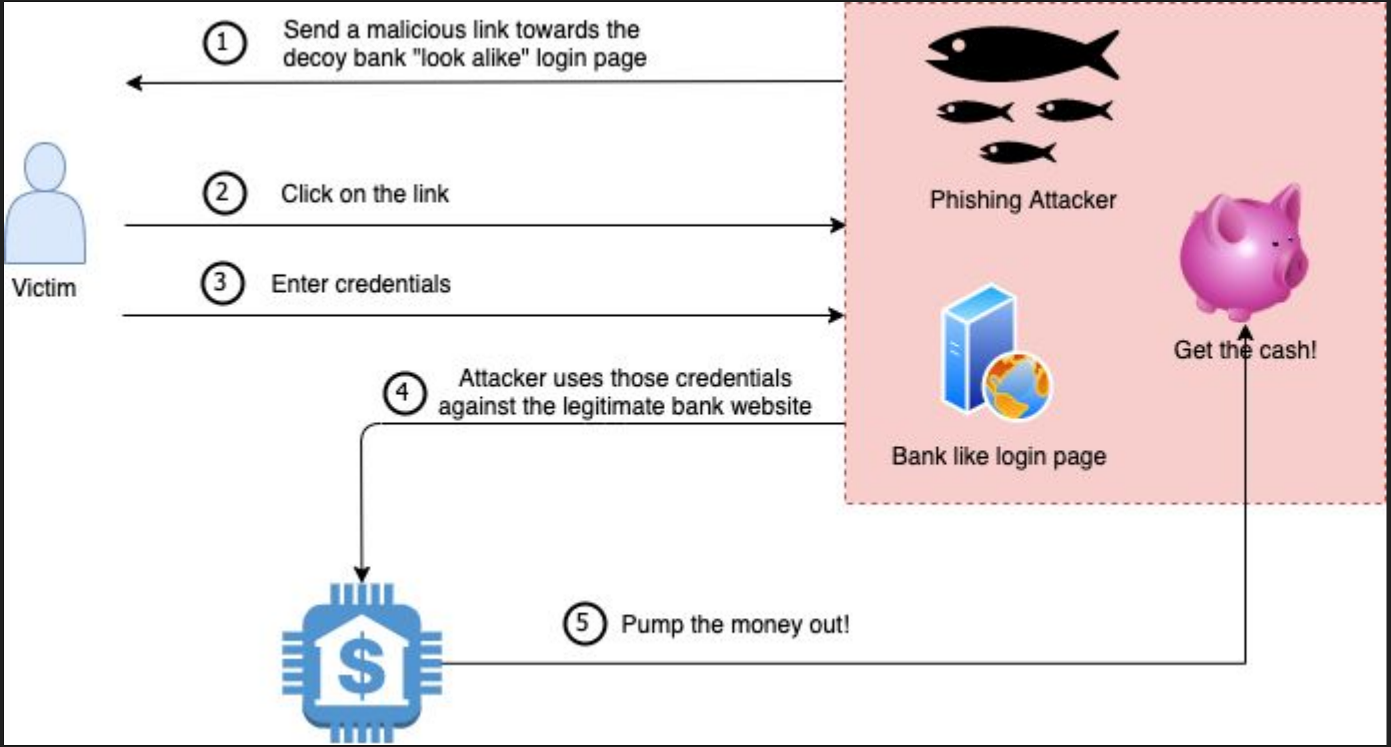
Attacking Networks with pCraft

Sebastien Tricaud
Director of Security Engineering at Devo Inc
@tricaud

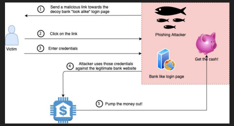
#whoami

- Security Research Director at Devo
- MISP contributor
- Lead developer of SightingsDB (https://github.com/stricaud/sightingdb)
- Lead developer of Faup (https://github.com/stricaud/faup)
- Honeynet Project, former CTO and current board member
- Worked on Linux PAM, Prelude IDS etc.

Have you ever seen this?


