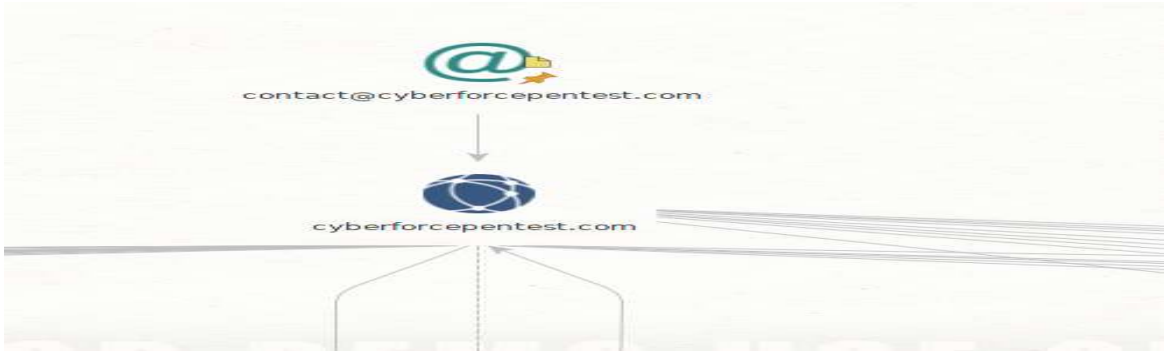


Figure 1: Email Entity on Maltego

First we have established that the email is associated with the domain: cyberforcepentest.com which have already known in Figure 1.

Figure 2: Found a Person and Phone Number using Maltego

The domain cyberforcepentest.com is associated with person entity and phone number as seen in Figure 2.

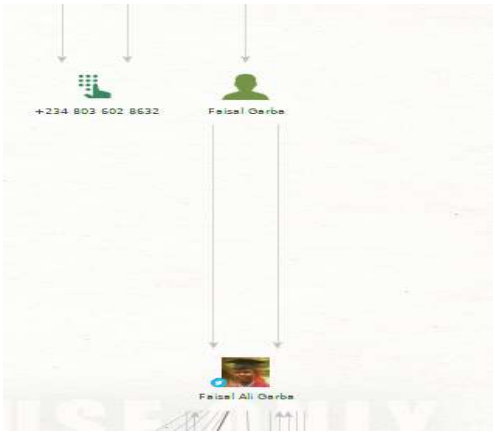


Figure 3: The Person is Associated with a Twitter Account

From Figure 3, we can see that the person entity also has a Twitter handle which we can further investigate to mine for more data.

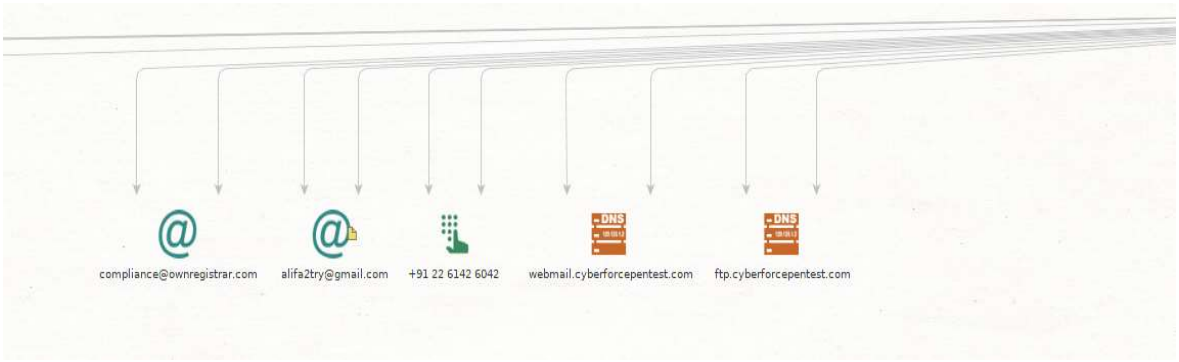


Figure 4: Email Associated with cyberforcepentest.com domain

Figure 4 also show us another email address of interest: alifa2try@gmail.com. We can now use this email address alifa2try@gmail.com to deliver our spear phishing email.

Weaponization

We are going to make use of Veil to create a backdoor. Metasploit payloads that bypasses common antivirus solutions are generated using Veil (Veil, n.d.). Developed by H. D. Moore in 2003, Metasploit Framework is an open source attack framework. Metasploit offer useful information to people who perform penetration testing, Intrusion Detection System (IDS) signature development and exploit research.

