



This site is dedicated to sharing information about the practice, ideas, concepts and patterns regarding computer security.

How to securely isolate and execute Scapy from Kali Linux, part one

Version 0.1, Last Updated: Sep 3

Table of Contents

1. Introduction	1
2. Requirements	2
2.1. Writing Conventions	2
2.2. VirtualBox	2
2.2.1. Clean VirtualBox Networking	2
2.2.2. Add VirtualBox Networking	4
2.3. Vagrant	4
2.4. Kali Linux and Damn Vulnerable Web Application (DVWA)	5
2.4.1. Vagrantfile	5
2.4.2. bootstrap.sh	7
3. Scapy	13
3.1. Scapy Python Library install	19
4. Conclusion	20
5. Appendix	21

Chapter 1. Introduction

The motivation behind part one of this series is to explore using the tool Scapy that comes with Kali Linux.

This is only an overview to give the audience a taste of what is in the tool.

What is Scapy:

Scapy is a Python program that enables the user to send, sniff, dissect, and forge network packets. This capability allows construction of tools that can probe, scan or attack target networks.

What makes Scapy so darn awesome:

"First, with most other networking tools, you won't build something the author did not imagine. These tools have been built for a specific goal and can't deviate much from it. For example, an ARP cache poisoning program won't let you use double 802.1q encapsulation. Or try to find a program that can send, say, an ICMP packet with padding (I said padding, not payload, see?). In fact, each time you have a new need, you have to build a new tool.

Second, they usually confuse decoding and interpreting. Machines are good at decoding and can help human beings with that. Interpretation is reserved for human beings. Some programs try to mimic this behavior. For instance they say "this port is open" instead of "I received a SYN-ACK". Sometimes they are right. Sometimes not. It's easier for beginners, but when you know what you're doing, you keep on trying to deduce what really happened from the program's interpretation to make your own, which is hard because you lost a big amount of information. And you often end up using `tcpdump -xX` to decode and interpret what the tool missed.

Third, even programs which only decode do not give you all the information they received. The network's vision they give you is the one their author thought was sufficient. But it is not complete, and you have [now injected] a bias. For instance, do you know a tool that reports the Ethernet padding?

Scapy tries to overcome those problems. It enables you to build exactly the packets you want. Even if I think stacking a 802.1q layer on top of TCP has no sense, it may have some for somebody else working on some product I don't know. Scapy has a flexible model that tries to avoid such arbitrary limits. You're free to put any value you want in any field you want and stack them like you want. You're an adult after all.

In fact, it's like building a new tool each time, but instead of dealing with a hundred line C program, you only write 2 lines of Scapy." - Official Docs

Scapy can be run in two different modes, either interactively from a terminal or written into a Python script.

Let's get started with our isolated testing environment.

Chapter 2. Requirements

2.1. Writing Conventions

If you see the following \$ symbol on a command line to execute, what that means is that the command is executed as a regular user; meaning an account that does not have administrative privileges. Ignore the leading \$ and execute the rest of the command.

```
$ command to execute as a regular user
```

If you see a command line lead with the # symbol, then that means that the command is executed as the root user. This implies you need to elevate to the root user before running the command, e.g. with: `sudo su - root`.

```
# command to execute as the root user
```

2.2. VirtualBox

Go to: <https://www.virtualbox.org/wiki/Downloads> and download VirtualBox.

The author is running on Ubuntu 18.04, so following to this URL: https://www.virtualbox.org/wiki/Linux_Downloads

For Ubuntu, double click on the .deb file, i.e. `virtualbox-5.2_5.2.0-118431-Ubuntu-zesty_amd64.deb`, and install VirtualBox on your local workstation.

2.2.1. Clean VirtualBox Networking

This section is here in case you already had virtualbox installed from before. The intent is to clean up the previous networking. If you do not need to do this, skip to [Add VirtualBox Networking](#)

Run these two commands from a Terminal:

```
$ VBoxManage list natnetworks  
$ VBoxManage list dhcpservers
```

Output (example):

```
NetworkName:    192.168.139-NAT  
IP:             192.168.139.1  
Network:       192.168.139.0/24  
IPv6 Enabled:  No  
IPv6 Prefix:   fd17:625c:f037:2::/64  
DHCP Enabled:  Yes
```

```
Enabled:      Yes
loopback mappings (ipv4)
    127.0.0.1=2
```

```
NetworkName:  192.168.139-NAT
Dhcpd IP:     192.168.139.3
LowerIPAddress: 192.168.139.101
UpperIPAddress: 192.168.139.254
NetworkMask:  255.255.255.0
```

```
Enabled:      Yes
Global Configuration:
    minLeaseTime:    default
    defaultLeaseTime: default
    maxLeaseTime:    default
    Forced options:  None
    Suppressed opts.: None
    1/legacy: 255.255.255.0
```

```
Groups:      None
Individual Configs:  None
```

```
NetworkName:  HostInterfaceNetworking-vboxnet0
Dhcpd IP:     172.20.0.3
LowerIPAddress: 172.20.0.101
UpperIPAddress: 172.20.0.254
NetworkMask:  255.255.255.0
```

```
Enabled:      Yes
Global Configuration:
    minLeaseTime:    default
    defaultLeaseTime: default
    maxLeaseTime:    default
    Forced options:  None
    Suppressed opts.: None
    1/legacy: 255.255.255.0
```

```
Groups:      None
Individual Configs:  None
```

Now, delete ALL of the pre-installed VirtualBox networks (one at a time following the syntax below):

```
VBoxManage natnetwork remove --netname <NetworkName_from_above>
VBoxManage natnetwork remove --netname 192.168.139-NAT
```

Repeat as many times as necessary to delete all of them.

Now, delete ALL of the pre-installed DHCP services:

```
VBoxManage dhcpserver remove --netname <DHCP_Server_NetworkName_from_above>
```

```
VBoxManage dhcpserver remove --netname 192.168.139-NAT
```

Repeat as many times as necessary to delete all of them.

2.2.2. Add VirtualBox Networking

Now, add the new VirtualBox networks so the Kali Linux guides work.

```
VBoxManage natnetwork add \  
  --netname 192.168.139-NAT \  
  --network "192.168.139.0/24" \  
  --enable --dhcp on  
  
VBoxManage dhcpserver add \  
  --netname 192.168.139-NAT \  
  --ip 192.168.139.3 \  
  --lowerip 192.168.139.101 \  
  --upperip 192.168.139.254 \  
  --netmask 255.255.255.0 \  
  --enable  
  
VBoxManage hostonlyif create  
  
VBoxManage hostonlyif ipconfig vboxnet0 \  
  --ip 172.20.0.1 \  
  --netmask 255.255.255.0  
  
VBoxManage dhcpserver add \  
  --ifname vboxnet0 \  
  --ip 172.20.0.3 \  
  --lowerip 172.20.0.101 \  
  --upperip 172.20.0.254 \  
  --netmask 255.255.255.0  
  
VBoxManage dhcpserver modify \  
  --ifname vboxnet0 \  
  --enable
```

VirtualBox install complete.