1 Send a malicious link towards the decoy bank "look alike" login page
Phishing Attacker
Victim
2 Click on the link
3 Enter credentials
Get the cash!
4 Attacker uses those credentials against the legitimate bank website
Bank like login page
5 Pump the money out!

Diagrams are insufficient


1 Send a malicious link towards the decoy bank "look alike" login page
Victim
2 Click on the link
3 Enter credentials
4 Attacker uses those credentials against the legitimate bank website
5 Pump the money out!
Phishing Attacker
Bank like login page
Get the cash!

- They summarize an attack for the general public
- You are not the general public, you want to scratch the surface!
- You REALLY want to understand the attack, details are hidden
- You search the web and ask your friends if they have a PCAP
- Would you have detected it with your IDS, SIEMs etc.?

Creating a pcap about this Phishing attack

- Clicking on a link
  - Do a DNS request to get the IP address of the Host
  - HTTP Session:
    - Send TCP Three Way Handshake
    - Send the HTTP Request
    - Get an HTTP Response
    - Terminate
- Pcraft was built to help you do this
  - https://github.com/devoinc/pcraft

Installation

Required tools

- Pcraft (https://github.com/devoinc/pcraft)
  - pip3 install pcraft
- TCPreplay https://tcpreplay.appneta.com/
- Suricata https://suricata-ids.org/

Docker

```
$ docker pull sightingdb/pcraft:0.1.1

$ docker run --name pcraft -d sightingdb/pcraft:0.1.1
```

Your first pcap

Let's run to create our first pcap

```
start: dns1

dns1:
  _plugin: DNSConnection
  domain: redteamvillage.io
  _next: done
```

Let's run to create our first pcap

```yaml
start: dns1

dns1:

  _plugin: DNSConnection

  domain: redteamvillage.io

  _next: done
```

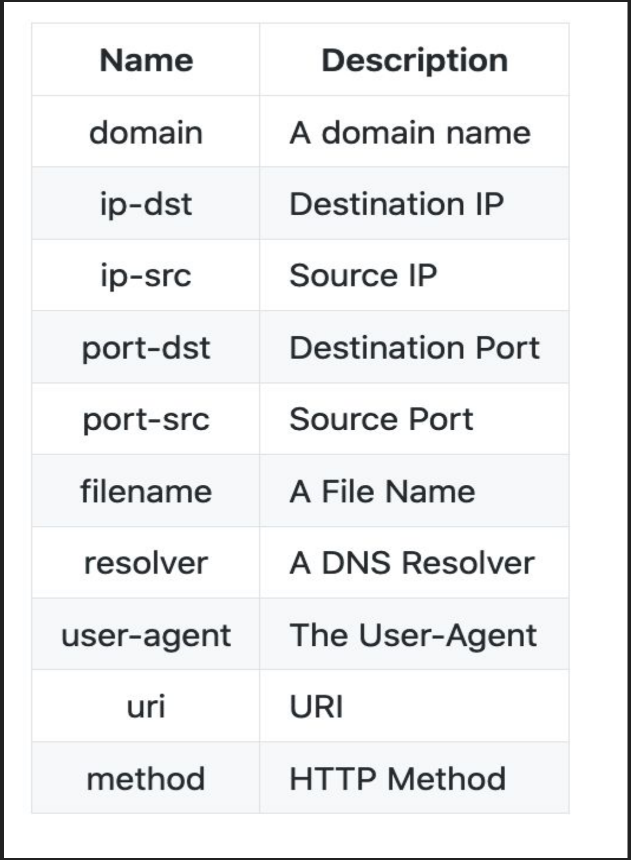
```
$ ./pcrafter st.yaml st.pcap

$ tshark -r st.pcap

      1   0.000000 192.168.214.149 → 1.1.1.1      DNS 77  Standard query 0x0000 A redteamvillage.io

      2   0.000824    1.1.1.1 → 192.168.214.149 DNS 110  Standard query response 0x0000 A
redteamvillage.io A 10.252.148.119
```

Pcraft Engine

Taxonomy

In pcraft a Taxonomy is just to have all the Plugins agreeing with each other on how you label something such as a "source IP address". It shall be "ip-src".