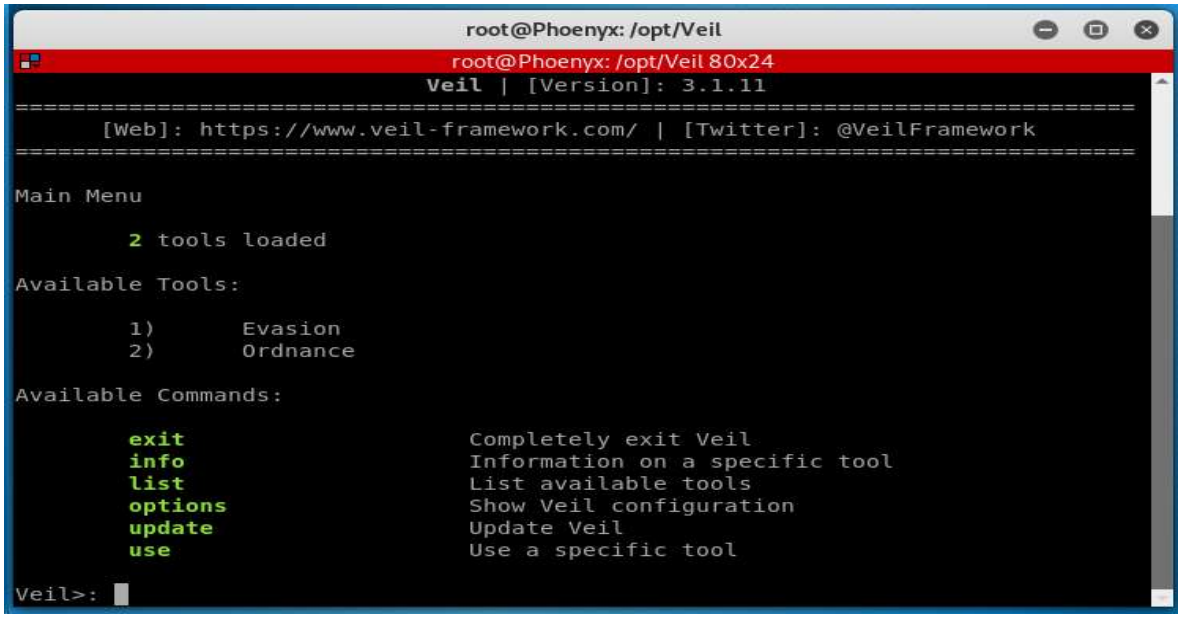


Figure 5: Veil-Framework on Kali Linux 2019

We are going to use the first tool Evasion to generate our payload. In Figure 2, we can see that Veil Evasion has 41 payloads. To list the Viel Evasion payloads, we issue the command "list".

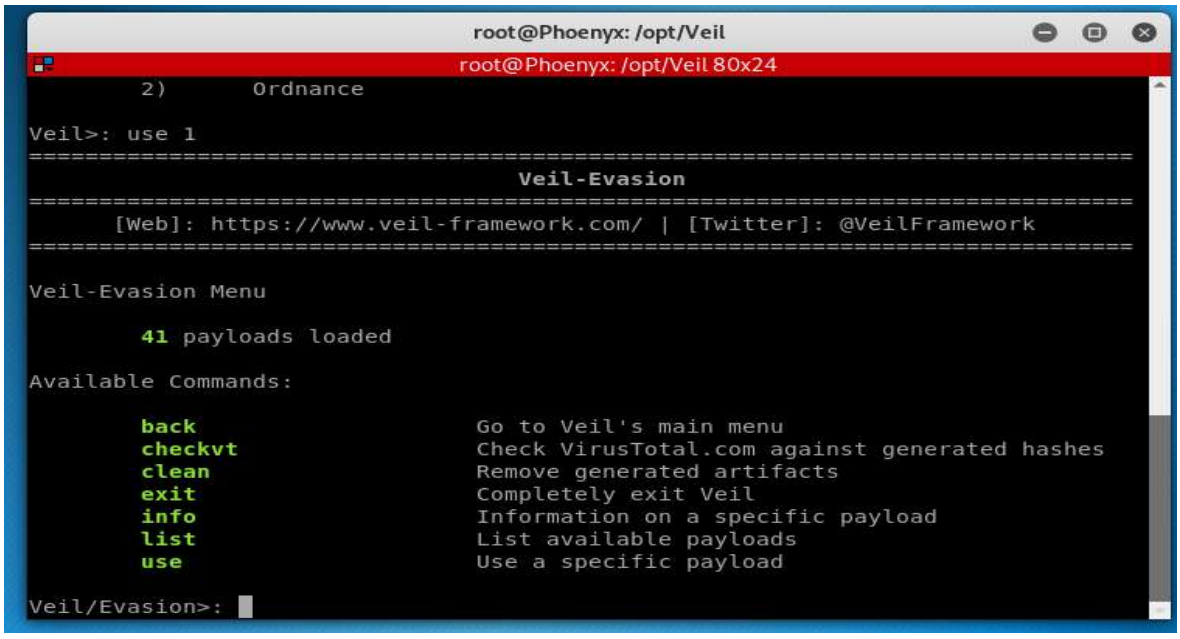


Figure 6: Veil Evasion Menu

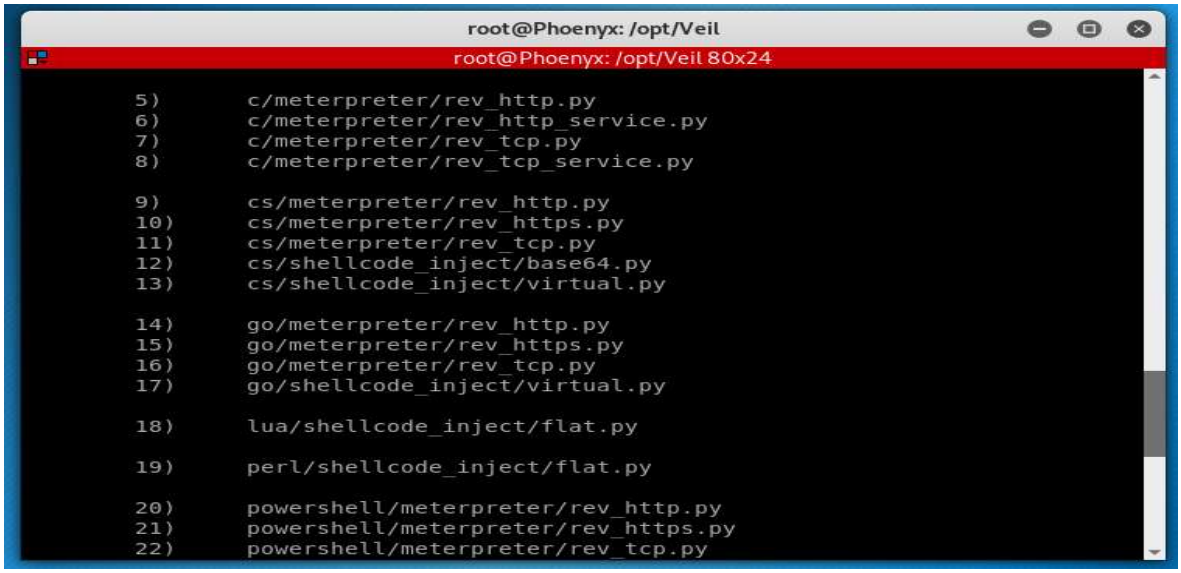


Figure 7: Veil Evasion Payload Types

We are going to be using the 15th payload which is the: go/meterpreter/rev_https.py. This payload is created using the Go programming language. Meterpreter is the type of the payload. Meterpreter payload runs in the memory and allows us to migrate to normal process running on the computer to avoid detection. It also doesn't leave a lot of footprint. The payload will also use rev_tcp.py that is it will use the tcp protocol to create a reverse connection back to our attacking computer. This will enable us to bypass antivirus and unsuspecting since it uses an innocuous protocol tcp and will work even if the victim computer is behind a firewall.