2.3. Vagrant

Go to: <https://www.vagrantup.com/downloads.html>, follow the appropriate link to your OS and 32 or 64 bit version representing your local workstation. Download.

For Ubuntu, double click on the .deb file, i.e. vagrant_2.0.1_x86_64.deb, and install Vagrant on your local system.

NOTE | Update vagrant vm: [vagrant box update](#)

2.4. Kali Linux and Damn Vulnerable Web Application (DVWA)

The author highly recommends to create a directory structure that is easy to navigate and find your code. As an example, you could use something similar to:

```
`${HOME}/Source_Code/Education/vagrant-machines/kali-linux-vm/`
```

Go ahead and make this structure with the following command (inside a Terminal):

```
$ mkdir -p `${HOME}/Source_Code/Education/vagrant-machines/kali-linux-vm/`
```

From a Terminal, change directory to:

```
$ cd `${HOME}/Source_Code/Education/vagrant-machines/kali-linux-vm/`
```

2.4.1. Vagrantfile

Inside of the kali-linux-vm directory, populate a new file with the exact name, “Vagrantfile”. Case matters, uppercase the “V”. This file will contain both virtual machines for Kali Linux as well as setting up the DVWA virtual machine. Aggregating both virtual machines into one file has saved the author a lot of time. The coolness here is setting up the variables at the top of the Vagrantfile mimicing shell scripting inside of a virtual machine (passed in with provision: shell). I tested using: `apt-get update && apt-get upgrade -y`, but opted to take it out since it took over 45 minutes on my slower (old) hardware. See comment about downloading this file immediately preceding the code block.

```
# -*- mode: ruby -*-
# vi: set ft=ruby :

$os_update = <<SCRIPT
apt-get update
SCRIPT

VAGRANTFILE_API_VERSION = "2"

Vagrant.configure(VAGRANTFILE_API_VERSION) do |config|
  config.vm.define "kali-linux-vagrant" do |conf|
    conf.vm.box = "kalilinux/rolling"

    # For Linux systems with the Wireless network, uncomment the line:
```

```

conf.vm.network "public_network", bridge: "wlo1", auto_config: true

# For macbook/OSx systems, uncomment the line and comment out the Linux
Wireless network:
#conf.vm.network "public_network", bridge: "en0: Wi-Fi (AirPort)",
auto_config: true

conf.vm.hostname = "kali-linux-vagrant"
conf.vm.provider "virtualbox" do |vb|
  vb.gui = true
  vb.memory = "4096"
  vb.cpus = "2"
  vb.customize ["modifyvm", :id, "--vram", "32"]
  vb.customize ["modifyvm", :id, "--accelerate3d", "off"]
  vb.customize ["modifyvm", :id, "--ostype", "Debian_64"]
  vb.customize ["modifyvm", :id, "--boot1", "dvd"]
  vb.customize ["modifyvm", :id, "--boot2", "disk"]
  vb.customize ["modifyvm", :id, "--audio", "none"]
  vb.customize ["modifyvm", :id, "--clipboard", "hosttoguest"]
  vb.customize ["modifyvm", :id, "--draganddrop", "hosttoguest"]
  vb.customize ["modifyvm", :id, "--paravirtprovider", "kvm"]
end
conf.vm.provision "shell", inline: $os_update
end

config.vm.define "dvwa-vagrant" do |conf|

  conf.vm.box = "ubuntu/xenial64"

  conf.vm.hostname = "dvwa-vagrant"

  # For Linux systems with the Wireless network, uncomment the line:
  conf.vm.network "public_network", bridge: "wlo1", auto_config: true

  # For macbook/OSx systems, uncomment the line and comment out the Linux
Wireless network:
  #conf.vm.network "public_network", bridge: "en0: Wi-Fi (AirPort)",
auto_config: true

  config.vm.network "forwarded_port", guest: 80, host: 8080, auto_correct: true
  config.vm.network "forwarded_port", guest: 3306, host: 3306, auto_correct:
true

  conf.vm.provider "virtualbox" do |vb|
    vb.memory = "1024"
    vb.cpus = "2"
    vb.gui = false
    vb.customize ["modifyvm", :id, "--vram", "32"]
    vb.customize ["modifyvm", :id, "--accelerate3d", "off"]
    vb.customize ["modifyvm", :id, "--ostype", "Ubuntu_64"]
    vb.customize ["modifyvm", :id, "--boot1", "dvd"]
  end
end

```

```

        vb.customize ["modifyvm", :id, "--boot2", "disk"]
        vb.customize ["modifyvm", :id, "--audio", "none"]
        vb.customize ["modifyvm", :id, "--clipboard", "hosttoguest"]
        vb.customize ["modifyvm", :id, "--draganddrop", "hosttoguest"]
        vb.customize ["modifyvm", :id, "--paravirtprovider", "kvm"]
    end
    conf.vm.provision "shell", inline: $os_update
    conf.vm.provision :shell, path: "bootstrap.sh"
end
end
end

```

Save and write this file.

You can also download from:

```
$ curl -o Vagrantfile http://securityhardening.com/files/Vagrantfile_20200928.txt
```

2.4.2. bootstrap.sh

Inside of the kali-linux-vm directory, populate a new file with the exact name, `bootstrap.sh`. Case matters, all lowercase. See comment about downloading this file immediately preceding the code block. `bootstrap.sh` (include the shebang in your file: the first line with `#!/usr/bin/env bash`):

```

#!/usr/bin/env bash
PHP_FPM_PATH_INI='/etc/php/7.0/fpm/php.ini'
PHP_FPM_POOL_CONF='/etc/php/7.0/fpm/pool.d/www.conf'
MYSQL_ROOT_PW='Assword12345'
MYSQL_dvwa_user='dvwa'
MYSQL_dvwa_password='sunshine'
DVWA_admin_password='admin'
recaptcha_public_key='u8392ihj32k18hujalkshuil32'
recaptcha_private_key='89ry8932873832lih32ilj32'

install_base() {
    add-apt-repository -y ppa:nginx/stable
    sudo apt-get update
    sudo apt-get dist-upgrade -y
    sudo apt-get install -y \
        nginx \
        mariadb-server \
        mariadb-client \
        php \
        php-common \
        php-cgi \
        php-fpm \
        php-gd \
        php-cli \