It is stored in docs/taxonomy.md and will evolve anytime we need something new. However, the ones that are set will never change.



Name	Description
domain	A domain name
ip-dst	Destination IP
ip-src	Source IP
port-dst	Destination Port
port-src	Source Port
filename	A File Name
resolver	A DNS Resolver
user-agent	The User-Agent
uri	URI
method	HTTP Method

Adding the ip-dst in our DNS transaction

```
start: dns1

dns1:
  _plugin: DNSConnection
  domain: redteamvillage.io
  resolver: 8.8.8.8
  ip-dst: 185.199.108.153
  _next: done
```

Creating our domain outside of the DNS part (one way)

```
start: newdomain

newdomain:
  _plugin: GenerateNewDomain
  _next: dns1

dns1:
  _plugin: DNSConnection
  resolver: 8.8.8.8
  ip-dst: 185.199.108.153
  _next: done
```

- Thank to Taxonomy, as long as we have a variable set with the "domain" key, it can be used instead.
- We use the GenerateNewDomain plugin which will create a valid non-existing domain, using "domain" as the way to communicate output to the other plugins
- We can remove the domain variable from the dns1 step

Creating our domain outside of the DNS part (another way)

```
start: newdomain

newdomain:
  _plugin: MakeVariables
  domain: redteamvillage.io
  _next: dns1

dns1:
  _plugin: DNSConnection
  resolver: 8.8.8.8
  ip-dst: 185.199.108.153
  _next: done
```

- Instead of using the GenerateNewDomain plugin, we set the domain variable ourselves
- It is useful to start a scenario with the MakeVariables plugin, to define who are the attacker's IP addresses and the machines being targeted. A Variable can be reused either automatically if a Plugin depend on it, or using $variable as an argument to a parameter

Taxonomy in plugins

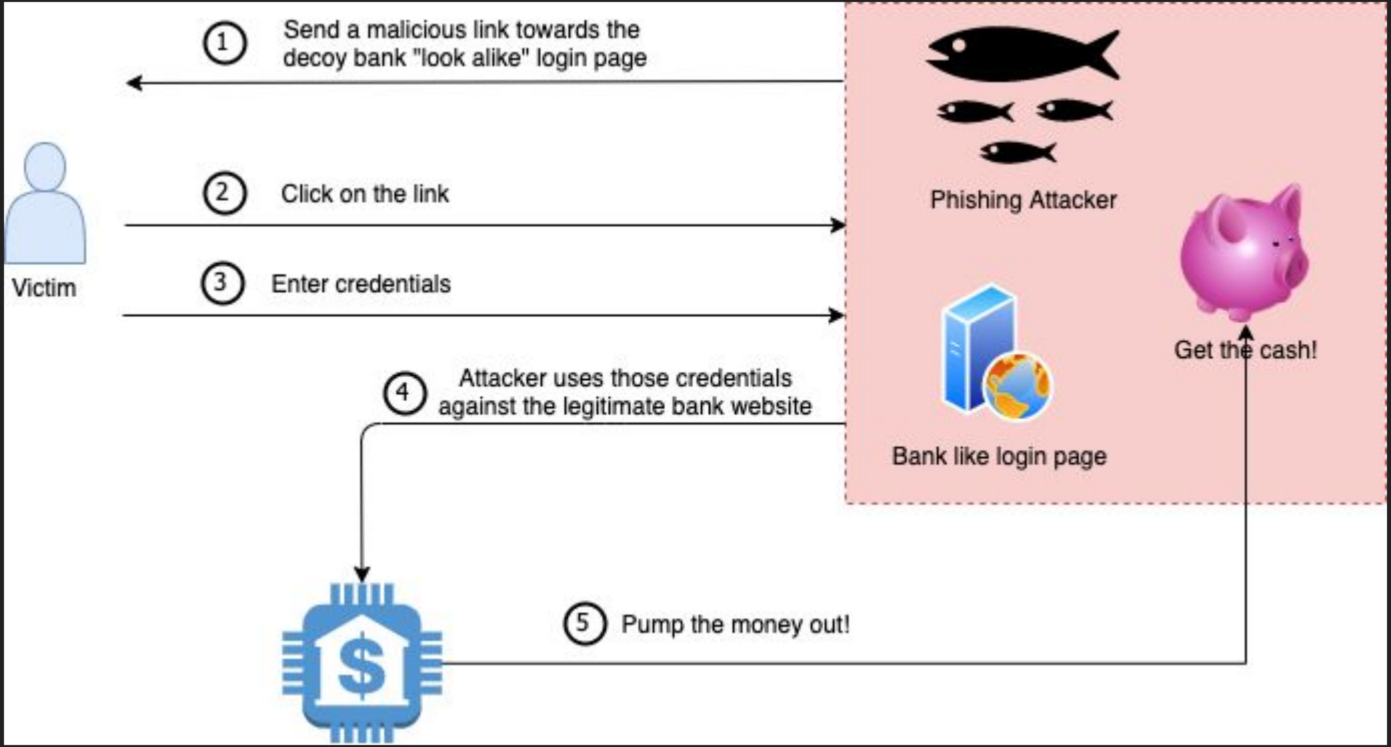
- Each action type is defined by a Plugin
- Plugins are given a plugin context (state that remain in the entire flow)
- They define the required variables: required = ["ip-dst", "domain"]; They will not work if they are not set
- The get variables from that context: self.getvar("ip-dst")