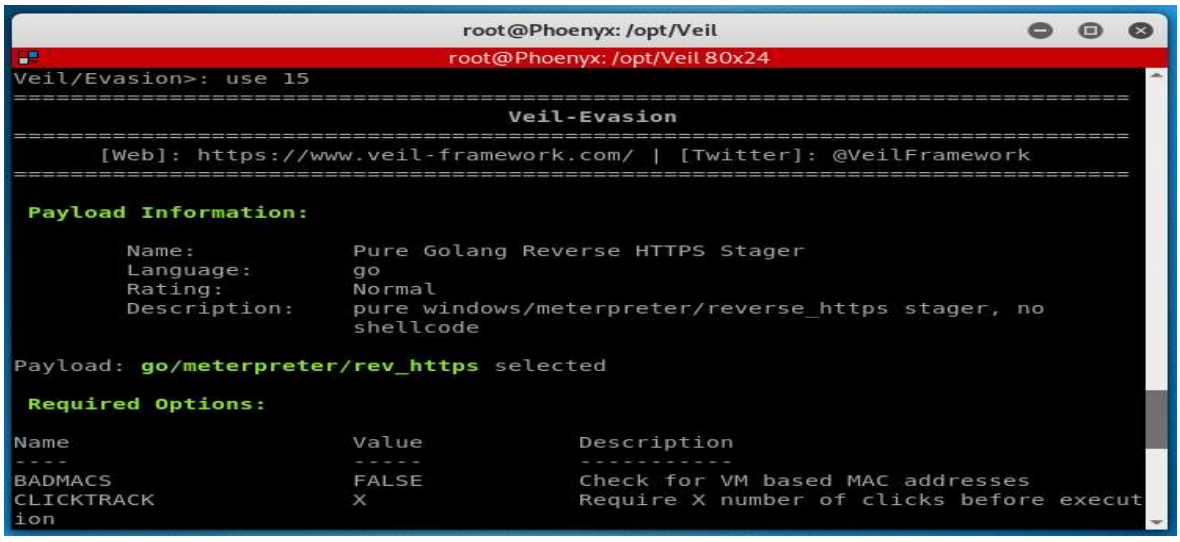


Figure 8: The 15th Payload is Selected

The next step is set the payload various options.

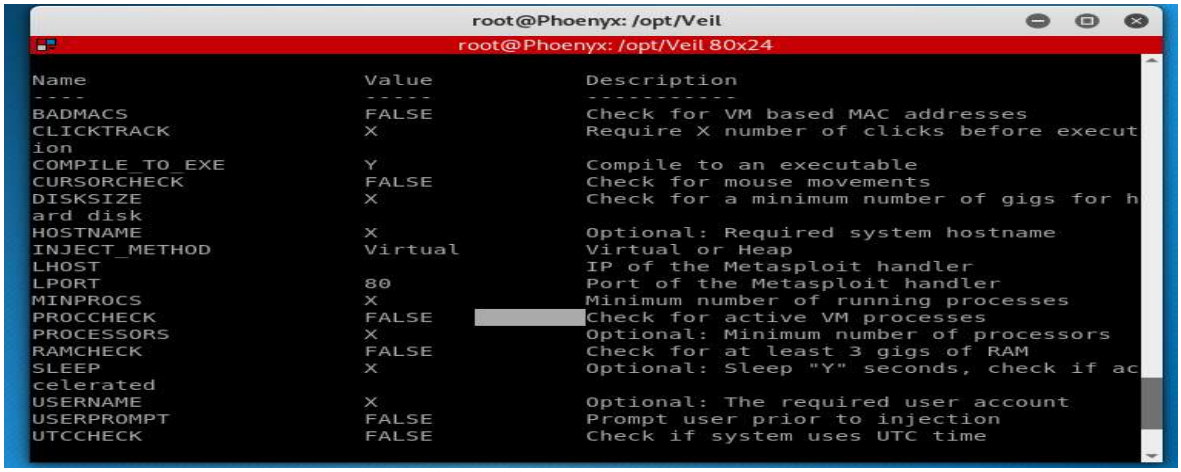


Figure 9: Payload Options

We find our IP address by issuing the ifconfig command. We set the LHOST value with the value of our attacking machine IP address. You will notice that the IP address however, is a private IP address. This is because we in the same Local Area Network (LAN) as the victim machine. However, if we are attacking macine remotely, that is the victim machine is not in the same LAN as our machine, we use static, dedicated public IP as the LHOST.