```

```

    php-pear \
    php-mcrypt \
    php-mysql \
    php-gd \
    git \
    vim
}

config_mysql(){
    mysqladmin -u root password "${MYSQL_ROOT_PW}"
    ## Config the mysql config file for root so it doesn't prompt for password.
    ## Also sets pw in plain text for easy access.
    ## Don't forget to change the password here!!

    cat <<EOF > /root/.my.cnf
    [client]
    user="root"
    password="${MYSQL_ROOT_PW}"
    EOF

    mysql -BNe "drop database if exists dvwa;"
    mysql -BNe "CREATE DATABASE dvwa;"
    mysql -BNe "GRANT ALL ON *.* TO '${MYSQL_dvwa_user}'@'localhost' IDENTIFIED BY
    '${MYSQL_dvwa_password}';"

    systemctl enable mysql
    systemctl restart mysql
    sleep 2
}

config_php(){
    ## Config PHP FPM INI to disable some security settings:

    sed -i 's/^;cgi.fix_pathinfo.*$/cgi.fix_pathinfo = 0/g' ${PHP_FPM_PATH_INI}
    sed -i 's/allow_url_include = Off/allow_url_include = On/g' ${PHP_FPM_PATH_INI}
    sed -i 's/allow_url_fopen = Off/allow_url_fopen = On/g' ${PHP_FPM_PATH_INI}
    sed -i 's/safe_mode = On/safe_mode = Off/g' ${PHP_FPM_PATH_INI}
    echo "magic_quotes_gpc = Off" >> ${PHP_FPM_PATH_INI}
    sed -i 's/display_errors = Off/display_errors = On/g' ${PHP_FPM_PATH_INI}

    ## explicitly set pool options
    ## (these are defaults in ubuntu 16.04 so i'm commenting them out.
    ## If they are not defaults for you try uncommenting these)
    #sed -i 's/^;security.limit_extensions.*$/security.limit_extensions = \
    #.php .php3 .php4 .php5 .php7/g' /etc/php/7.0/fpm/pool.d/www.conf
    #sed -i 's/^listen.owner.*$/listen.owner = www-data/g'
    /etc/php/7.0/fpm/pool.d/www.conf
    #sed -i 's/^listen.group.*$/listen.group = www-data/g'
    /etc/php/7.0/fpm/pool.d/www.conf
    #sed -i 's/^listen.mode.*$/listen.mode = 0660/g' /etc/php/7.0/fpm/pool.d/www.conf

```

```

    systemctl restart php7.0-fpm
}

config_nginx(){

cat << 'EOF' > /etc/nginx/sites-enabled/default
server
{
    listen 80;
    root /var/www/html;
    index index.php index.html index.htm;
    #server_name localhost
    location "/"
    {
        index index.php index.html index.htm;
        #try_files $uri $uri/ =404;
    }

    location ~ \.php$
    {
        include /etc/nginx/fastcgi_params;
        fastcgi_pass unix:/var/run/php/php7.0-fpm.sock;
        fastcgi_index index.php;
        fastcgi_param SCRIPT_FILENAME $request_filename;
    }
}
EOF

    systemctl restart nginx
}

install_dvwa(){

    if [[ ! -d "/var/www/html" ]];
    then
        mkdir -p /var/www;
        ln -s /usr/share/nginx/html /var/www/html;
        chown -R www-data. /var/www/html;
    fi

    cd /var/www/html
    rm -rf /var/www/html/.[!.*]
    rm -rf /var/www/html/*
    git clone https://github.com/ethicalhack3r/DVWA.git ./
    chown -R www-data. ./
    cp config/config.inc.php.dist config/config.inc.php

    ### chmod uploads and log file to be writable by nobody

```

```

chmod 777 ./hackable/uploads/
chmod 777 ./external/phpids/0.6/lib/IDS/tmp/phpids_log.txt

## change the values in the config to match our setup (these are what you need to
update!
sed -i '/db_user/ s/root/'${MYSQL_dvwa_user}'/'
/var/www/html/config/config.inc.php
sed -i '/db_password/ s/p@ssw0rd/'${MYSQL_dvwa_password}'/'
/var/www/html/config/config.inc.php
sed -i "/recaptcha_public_key/ s/'/'"${recaptcha_public_key}"'/"
/var/www/html/config/config.inc.php
sed -i "/recaptcha_private_key/ s/'/'"${recaptcha_private_key}"'/"
/var/www/html/config/config.inc.php

}

update_mysql_user_pws(){
## The mysql passwords are set via /usr/share/nginx/html/dvwa/includes/DBMS/MySQL.php.
# If you edit this every time they are reset it will reset to those.
# Otherwise you can do a sql update statement to update them all (they are just md5's
of the string.
# The issue is the users table doesn't get created until you click that button T_T to
init.

#mysql -Bne "UPDATE dvwa.users SET password = md5('YOUR_MYSQL_PW_HERE') WHERE user =
'admin';"
#mysql -Bne "UPDATE dvwa.users SET password = md5('YOUR_MYSQL_PW_HERE') WHERE user =
'gordonb';"
#mysql -Bne "UPDATE dvwa.users SET password = md5('YOUR_MYSQL_PW_HERE') WHERE user =
'1337';"
#mysql -Bne "UPDATE dvwa.users SET password = md5('YOUR_MYSQL_PW_HERE') WHERE user =
'pablo';"
#mysql -Bne "UPDATE dvwa.users SET password = md5('YOUR_MYSQL_PW_HERE') WHERE user =
'smithy';"

sed -i '/admin/ s/password/'${DVWA_admin_password}'/g'
/var/www/html/dvwa/includes/DBMS/MySQL.php
sed -i '/gordonb/ s/abc123/'${DVWA_admin_password}'/g'
/var/www/html/dvwa/includes/DBMS/MySQL.php
sed -i '/1337/ s/charley/'${DVWA_admin_password}'/g'
/var/www/html/dvwa/includes/DBMS/MySQL.php
sed -i '/pablo/ s/letmein/'${DVWA_admin_password}'/g'
/var/www/html/dvwa/includes/DBMS/MySQL.php
sed -i '/smithy/ s/password/'${DVWA_admin_password}'/g'
/var/www/html/dvwa/includes/DBMS/MySQL.php
}

install_base
config_mysql

```

```
install_dvwa
update_mysql_user_pws
config_php
config_nginx
```

Save and write this file.