Available Plugins

- MakeVariables
  - Create variables
- TcpRst
  - Add a TCP-RST exchange
- HTTPConnection
  - Create an HTTP connection
- GenerateNewDomain
  - Create a new valid non existing domain
- DNSConnection
  - Create a DNS query and reply
- Ping
  - Add an ICMP request and reply
- PcapImport
  - Append data from another PCAP
- HostnameFromIP
  - Generate a consistent fake hostname from an IP address
- FakeNames
  - Generate 3 variables: firstname, lastname and email
- Suricata
  - Import a Suricata rule to create a packet that will trigger that rule
- <YOURS SOON>

Your first scenario

Remember this?



1 Send a malicious link towards the decoy bank "look alike" login page
Victim
2 Click on the link
3 Enter credentials
Phishing Attacker
Bank like login page
Get the cash!
4 Attacker uses those credentials against the legitimate bank website
5 Pump the money out!

Starting

```
start: vars

vars:
  _plugin: MakeVariables
  victimip: 192.168.0.55
  fakebankip: 185.199.108.153
  _next: domaingen
```

- We create the start condition
- We call the MakeVariables plugin so it will be easier to know how we reference the victim and the Fake Bank IP addresses
- We jump to the next step: domaingen

The user clicks on the link

```
domaingen:
  _plugin: GenerateNewDomain
  _next: dnsreq

dnsreq:
  _plugin: DNSConnection
  ip-src: $victimip
  ip-dst: $fakebankip
  _next: httppost
```

- We call the GenerateNewDomain to create a "domain" variable
- We jump to the dns requet creation (dnsreq)
- We call the DNSConnection plugin using the victim ip which will resolve to the fake bank IP
- We jump to httppost

Generate the HTTP Post

```
httppost:
  _plugin: HTTPConnection
  method: POST
  content-type:
application/x-www-form-urlencoded
  content:
login=Alfred.Wallace@example.com&password=qw
erty1234
  _next: done
```

- We call the HTTPConnection plugin to create the POST form we want which includes the login and password for our victim
- We finish the scenario with _next: done

Adding a loop?

```
httppost:
  _plugin: HTTPConnection
  method: POST
  content-type:
application/x-www-form-urlencoded
  content:
login=Alfred.Wallace@example.com&password=qw
erty1234
  _next: loop-1

loop-1:
  _start: httppost
  count: 3
  _sleep: {"once-finished":0.3}
  _next: done
```

- We must call our loop with loop-ID, we change the _next value to set it to loop-1
- We set the counter to 3, so in total that will make 4 HTTP Connections
- We sleep 0.3 s when we are done
- We finish the scenario with _next: done

Alfred.Wallace@example.com? yuk!

```
fake:
  _plugin: FakeNames
  orgdomain: redteamvillage.io
  _next: httppost

httppost:
  _plugin: HTTPConnection
  method: POST
  content-type:
application/x-www-form-urlencoded
  content: login=$email&password=qwerty1234
  _next: done
```

- You don't like the email address we wrote? Fine, we have a plugin to generate user names and email addresses: FakeNames attached to the organization domain "redteamvillage.io"

Writing a Plug-in

Where do plugins live?