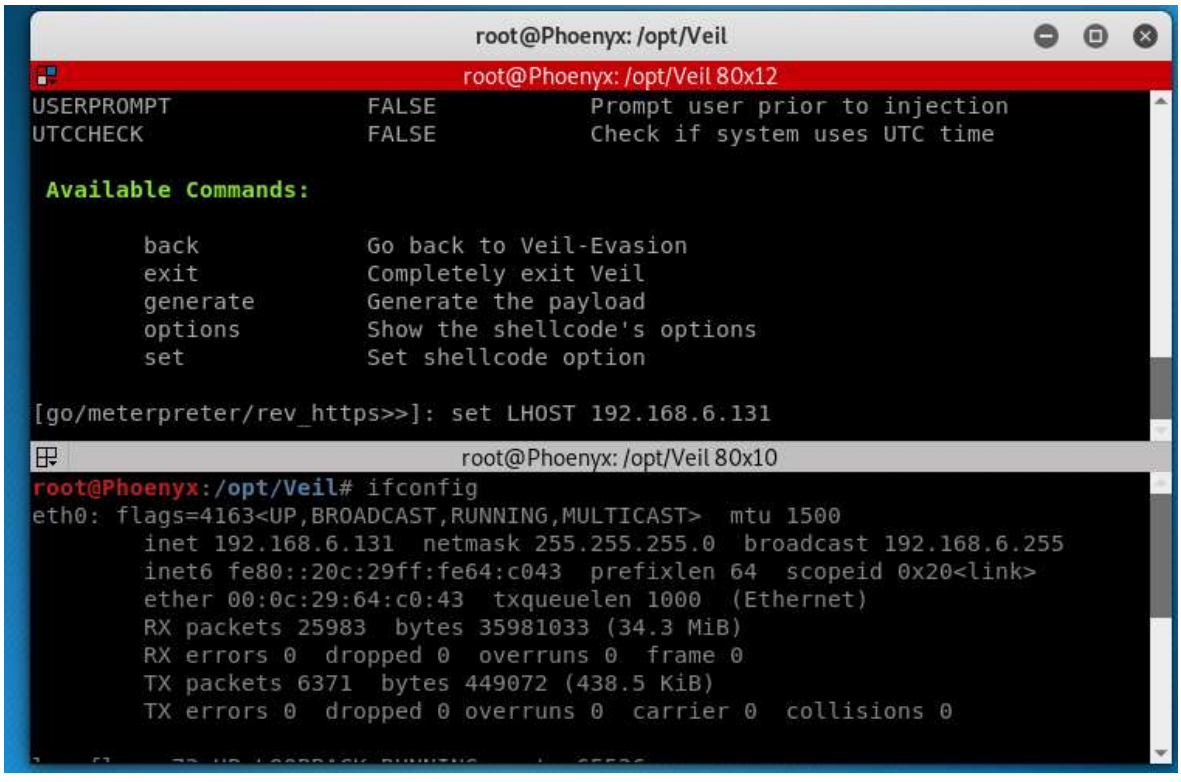


Figure 10: Setting Value for LHOST

Since there is already a web server on the attacking machine using port 80, we will set the LPORT here to 8080. With these options set we can bypass most AVs with the exception of the AVG AV. All the options required by the payload have been set as seen in Table 1.

Table 1: Payload Options

Option Name	Value
LHOST	192.168.6.43
LPORT	8080
PROCESSORS	1
SLEEP	6

The next step is to generate the payload by entering the generate command and this will prompt us to enter the name of the payload we want to generate.

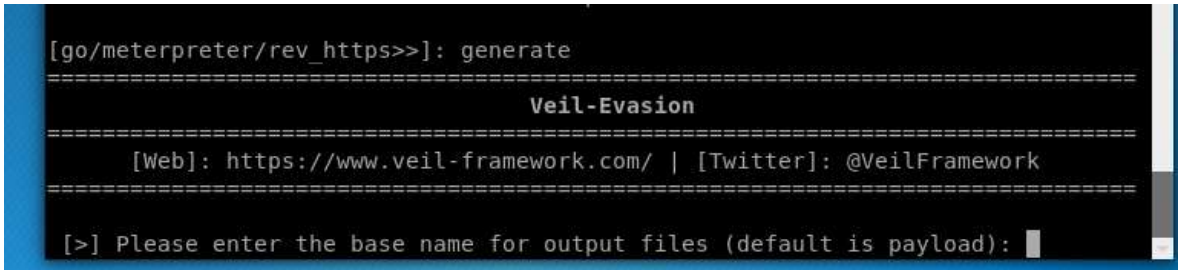


Figure 11: Generating a Payload

I name it rev_https_8080 and hit the enter button. The payload has been successfully generated:

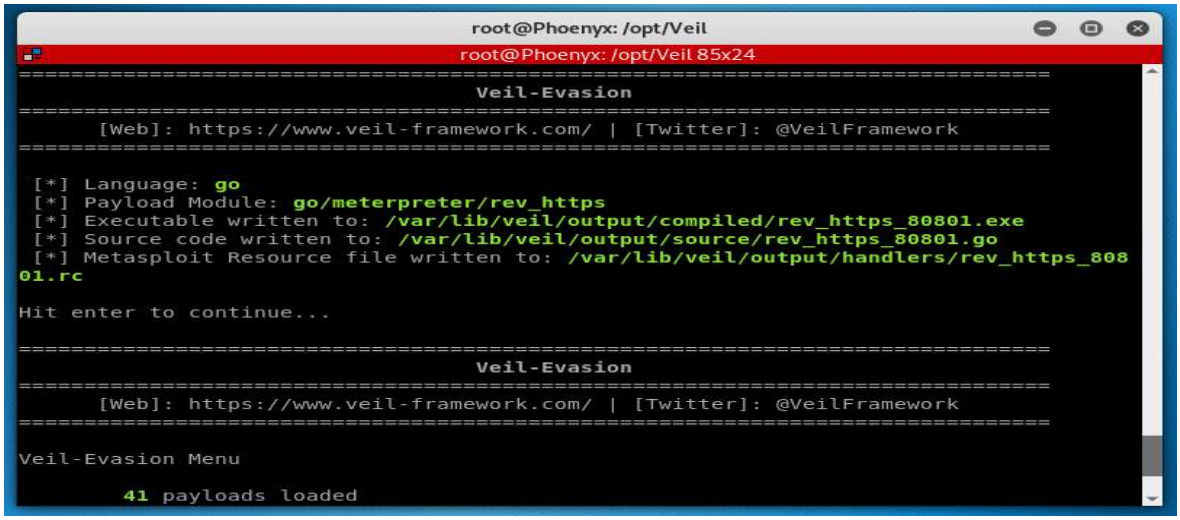


Figure 12: Payload Generated

We are going to test the efficacy of our payload by using a site called Antiscan.me. Though we can use VirusTotal but it is not recommended because VirusTotal will share the signature of the payload with Antivirus programs.