If you have issues with copying and pasting the above file because code blocks in PDFs always copy correctly [NOT!], you could use curl, i.e. Make sure the bootstrap.sh file ends up in the same directory as the Vagrantfile.

```
$ curl -o bootstrap.sh http://securityhardening.com/files/bootstrap_sh_20200928.txt
```

From a Terminal, change directory to:

```
$ cd ${HOME}/Source_Code/Education/vagrant-machines/kali-linux-vm/
```

Then run (inside the directory kali-linux-vm):

```
$ vagrant up
```

This will download the appropriate images and start the virtual machines. Once running, through the VirtuaBox GUI, login as root. Password is “toor”, root backwards. Edit the following file: [/etc/ssh/sshd_config](#)

And change the line: `#PermitRootLogin prohibit-password` To: `PermitRootLogin yes` Meaning strip the comment out on the beginning of the line and alter `prohibit-password` to `yes`.

Then restart the ssh daemon:

```
# kill -HUP $(pgrep sshd)
```

Notice, you are on a Bridged adapter, this will open the instance to allow root to ssh in with the most unsecure password in the world. Only make this change (allowing root to login via SSH) if you require root SSH access. You can change the root user’s password, which is highly recommended.

For the DVWA instance, I would first run ‘vagrant status’ to capture the name that vagrant is using for the running instance.

```
# vagrant status
```

Choose

```
Current machine states:
```

```
kali-linux-vagrant running (virtualbox)
dvwa-vagrant running (virtualbox)
```

This environment represents multiple VMs. The VMs are all listed above with their current state. For more information about a specific VM, run `vagrant status NAME`.

From there, log into the DVWA instance with:

```
$ vagrant ssh dvwa-vagrant
```

And then get the current IP address.

```
$ ip a
```

Choose the second network adapter, it should look like:

```
ubuntu@dvwa:~$ ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen
1
    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: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group
default qlen 1000
    link/ether 02:53:17:3c:de:80 brd ff:ff:ff:ff:ff:ff
    inet 10.0.2.15/24 brd 10.0.2.255 scope global enp0s3
        valid_lft forever preferred_lft forever
    inet6 fe80::53:17ff:fe3c:de80/64 scope link
        valid_lft forever preferred_lft forever
3: enp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group
default qlen 1000
    link/ether 08:00:27:f0:77:2d brd ff:ff:ff:ff:ff:ff
    inet 172.20.156.76/24 brd 172.20.156.255 scope global enp0s8
        valid_lft forever preferred_lft forever
    inet6 fe80::a00:27ff:fef0:772d/64 scope link
        valid_lft forever preferred_lft forever
```

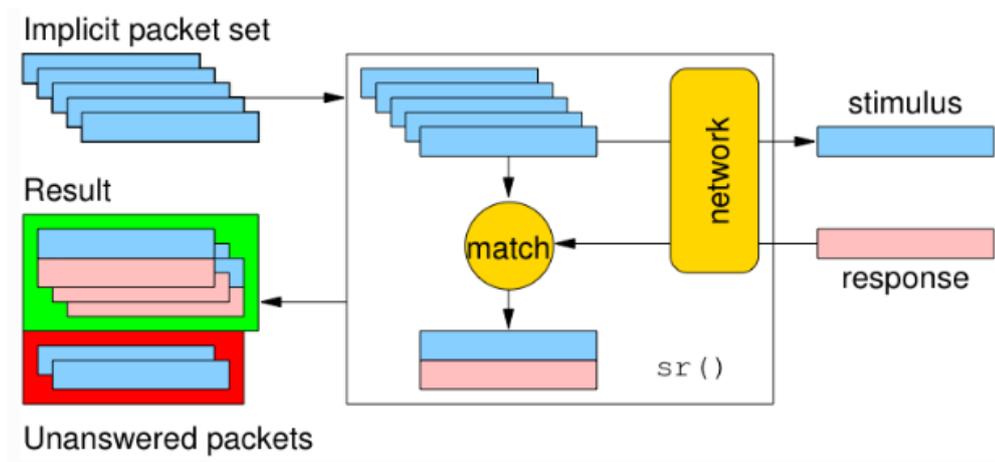
The test network used for this paper uses 172.20.156.0/24 as the network range [shown here in section 3]. Therefore, the adapter, enp0s8 is what he is looking for. The IP to use as a target is 172.20.156.76. Write down your value.

Chapter 3. Scapy

To understand what we are doing here, the official documentation covers this best. See Appendix for notes. Bear with the author, these concepts are important to understand.

Probe once, interpret many

"Network discovery is blackbox testing. When probing a network, many stimuli are sent while only a few of them are answered. If the right stimuli are chosen, the desired information may be obtained by the responses or the lack of responses. Unlike many tools, Scapy gives all the information, i.e. all the stimuli sent and all the responses received. Examination of this data will give the user the desired information. When the dataset is small, the user can just dig for it. In other cases, the interpretation of the data will depend on the point of view taken. Most tools choose the viewpoint and discard all the data not related to that point of view. Because Scapy gives the complete raw data, that data may be used many times allowing the viewpoint to evolve during analysis. For example, a TCP port scan may be probed and the data visualized as the result of the port scan. The data could then also be visualized with respect to the TTL of response packet. A new probe need not be initiated to adjust the viewpoint of the data." - Official Docs



Scapy decodes, it does not interpret

"A common problem with network probing tools is they try to interpret the answers received instead of only decoding and giving facts. Reporting something like Received a TCP Reset on port 80 is not subject to interpretation errors. Reporting Port 80 is closed is an interpretation that may be right most of the time but wrong in some specific contexts the tool's author did not imagine. For instance, some scanners tend to report a filtered TCP port when they receive an ICMP destination unreachable packet. This may be right, but in some cases, it means the packet was not filtered by the firewall but rather there was no host to forward the packet to.

Interpreting results can help users that don't know what a port scan is but it can also make more harm than good, as it injects bias into the results. What can tend to happen is that so that they can do the interpretation themselves, knowledgeable users will try to reverse engineer the tool's interpretation to derive the facts that triggered that interpretation. Unfortunately, much information is lost in this operation." - Official Docs

Without further ado, let us get into the application.