- If you have the docker image, they are in:
  - /usr/local/lib/python3.8/dist-packages/pcraft/plugins/
  - We are running as root in this docker image, so you can play with the directory
- If you ran a git clone on https://github.com/devoinc/pcraft they are in pcraft/plugins
- If you ran pip3 install pcraft, you have to find out
  - One trick: `$ pcrafter /bin/ls foo`
    - Forget the error, look at the first line which dumps the loaded plugins with their directories
- They must be dropped in the plugin/ directory so it would be loaded at startup time with pcraft

Plugin structure

```
from pcraft.PluginsContext import PluginsContext

class PCraftPlugin(PluginsContext):
    name = "MyOwnStuff"

    def __init__(self, app, session, plugins_data):
        super().__init__(app, session, plugins_data)

    def run(self, script=None):
        self.update_vars_from_script(script)

        print("Hello, from MyOwnStuff")

        if script:
            return script["_next"], self.plugins_data
        else:
            return None, self.plugins_data
```

Plugin structure

```
from pcraft.PluginsContext import PluginsContext
```
1

```
class PCraftPlugin(PluginsContext):
    name = "MyOwnStuff"
```
2

3
```
    def __init__(self, app, session, plugins_data):
        super().__init__(app, session, plugins_data)
```

4
```
    def run(self, script=None):
        self.update_vars_from_script(script)

        print("Hello, from MyOwnStuff" )

        if script:
            return script["_next"], self.plugins_data
        else:
            return None, self.plugins_data
```

1. We import the PluginsContext
2. We create a class "PCraftPlugin" and we call it with the same name that will be used for the file
3. Initialization with Instanciation from PluginsContext
4. Called when we run:
   a. Update variables from the script
   b. Your code
   c. Return to go to the next script unless we should not because this plugin was called from another plugin

Passing Variables

```
def run(self, script=None):
    self.update_vars_from_script(script)

    print("The domain variable:" + self.getvar("domain"))
    self.setvar("ip-src", "192.168.0.0")

    if script:
        return script["_next"], self.plugins_data
    else:
        return None, self.plugins_data
```

- Simply use self.setvar() and self.getvar()

Packet Manipulation

- We are writing a pcap
  - We craft a packet using Scapy
  - We append that packet to the array which is used in the end to write the whole pcap
- Import Scapy in your Plugin:
  - `from scapy.all import *`

Packet Manipulation

- We are writing a pcap
  - We craft a packet using Scapy
  - We append that packet to the array which is used in the end to write the whole pcap
- Import Scapy in your Plugin:
  - `from scapy.all import *`
- Mangle your ICMP packet the Scapy way:

```
echo_request = Ether() / IP(src=script["ip-src"], dst=str(individual_ip)) /
ICMP(type="echo-request")
```

Packet Manipulation

- We are writing a pcap
  - We craft a packet using Scapy
  - We append that packet to the array which is used in the end to write the whole pcap
- Import Scapy in your Plugin:
  - `from scapy.all import *`
- Mangle your ICMP packet the Scapy way:

```
echo_request = Ether() / IP(src=script["ip-src"], dst=str(individual_ip)) /
ICMP(type="echo-request")
```

- Append your packet to the global array

```
self.plugins_data.pcap.append(echo_request)
```

Example, packet writing with ICMP

```
echo_request = Ether() / IP(src=script["ip-src"], dst=str(individual_ip)) / ICMP(type="echo-request")
self.plugins_data.pcap.append(echo_request)
echo_reply = Ether() / IP(src=str(individual_ip), dst=script["ip-src"]) / ICMP(type="echo-reply")
self.plugins_data.pcap.append(echo_reply)
```