We browse to the location of the generated payload and upload it to No Distribute and click on Scan the File.

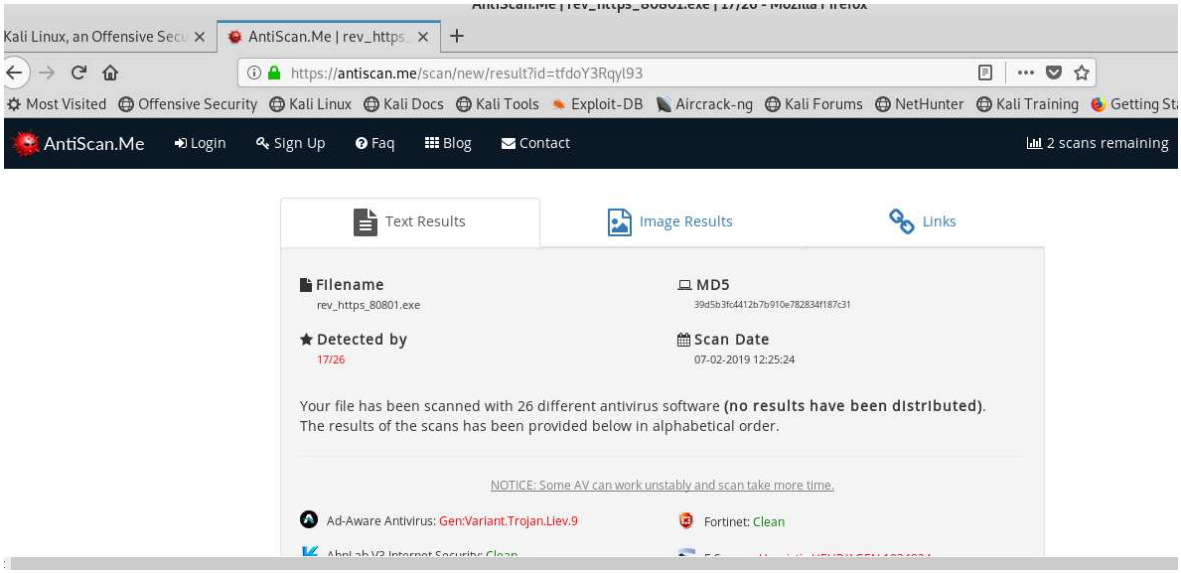


Figure 13: Scanning Payload with Antiscan.Me

Unfortulately, however 17 out 26 antiviruses have detected our payload. So we go back and play with the various options until we arrive at a payload that is not deteted by any anti-virus. Once we have obtained a 100% undetectable payload, we transfer it to our target.

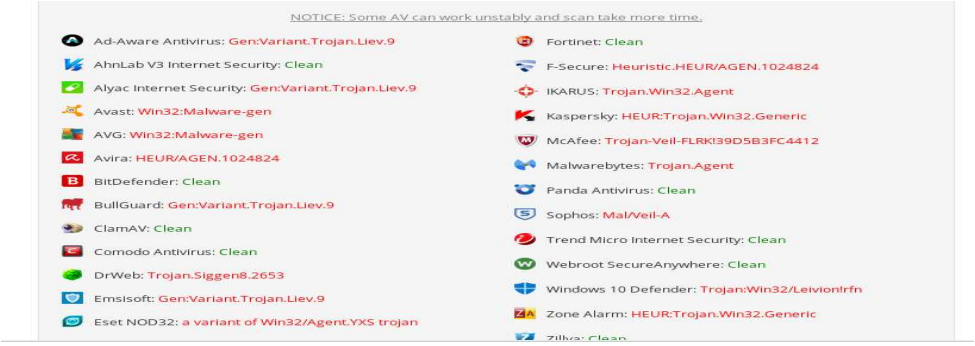


Figure 14: Payload Detection with Antivirus Solutions

Next we are launch our Metasploit. We first start postgresql database which is required by Metasploit and launch Metasploit by issuing the command: msfconsole.

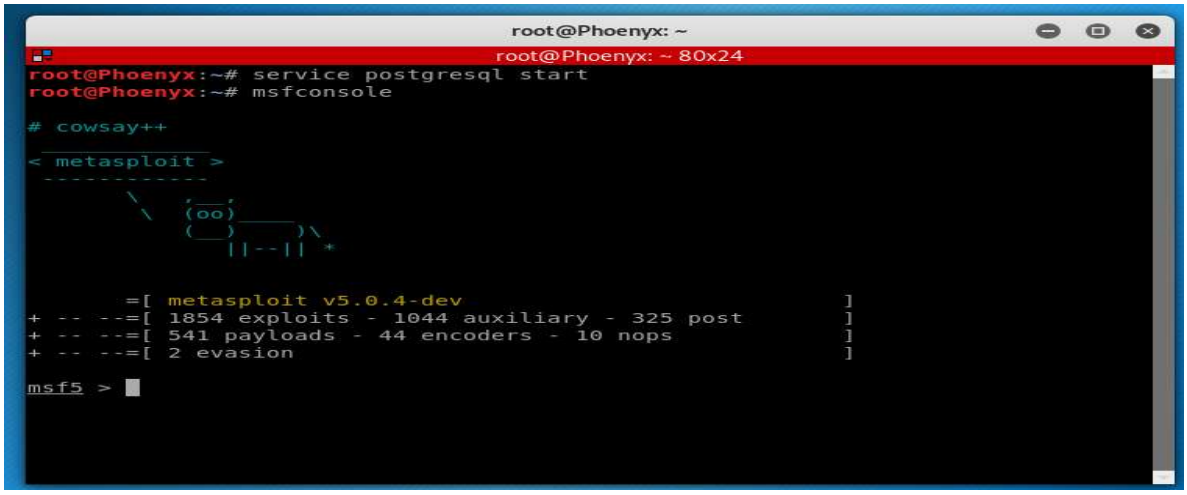


Figure 15: Launching Metasploit Framework

We are going to use a Metasploit exploit module called: exploit/multi/handler.