1. Open a terminal
2. launch Scapy by typing into the terminal, `scapy`

```

root@kali: ~
File Edit View Search Terminal Help
root@kali:~# scapy
INFO: Can't import matplotlib. Won't be able to plot.
INFO: Can't import PyX. Won't be able to use psdump() or pdfdump().
WARNING: No route found for IPv6 destination :: (no default route?)
WARNING: IPython not available. Using standard Python shell instead.
AutoCompletion, History are disabled.

      aSPY//YASa
    apyyyyCY/////////YCa
  sY/////////YSpcs  scpCY//Pp
ayp ayyyyyySCP//Pp  syY//C
AYAsAYYYYYYYY//Ps  cy//S
      pCCCCY//p      cSSps y//Y
      SPPPP//a       pP//AC//Y
      A//A           cyP//C
      p//Ac         sC//a
      P//Ycpc      A//A
scccccp//pSP//p    p//Y
sY/////////y  caa    S//P
cayCayP//Ya      pY/Ya
sY/PsY//Ycc      ac//Yp
sc  sccaCN//PCypaapyCP//YsS
      spcPY/////////YPSps
      ccaacs

Welcome to Scapy
Version 2.4.2
https://github.com/secdev/scapy
Have fun!
We are in France, we say Skaptee.
OK? Merci.
-- Sebastien Chabal
>>>

```

This is the base page when you launch scapy. To exit at any time, just depress the keys, **CTRL + D** to exit out of Python.

```

root@kali: ~
File Edit View Search Terminal Help
>>> lsc()
IPID_count      : Identify IP id values classes in a list of packets
arpcachepoison  : Poison target's cache with (your MAC,victim's IP) couple
arping          : Send ARP who-has requests to determine which hosts are up
arp Leak        : Exploit ARP leak flaws, like NetBSD-SA2017-002.
bind layers     : Bind 2 layers on some specific fields' values. It makes the packet being built # noqa: E501
bridge_and_sniff : Forward traffic between interfaces if1 and if2, sniff and return
chexdump        : Build a per byte hexadecimal representation
computeNIGroupAddr : Compute the NI group Address. Can take a FQDN as input parameter
corrupt_bits    : Flip a given percentage or number of bits from a string
corrupt_bytes   : Corrupt a given percentage or number of bytes from a string
defrag          : defrag(plist) -> ([not fragmented], [defragmented]),
defragment      : defragment(plist) -> plist defragmented as much as possible
dhcp_request    : Send a DHCP discover request and return the answer
dynDNS_add     : Send a DNS add message to a nameserver for "name" to have a new "rdata"
dynDNS_del     : Send a DNS delete message to a nameserver for "name"
etherleak       : Exploit Etherleak flaw
explore         : Function used to discover the Scapy layers and protocols.
fletcher16_checkbytes : Calculates the Fletcher-16 checkbytes returned as 2 byte binary-string.
fletcher16_checksum : Calculates Fletcher-16 checksum of the given buffer.
fragleak       : --
fragleak2      : --
fragment       : Fragment a big IP datagram
fuzz           : Transform a layer into a fuzzy layer by replacing some default values by random objects
getmacbyip     : Return MAC address corresponding to a given IP address
getmacbyip6    : Returns the MAC address corresponding to an IPv6 address
hexdiff        : Show differences between 2 binary strings
hexdump        : Build a tcpdump like hexadecimal view
hexedit        : Run hexedit on a list of packets, then return the edited packets.
hexstr         : Build a fancy tcpdump like hex from bytes.
import hexcap  : Imports a tcpdump like hexadecimal view
is_promisc     : Try to guess if target is in Promisc mode. The target is provided by its ip.
linehexdump    : Build an equivalent view of hexdump() on a single line
ls             : List available layers, or infos on a given layer class or name.
neighsol       : Sends and receive an ICMPv6 Neighbor Solicitation message
overlap_frag   : Build overlapping fragments to bypass NIPS
promiscping    : Send ARP who-has requests to determine which hosts are in promiscuous mode
rdpcap         : Read a pcap or pcapng file and return a packet list
report_ports   : portscan a target and output a LaTeX table
restart        : Restarts scapy
send           : Send packets at layer 3
sendp          : Send packets at layer 2
sendprst       : Send packets at layer 2 using tcreplay for performance
sniff          : Sniff packets and return a list of packets.
split layers   : Split 2 layers previously bound.

```

Run the command `lsc()` to see a list of all commands available in Scapy. Think of `lsc` as List Commands.

```
root@kali: ~  
File Edit View Search Terminal Help  
fragleak : --  
fragleak2 : --  
fragment : Fragment a big IP datagram  
fuzz : Transform a layer into a fuzzy layer by replacing some default values by random objects  
getmacbyip : Return MAC address corresponding to a given IP address  
getmacbyip6 : Returns the MAC address corresponding to an IPv6 address  
hexdiff : Show differences between 2 binary strings  
hexdump : Build a tcpdump like hexadecimal view  
hexedit : Run hexedit on a list of packets, then return the edited packets.  
hexstr : Build a fancy tcpdump like hex from bytes.  
import_hexcap : Imports a tcpdump like hexadecimal view  
ls_promisc : Try to guess if target is in Promisc mode. The target is provided by its ip.  
linehexdump : Build an equivalent view of hexdump() on a single line  
ls : List available layers, or infos on a given layer class or name.  
neighbor : Sends and receive an ICMPv6 Neighbor Solicitation message  
overlap_frag : Build overlapping fragments to bypass NIPS  
promiscping : Send ARP who-has requests to determine which hosts are in promiscuous mode  
rdpcap : Read a pcap or pcapng file and return a packet list  
report_ports : portscan a target and output a LaTeX table  
restart : Restarts scapy  
send : Send packets at layer 3  
sendp : Send packets at layer 2  
sendpfast : Send packets at layer 2 using tcpreplay for performance  
sniff : Sniff packets and return a list of packets.  
split_layers : Split 2 layers previously bound.  
sr : Send and receive packets at layer 3  
sr1 : Send packets at layer 3 and return only the first answer  
sr1flood : Flood and receive packets at layer 3 and return only the first answer  
srbt : send and receive using a bluetooth socket  
srbt1 : send and receive 1 packet using a bluetooth socket  
sr1flood : Flood and receive packets at layer 3  
srloop : Send a packet at layer 3 in loop and print the answer each time  
srp : Send and receive packets at layer 2  
srp1 : Send and receive packets at layer 2 and return only the first answer  
srp1flood : Flood and receive packets at layer 2 and return only the first answer  
srpflood : Flood and receive packets at layer 2  
srploop : Send a packet at layer 2 in loop and print the answer each time  
tcpdump : Run tcpdump or tshark on a list of packets  
traceroute : Instant TCP traceroute  
traceroute6 : Instant TCP traceroute using IPv6  
traceroute_map : Util function to call traceroute on multiple targets, then  
tshark : Sniff packets and print them calling pkt.summary(), a bit like text wireshark  
wireshark : Run wireshark on a list of packets  
wpcap : Write a list of packets to a pcap file  
>>>
```