DNS Packet writing

```
query = Ether() / IP(src=self.getvar("ip-src"),dst=self.getvar("resolver")) / UDP(sport=4096,dport=53)/DNS(rd=1,
                                                                                                          qd=DNSQR(qname=self.getvar("domain")))
self.plugins_data.pcap.append(query)
resp = Ether() / IP(dst=self.getvar("ip-src"),src=self.getvar("resolver")) / UDP(sport=53,dport=4096)/DNS(id=query[DNS].id,
                                                                                                         qr=1, qd=query[DNS].qd,
                                                                                                         an=DNSRR(rrname=query[DNS].qd.qname,
                                                                                                                  rdata=self.getvar("ip-dst")))
self.plugins_data.pcap.append(resp)
```

TCP

- TCP requires more work, because there is a handshake, we must keep the session flow consistent etc.
- We have a util library that helps to write the handshake for us
- We have a session helper to give the proper sequence and acknowledgement number

Adding a three-way handshake

```
from . import _utils as utils

utils.append_tcp_three_way_handshake(self.session,
self.plugins_data, self.getvar("port-src"))
```

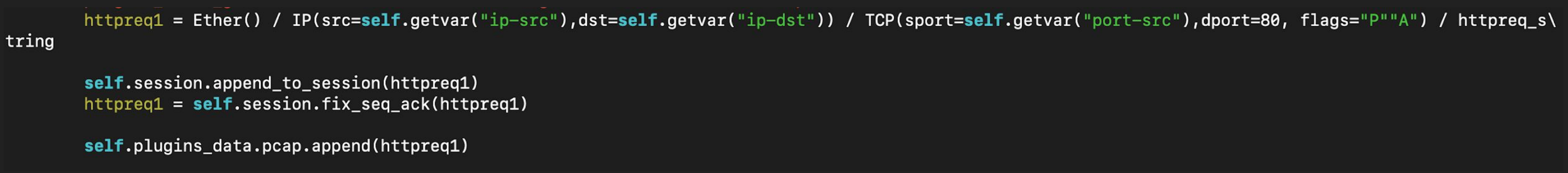
Correct Sequence and Acknowledgement

```
packet = Ether() / IP( …

self.session.append_to_session(packet)

packet = self.session.fix_seq_ack(packet)

self.plugins_data.pcap.append(packet)
```

Example from the HTTPConnection Plugin

```
        if self.getvar("method").upper() == "POST":
            httpreq_string = "{method} {uri} HTTP/1.1\r\nAccept: */*\r\nUser-Agent: {useragent}\r\nHost:{host}{user}\r\nContent-Type:{contenttype}\r\nConten\
t-Length:{contentlen}\r\n\r\n{content}".format(
                method=self.getvar("method"),
                uri=self.getvar("uri"),
                useragent=self.getvar("user-agent"),
                host=self.getvar("domain"),
                user=user,
                contenttype=self.getvar("content-type"),
                contentlen=len(self.getvar("content")),
                content=self.getvar("content"))
```

Example from the HTTPConnection Plugin



```
        httpreq1 = Ether() / IP(src=self.getvar("ip-src"),dst=self.getvar("ip-dst")) / TCP(sport=self.getvar("port-src"),dport=80, flags="P""A") / httpreq_s\
tring

        self.session.append_to_session(httpreq1)
        httpreq1 = self.session.fix_seq_ack(httpreq1)

        self.plugins_data.pcap.append(httpreq1)
```

Example from the HTTPConnection Plugin

```
        ack = Ether() / IP(src=self.getvar("ip-src"),dst=self.getvar("ip-dst")) / TCP(sport=80, dport=self.getvar("port-src"), flags="A")

        self.session.append_to_session(ack)
        ack = self.session.fix_seq_ack(ack)
        self.plugins_data.pcap.append(ack)

        httpreq2 = Ether() / IP(src=self.getvar("ip-dst"),dst=self.getvar("ip-src")) / TCP(sport=80,dport=self.getvar("port-src"), flags="P""A") / httpresp_\
string

        self.session.append_to_session(httpreq2)
        httpreq2 = self.session.fix_seq_ack(httpreq2)

        self.plugins_data.pcap.append(httpreq2)
```