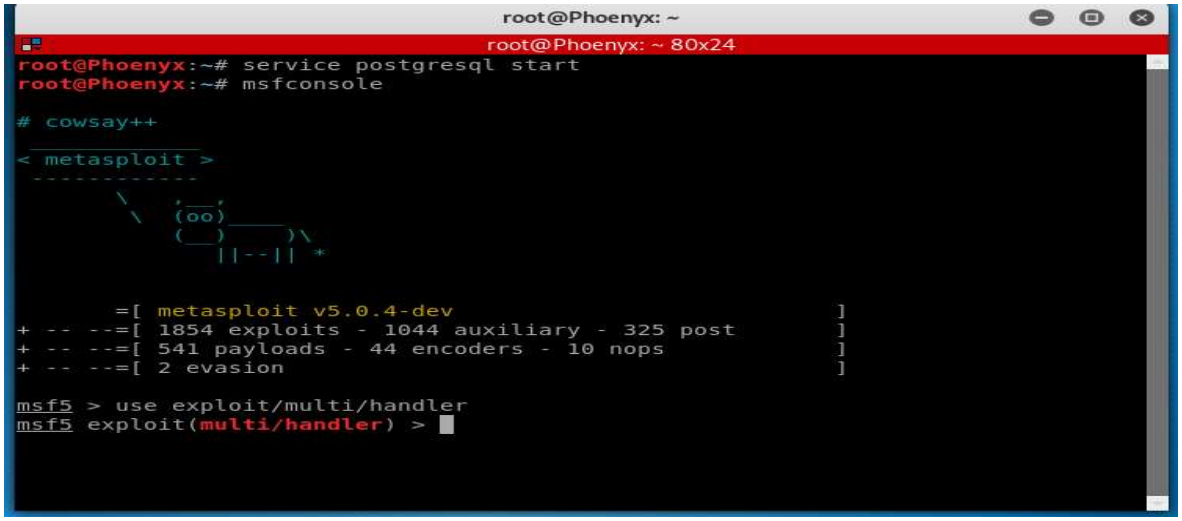


Figure 16: Using exploit/multi/handler

Next we specify the payload we are going to be using with the following commands:

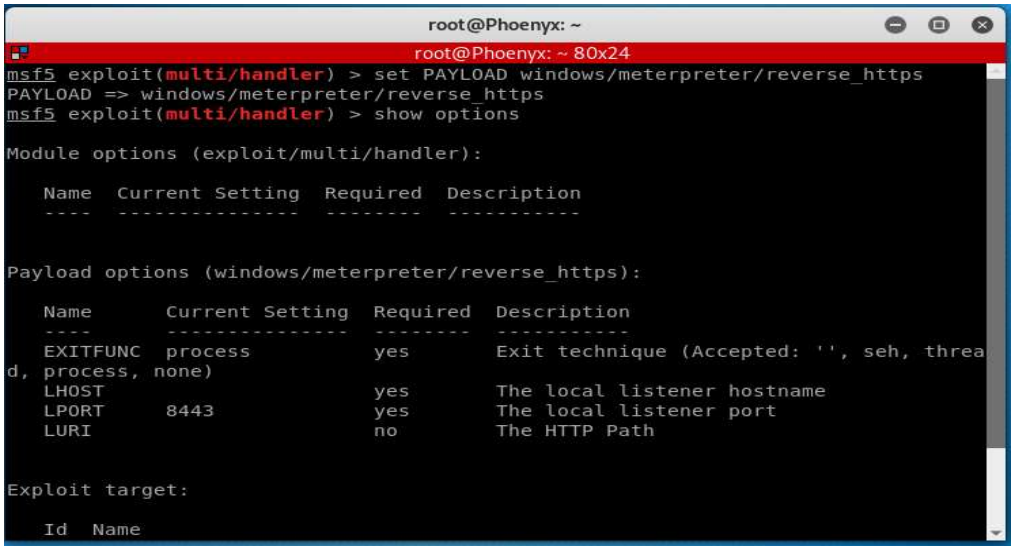


Figure 17: Payload Selection

Next we set LHOST and the LPORT options

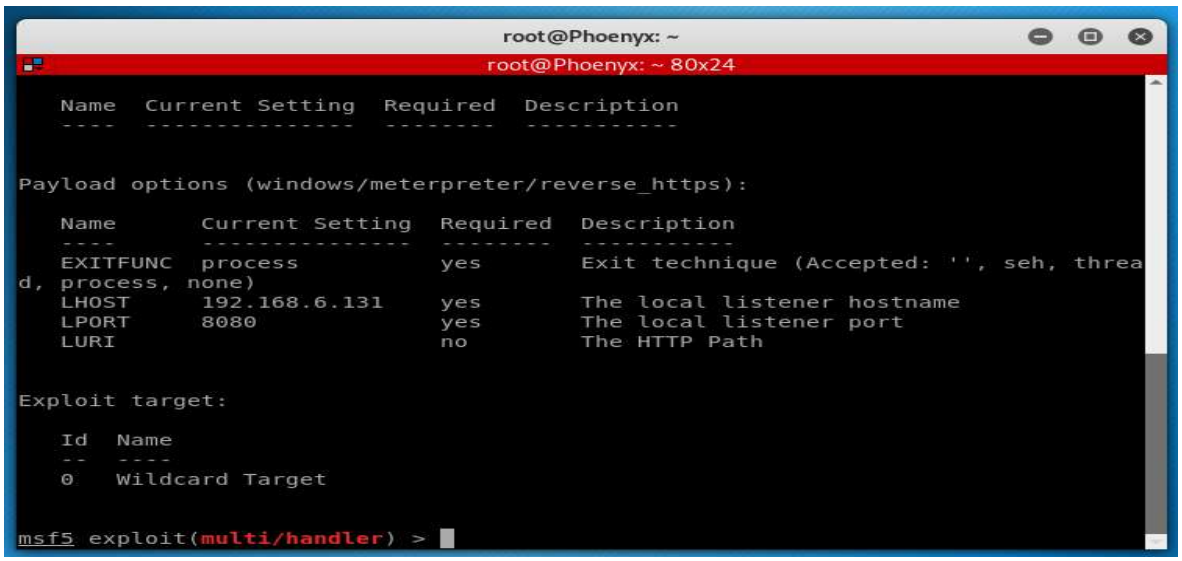


Figure 18: Setting the LHOST and the LPORT Options

Delivery

In the delivery phase, the generated payload is delivered to the victim machine. There are variety of ways to deliver the payload. We can deliver the payload through spear phishing and send it to the victim. The victim receives the phishing email with a message asking him to click on a link

which the victim cannot resist clicking. The victim proceeds to click on the link to download the malicious payload.