Part two of the lsc list.

```
root@kali: ~  
File Edit View Search Terminal Help  
X509_ExtOCSStatement : None  
X509_ExtOCSStatements : None  
X509_ExtReasonCode : None  
X509_ExtSubjInfoAccess : None  
X509_ExtSubjectAltName : None  
X509_ExtSubjectDirectoryAttributes : None  
X509_ExtSubjectKeyIdentifier : None  
X509_ExtUserNotice : None  
X509_Extension : None  
X509_Extensions : None  
X509_GeneralName : None  
X509_IPAddress : None  
X509_OtherName : None  
X509_PolicyMapping : None  
X509_RDN : None  
X509_RFC822Name : None  
X509_RegisteredID : None  
X509_RevokedCertificate : None  
X509_SubjectPublicKeyInfo : None  
X509_TBSCertList : None  
X509_TBSCertificate : None  
X509_URI : None  
X509_Validity : None  
X509_X400Address : None  
ZCLGeneralReadAttributes : General Domain: Command Frame Payload: read attributes  
ZCLGeneralReadAttributesResponse : General Domain: Command Frame Payload: read attributes_response  
ZCLMeteringGetProfile : Metering Cluster: Get Profile Command (Server: Received)  
ZCLPriceGetCurrentPrice : Price Cluster: Get Current Price Command (Server: Received)  
ZCLPriceGetScheduledPrices : Price Cluster: Get Scheduled Prices Command (Server: Received)  
ZCLPricePublishPrice : Price Cluster: Publish Price Command (Server: Generated)  
ZCLReadAttributeStatusRecord : ZCL Read Attribute Status Record  
ZEP1 : Zigbee Encapsulation Protocol (V1)  
ZEP2 : Zigbee Encapsulation Protocol (V2)  
ZigBeeBeacon : ZigBee Beacon Payload  
ZigBeeAppCommandPayload : Zigbee Application Layer Command Payload  
ZigBeeAppDataPayload : Zigbee Application Layer Data Payload (General APS Frame Format)  
ZigBeeAppDataPayloadStub : Zigbee Application Layer Data Payload for Inter-PAN Transmission  
ZigBeeClusterLibrary : Zigbee Cluster Library (ZCL) Frame  
ZigBeeNWK : Zigbee Network Layer  
ZigBeeNWKCommandPayload : Zigbee Network Layer Command Payload  
ZigBeeNWKStub : Zigbee Network Layer for Inter-PAN Transmission  
ZigBeeSecurityHeader : Zigbee Security Header  
TIP: You may use explore() to navigate through all layers using a clear GUI  
>>>
```

Next, run the `ls()` command. As we can see above, there are a lot of layers in this tool we can run the tool against.

From a cursory glance, the Layers the author is focused on at the moment are:

- DNS
- ICMP
- IP

- NTP
- Packet
- Raw
- TCP
- UDP
- X509_Verify

```

root@kali: ~
File Edit View Search Terminal Help
X509_URI : None
X509_Verify : None
X509_X400Address : None
ZCLGeneralReadAttributes : General Domain: Command Frame Payload: read_attributes
ZCLGeneralReadAttributesResponse : General Domain: Command Frame Payload: read_attributes_response
ZCLMeteringGetProfile : Metering Cluster: Get Profile Command (Server: Received)
ZCLPriceGetCurrentPrice : Price Cluster: Get Current Price Command (Server: Received)
ZCLPriceGetScheduledPrices : Price Cluster: Get Scheduled Prices Command (Server: Received)
ZCLPricePublishPrice : Price Cluster: Publish Price Command (Server: Generated)
ZCLReadAttributesStatusRecord : ZCL Read Attribute Status Record
ZEP1 : Zigbee Encapsulation Protocol (V1)
ZEP2 : Zigbee Encapsulation Protocol (V2)
ZigBeeBeacon : ZigBee Beacon Payload
ZigBeeAppCommandPayload : Zigbee Application Layer Command Payload
ZigBeeAppDataPayload : Zigbee Application Layer Data Payload (General APS Frame Format)
ZigBeeAppDataPayloadStub : Zigbee Application Layer Data Payload for Inter-PAN Transmission
ZigBeeClusterLibrary : Zigbee Cluster Library (ZCL) Frame
ZigBeeNWK : Zigbee Network Layer
ZigBeeNWKCommandPayload : Zigbee Network Layer Command Payload
ZigBeeNWKStub : Zigbee Network Layer for Inter-PAN Transmission
ZigBeeSecurityHeader : Zigbee Security Header

TIP: You may use explore() to navigate through all layers using a clear GUI
>>> ls(DNS)
length : ShortField (Cond) = (None)
id : ShortField = (0)
qr : BitField (1 bit) = (0)
opcode : BitEnumField (4 bits) = (0)
aa : BitField (1 bit) = (0)
tc : BitField (1 bit) = (0)
rd : BitField (1 bit) = (1)
ra : BitField (1 bit) = (0)
z : BitField (1 bit) = (0)
ad : BitField (1 bit) = (0)
cd : BitField (1 bit) = (0)
rcode : BitEnumField (4 bits) = (0)
qdcount : DNSRRCountField = (None)
ancount : DNSRRCountField = (None)
nscount : DNSRRCountField = (None)
arcount : DNSRRCountField = (None)
qd : DNSORField = (None)
an : DNSRRField = (None)
ns : DNSRRField = (None)
ar : DNSRRField = (None)
>>>