Advanced Scenario

Import another pcap

```
start: import

import:
  _plugin: PcapImport
  filename: phishing.pcap
  replace: {"ip": {"192.168.0.55": "10.0.43.2",
                   "185.199.108.153": "172.16.38.5"
        }}
  _next: done
```

Add a Suricata rule!

```
start: suricata

suricata:
  _plugin: Suricata
  EXTERNAL_NET: 192.168.0.55
  HTTP_SERVERS: 185.199.108.153
  ip-dst: 185.199.108.153
  domain: redteamvillage.io
  rule: |
    alert http $EXTERNAL_NET any -> $HTTP_SERVERS any (msg:"ET WEB_SERVER Possible
Custom Content Type Manager WP Backdoor Access"; flow:established,to_server;
http.uri; content:"/plugins/custom-content-type-manager/auto-update.php";
fast_pattern; nocase;
reference:url,blog.sucuri.net/2016/03/when-wordpress-plugin-goes-bad.html;
classtype:trojan-activity; sid:2022596; rev:4; metadata:created_at 2016_03_06,
updated_at 2020_06_24;)
  _next: done
```

Use functions! Loops and functions!

```
start: dns
dns:
  _plugin: DNSConnection
  domain: =@=fromcsv(sequential,
fromcsv.csv, header=true,
col=domain)=@=
  _next: loop-1

loop-1:
  _start: dns
  count: 2
  _next: done
```

```
fromcsv.csv:

ipsource,domain
127.0.0.1,cezasaduzo
192.168.0.42,zizicofydi
192.168.10.20,zizicotepa
10.20.32.12,bararepim
```

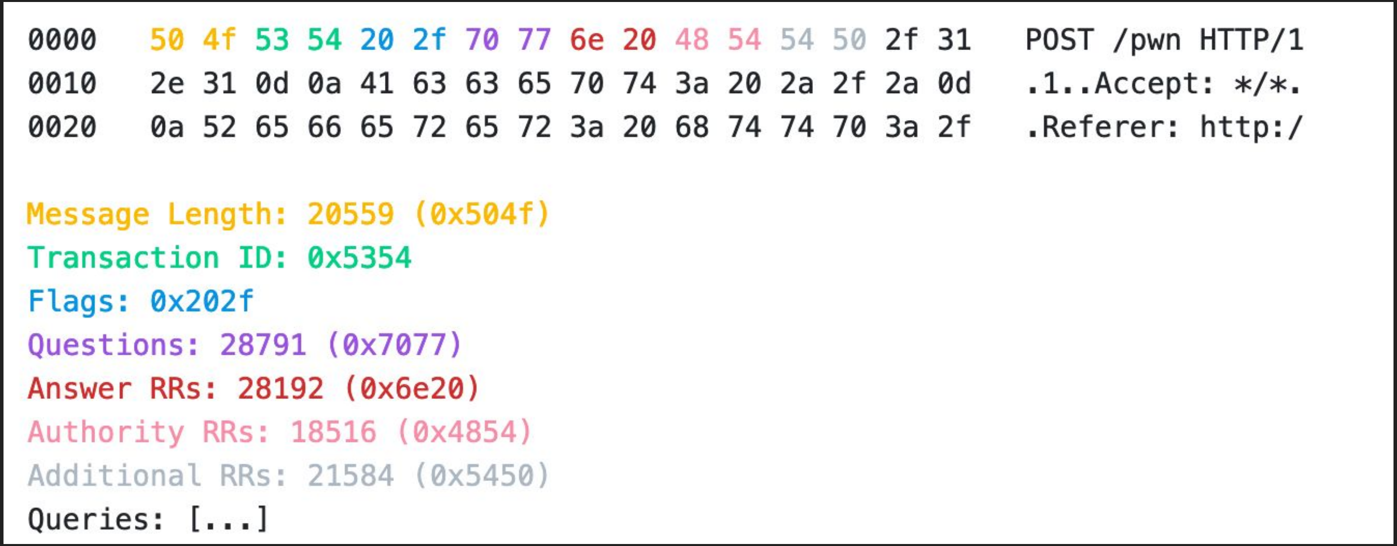
Create your attacks!