Exploitation

Prior to generating the payload we fire on our Metasploit by issuing the command *exploit.* As soon as the victim interacts with our delivered payload by running and installing the payload, the payload will communicates back to our victim machine and we gain a meterpreter session.

Installation

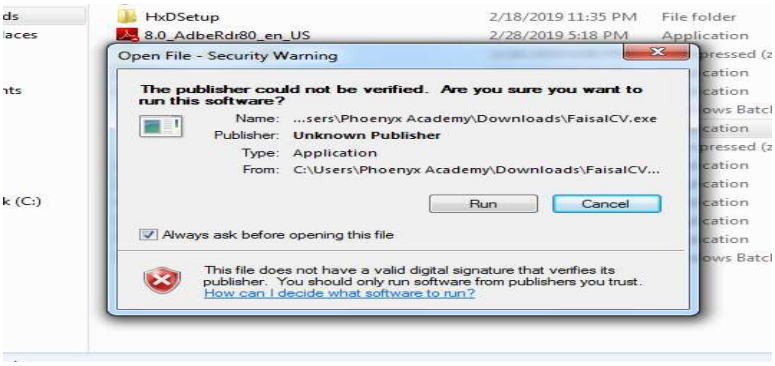
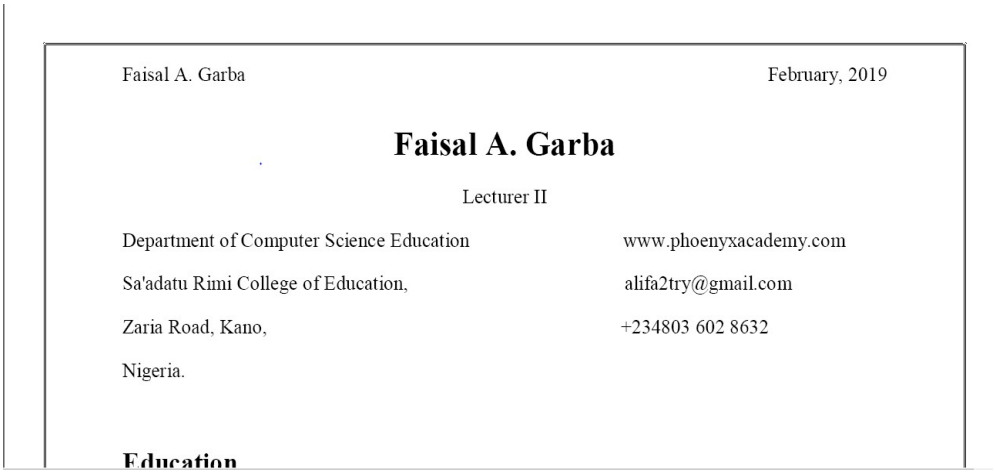


Figure 19: Victim Interacting with our Payload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Education

Figure 20: File Sent Along with Payload

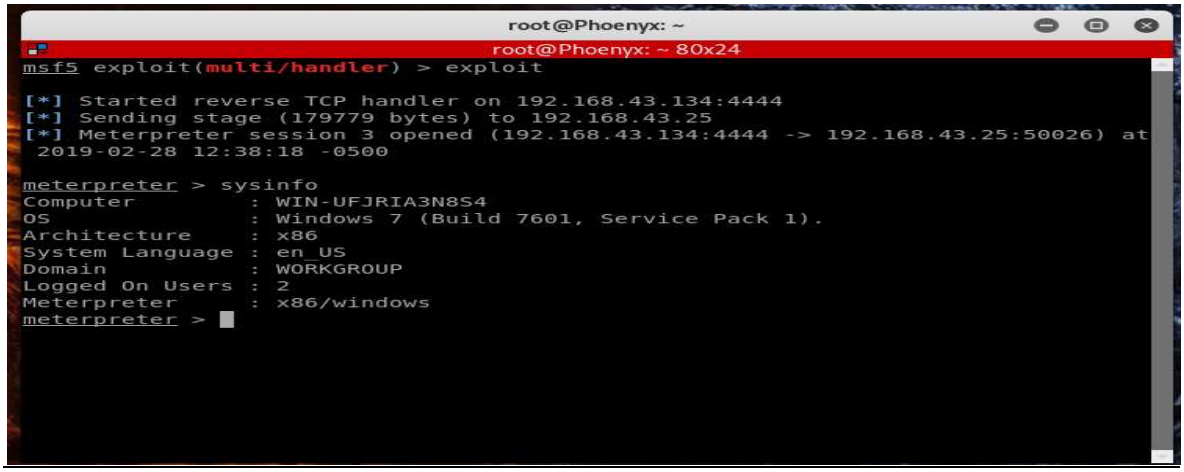

Figure 21: Meterpreter Session

Command & Control

Gaining a meterpreter session signifies establishing a foothold on the victim machine and successful establishment of a C & C channel.