```

Run: `ls(DNS)`

```

root@kali: ~
File Edit View Search Terminal Help
ZigBeeNWK : Zigbee Network Layer
ZigBeeNWKCommandPayload : Zigbee Network Layer Command Payload
ZigBeeNWKStub : Zigbee Network Layer for Inter-PAN Transmission
ZigBeeSecurityHeader : Zigbee Security Header

TIP: You may use explore() to navigate through all layers using a clear GUI
>>> ls(DNS)
length : ShortField (Cond) = (None)
id : ShortField = (0)
qr : BitField (1 bit) = (0)
opcode : BitEnumField (4 bits) = (0)
aa : BitField (1 bit) = (0)
tc : BitField (1 bit) = (0)
rd : BitField (1 bit) = (1)
ra : BitField (1 bit) = (0)
z : BitField (1 bit) = (0)
ad : BitField (1 bit) = (0)
cd : BitField (1 bit) = (0)
rcode : BitEnumField (4 bits) = (0)
qdcount : DNSRRCountField = (None)
ancount : DNSRRCountField = (None)
nscount : DNSRRCountField = (None)
arcount : DNSRRCountField = (None)
qd : DNSORField = (None)
an : DNSRRField = (None)
ns : DNSRRField = (None)
ar : DNSRRField = (None)
>>> ls(ICMP)
type : ByteEnumField = (8)
code : MultiEnumField (Depends on type) = (0)
chksum : XShortField = (None)
id : XShortField (Cond) = (0)
seq : XShortField (Cond) = (0)
ts_ori : ICMPTimeStampField (Cond) = (64885318)
ts_rx : ICMPTimeStampField (Cond) = (64885318)
ts_tx : ICMPTimeStampField (Cond) = (64885318)
gw : IPField (Cond) = ('0.0.0.0')
ptr : ByteField (Cond) = (0)
reserved : ByteField (Cond) = (0)
length : ByteField (Cond) = (0)
addr_mask : IPField (Cond) = ('0.0.0.0')
nextHopmtu : ShortField (Cond) = (0)
unused : ShortField (Cond) = (0)
unused : IntField (Cond) = (0)
>>>

```

Run: ls(ICMP)

```
root@kali: ~  
File Edit View Search Terminal Help  
ra : BitField (1 bit) = (0)  
z : BitField (1 bit) = (0)  
ad : BitField (1 bit) = (0)  
cd : BitField (1 bit) = (0)  
rcode : BitEnumField (4 bits) = (0)  
qdcount : DNSRRCountField = (None)  
ancount : DNSRRCountField = (None)  
nscount : DNSRRCountField = (None)  
arcount : DNSRRCountField = (None)  
qd : DNSORField = (None)  
an : DNSRRField = (None)  
ns : DNSRRField = (None)  
ar : DNSRRField = (None)  
>>> ls(ICMP)  
type : ByteEnumField = (8)  
code : MultiEnumField (Depends on type) = (0)  
chksum : XShortField = (None)  
id : XShortField (Cond) = (0)  
seq : XShortField (Cond) = (0)  
ts_ori : ICMPTimeStampField (Cond) = (64885318)  
ts_rx : ICMPTimeStampField (Cond) = (64885318)  
ts_tx : ICMPTimeStampField (Cond) = (64885318)  
gw : IPField (Cond) = ('0.0.0.0')  
ptr : ByteField (Cond) = (0)  
reserved : ByteField (Cond) = (0)  
length : ByteField (Cond) = (0)  
addr_mask : IPField (Cond) = ('0.0.0.0')  
nexthopmtu : ShortField (Cond) = (0)  
unused : ShortField (Cond) = (0)  
unused : IntField (Cond) = (0)  
>>> ls(IP)  
version : BitField (4 bits) = (4)  
ihl : BitField (4 bits) = (None)  
tos : XByteField = (0)  
len : ShortField = (None)  
id : ShortField = (1)  
flags : FlagsField (3 bits) = (<Flag 0 (!)>)  
frag : BitField (13 bits) = (0)  
ttl : ByteField = (64)  
proto : ByteEnumField = (0)  
chksum : XShortField = (None)  
src : SourceIPField = (None)  
dst : DestIPField = (None)  
options : PacketListField = ([])  
>>>
```

Run: ls(IP)

```
root@kali: ~  
File Edit View Search Terminal Help  
chksum : XShortField = (None)  
id : XShortField (Cond) = (0)  
seq : XShortField (Cond) = (0)  
ts_ori : ICMPTimeStampField (Cond) = (64885318)  
ts_rx : ICMPTimeStampField (Cond) = (64885318)  
ts_tx : ICMPTimeStampField (Cond) = (64885318)  
gw : IPField (Cond) = ('0.0.0.0')  
ptr : ByteField (Cond) = (0)  
reserved : ByteField (Cond) = (0)  
length : ByteField (Cond) = (0)  
addr_mask : IPField (Cond) = ('0.0.0.0')  
nexthopmtu : ShortField (Cond) = (0)  
unused : ShortField (Cond) = (0)  
unused : IntField (Cond) = (0)  
>>> ls(IP)  
version : BitField (4 bits) = (4)  
ihl : BitField (4 bits) = (None)  
tos : XByteField = (0)  
len : ShortField = (None)  
id : ShortField = (1)  
flags : FlagsField (3 bits) = (<Flag 0 (!)>)  
frag : BitField (13 bits) = (0)  
ttl : ByteField = (64)  
proto : ByteEnumField = (0)  
chksum : XShortField = (None)  
src : SourceIPField = (None)  
dst : DestIPField = (None)  
options : PacketListField = ([])  
>>> ls(NTP)  
>>> ls(Packet)  
>>> ls(Raw)  
load : StrField = ('')  
>>> ls(TCP)  
sport : ShortEnumField = (20)  
dport : ShortEnumField = (80)  
seq : IntField = (0)  
ack : IntField = (0)  
dataofs : BitField (4 bits) = (None)  
reserved : BitField (3 bits) = (0)  
flags : FlagsField (9 bits) = (<Flag 2 (S)>)  
window : ShortField = (8192)  
chksum : XShortField = (None)  
urgptr : ShortField = (0)  
options : TCPOptionsField = ('')  
>>>
```

Run: ls(TCP)

```

root@kali: ~
File Edit View Search Terminal Help
rcode      : BitEnumField (4 bits)      = (0)
qdcnt      : DNSRRCountField           = (None)
ancnt      : DNSRRCountField           = (None)
nscnt      : DNSRRCountField           = (None)
arcnt      : DNSRRCountField           = (None)
qd         : DNSORField                 = (None)
an         : DNSRRField                 = (None)
ns         : DNSRRField                 = (None)
ar         : DNSRRField                 = (None)
>>> ls(ICMP)
type       : ByteEnumField             = (8)
code       : MultiEnumField (Depends on type) = (0)
chksum     : XShortField               = (None)
id         : XShortField (Cond)        = (0)
seq        : XShortField (Cond)        = (0)
ts_ori     : ICMPTimeStampField (Cond) = (64885318)
ts_rx      : ICMPTimeStampField (Cond) = (64885318)
ts_tx      : ICMPTimeStampField (Cond) = (64885318)
gw         : IPField (Cond)            = ('0.0.0.0')
ptr        : ByteField (Cond)          = (0)
reserved   : ByteField (Cond)          = (0)
length     : ByteField (Cond)          = (0)
addr_mask  : IPField (Cond)            = ('0.0.0.0')
nexthopmtu : ShortField (Cond)         = (0)
unused     : ShortField (Cond)         = (0)
unused     : IntField (Cond)           = (0)
>>> ls(IP)
version    : BitField (4 bits)         = (4)
ihl        : BitField (4 bits)         = (None)
tos        : XByteField                 = (0)
len        : ShortField                 = (None)
id         : ShortField                 = (1)
flags      : FlagsField (3 bits)       = (<Flag 0 (>))
frag       : BitField (13 bits)        = (0)
ttl        : ByteField                 = (64)
proto      : ByteEnumField             = (0)
chksum     : XShortField               = (None)
src        : SourceIPField             = (None)
dst        : DestIPField               = (None)
options    : PacketListField          = ([])
>>> ls(NTP)
>>> ls(Packet)
>>> ls(Raw)
load       : StrField                  = ('')
>>>