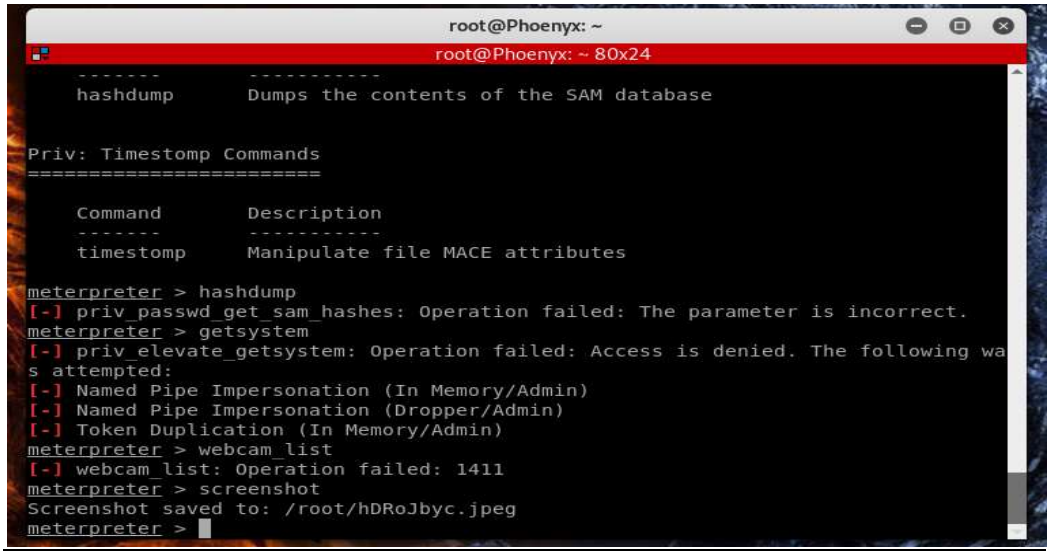

Figure 22: Controlling the Victim Machine

Act on Objectives

Now that we have gained a meterpreter session, we can proceed to achieve our objectives. We want to capture a screenshot of the desktop of the victim machine and shutdown the system. To capture the screenshot all we have to do is to issue the meterpreter command **shutdown** and to capture the screenshot we issue the command screenshot this is all seen in Figure 23, Figure 24 and Figure 25.

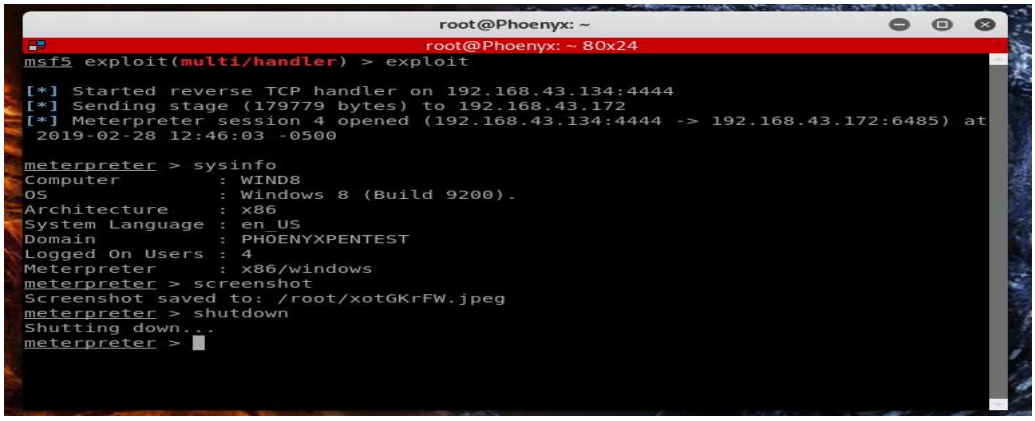

Figure 23: Shutting Down the Victim Machine

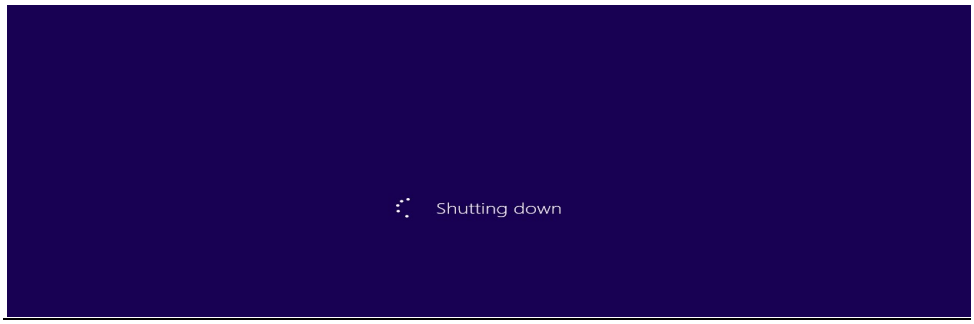

Figure 24: Shutting Down the Victim Machine

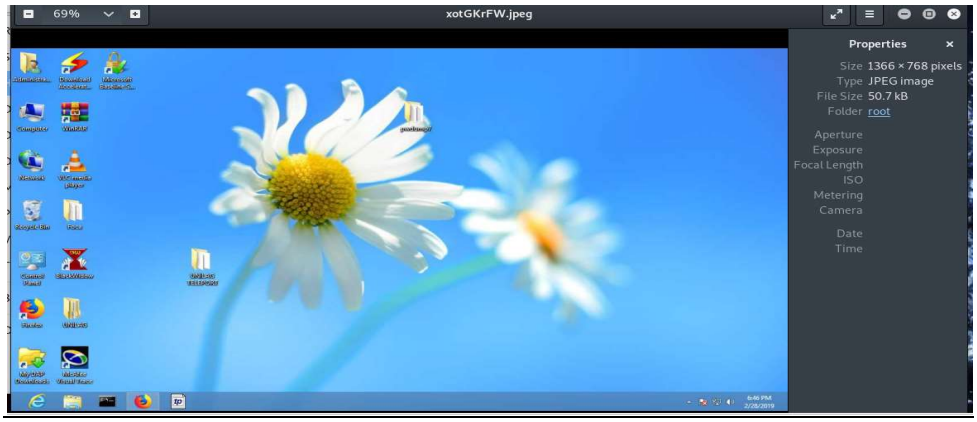

Figure 25: Capturing Screenshot of the Victim Machine

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