```

Run: **ls(Raw)**

```

root@kali: ~
File Edit View Search Terminal Help
ts_tx      : ICMPTimeStampField (Cond)  = (64885318)
gw         : IPField (Cond)            = ('0.0.0.0')
ptr        : ByteField (Cond)          = (0)
reserved   : ByteField (Cond)          = (0)
length     : ByteField (Cond)          = (0)
addr_mask  : IPField (Cond)            = ('0.0.0.0')
nexthopmtu : ShortField (Cond)         = (0)
unused     : ShortField (Cond)         = (0)
unused     : IntField (Cond)           = (0)
>>> ls(IP)
version    : BitField (4 bits)         = (4)
ihl        : BitField (4 bits)         = (None)
tos        : XByteField                 = (0)
len        : ShortField                 = (None)
id         : ShortField                 = (1)
flags      : FlagsField (3 bits)       = (<Flag 0 (>))
frag       : BitField (13 bits)        = (0)
ttl        : ByteField                 = (64)
proto      : ByteEnumField             = (0)
chksum     : XShortField               = (None)
src        : SourceIPField             = (None)
dst        : DestIPField               = (None)
options    : PacketListField          = ([])
>>> ls(NTP)
>>> ls(Packet)
>>> ls(Raw)
load       : StrField                  = ('')
>>> ls(TCP)
sport      : ShortEnumField            = (20)
dport      : ShortEnumField            = (80)
seq        : IntField                  = (0)
ack        : IntField                  = (0)
dataofs    : BitField (4 bits)         = (None)
reserved   : BitField (3 bits)         = (0)
flags      : FlagsField (9 bits)       = (<Flag 2 (S)>)
window     : ShortField                = (8192)
chksum     : XShortField               = (None)
urgptr     : ShortField                = (0)
options    : TCPOptionsField          = ('')
>>> ls(UDP)
sport      : ShortEnumField            = (53)
dport      : ShortEnumField            = (53)
len        : ShortField                = (None)
chksum     : XShortField               = (None)
>>>

```

Run: **ls(UDP)**

```
root@kali: ~
File Edit View Search Terminal Help
reserved : ByteField (Cond) = (0)
length : ByteField (Cond) = (0)
addr_mask : IPField (Cond) = ('0.0.0.0')
nextHopmtu : ShortField (Cond) = (0)
unused : ShortField (Cond) = (0)
unused : IntField (Cond) = (0)
>>> ls(IP)
version : BitField (4 bits) = (4)
ihl : BitField (4 bits) = (None)
tos : XByteField = (0)
len : ShortField = (None)
id : ShortField = (1)
flags : FlagsField (3 bits) = (<Flag 0 ()>)
frag : BitField (13 bits) = (0)
ttl : ByteField = (64)
proto : ByteEnumField = (0)
chksum : XShortField = (None)
src : SourceIPField = (None)
dst : DestIPField = (None)
options : PacketListField = ([])
>>> ls(NTP)
>>> ls(Packet)
>>> ls(Raw)
load : StrField = ('')
>>> ls(TCP)
sport : ShortEnumField = (20)
dport : ShortEnumField = (80)
seq : IntField = (0)
ack : IntField = (0)
dataofs : BitField (4 bits) = (None)
reserved : BitField (3 bits) = (0)
flags : FlagsField (9 bits) = (<Flag 2 (S)>)
window : ShortField = (8192)
chksum : XShortField = (None)
urgptr : ShortField = (0)
options : TCPOptionsField = ('')
>>> ls(UDP)
sport : ShortEnumField = (53)
dport : ShortEnumField = (53)
len : ShortField = (None)
chksum : XShortField = (None)
>>> ls(X509_Veracity)
not_before : ASN1F_CHOICE = (Oct 09 17:51:25 2022 GMT <ASN1_UTC_TIME['221009175125Z']>)
not_after : ASN1F_CHOICE = (Oct 10 18:01:25 2022 GMT <ASN1_UTC_TIME['221010180125Z']>)
>>>
```

Run: `ls(X509_Veracity)`

What we are looking at here are all of the fields that are available as inputs for a programmer. When the author saw this, he was blown away with the amount of detail `scapy` provides. As a reminder, this paper is just an overview and future papers will cover programs and execution of code.

Let's move on to the next section, in case you want to start programming with `scapy` in python3 now.

3.1. Scapy Python Library install

Simply run in a terminal [with Kali, you should be logged in as root]:

```
apt-get update
apt-get install python3-pip
pip3 install scapy
```

The above is what you will use if you want to write your own, or import other people's programs to run `scapy` against your target systems/domains.

Chapter 4. Conclusion

Scapy is a powerful tool that allows detailed testing of many components of your network. Part of the power is in the flexibility of this tool. One awesome feature is the ability to re-use information that it has already discovered without having to query the target a second time. The sheer amount of functions and methods pre-packaged in scapy are mind staggering. This tool is a blessing to the Cyber Security community and needs to be recognized by more professionals as a tool they routinely use (in and out of professional settings [meaning at work and in their home labs]).

The author cannot wait to start using this tool in a professional capacity and introduce to new clients and colleagues.

Keep your eyes sharp for Part Two of this series.

Chapter 5. Appendix

References

<https://www.kali.org/tools/scapy/>

<https://scapy.net/>

Official Docs: <https://scapy.readthedocs.io/en/latest/introduction.html>

<https://thepacketgeek.com/scapy/building-network-tools/>

source code: <https://github.com/secdev/scapy>

iPython tutorial with scapy: <https://github.com/secdev/scapy/blob/master/doc/notebooks/Scapy%20in%2015%20minutes.ipynb>