Built a Plugin or scenario?

- Checkout https://github.com/stricaud/defcon-redteamvillage-2020 for some hints of what we used here
- Please create a PR or an issue on https://github.com/devoinc/pcraft so I can add them to the repository and everybody will benefit!

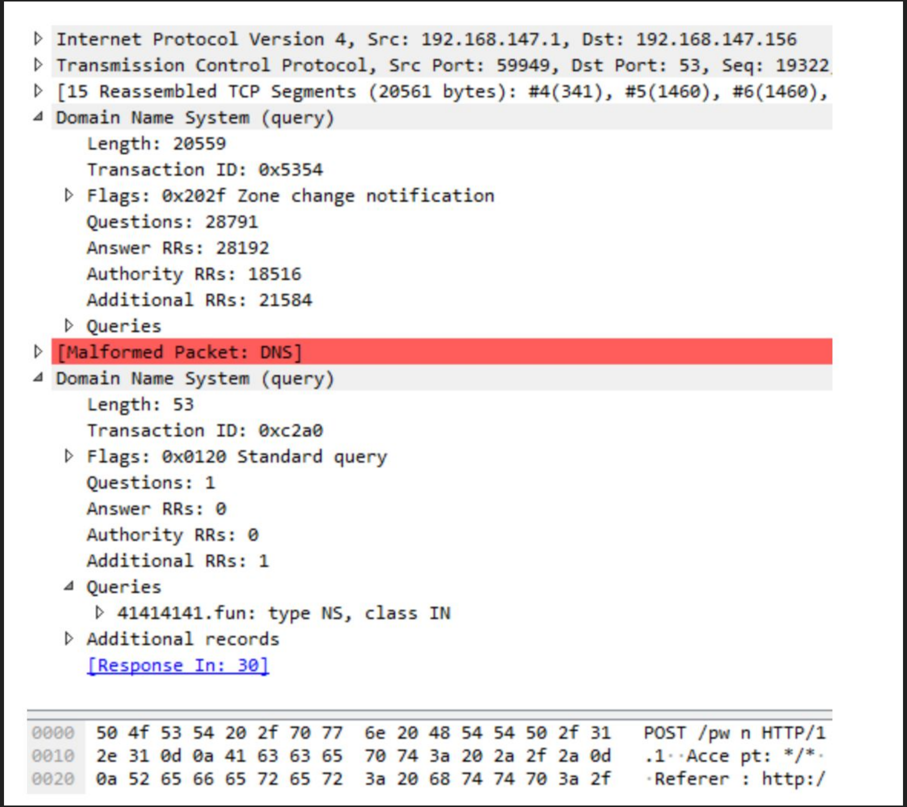
Example, Windows DNS Server vulnerability

- https://research.checkpoint.com/2020/resolving-your-way-into-domain-admin-exploiting-a-17-year-old-bug-in-windows-dns-servers/



```
0000   50 4f 53 54 20 2f 70 77 6e 20 48 54 54 50 2f 31   POST /pwn HTTP/1
0010   2e 31 0d 0a 41 63 63 65 70 74 3a 20 2a 2f 2a 0d   .1..Accept: */*.
0020   0a 52 65 66 65 72 65 72 3a 20 68 74 74 70 3a 2f   .Referer: http:/

Message Length: 20559 (0x504f)
Transaction ID: 0x5354
Flags: 0x202f
Questions: 28791 (0x7077)
Answer RRs: 28192 (0x6e20)
Authority RRs: 18516 (0x4854)
Additional RRs: 21584 (0x5450)
Queries: [...]
```

Example, Windows DNS Server vulnerability



```
▷ Internet Protocol Version 4, Src: 192.168.147.1, Dst: 192.168.147.156
▷ Transmission Control Protocol, Src Port: 59949, Dst Port: 53, Seq: 19322
▷ [15 Reassembled TCP Segments (20561 bytes): #4(341), #5(1460), #6(1460),
◢ Domain Name System (query)
    Length: 20559
    Transaction ID: 0x5354
  ▷ Flags: 0x202f Zone change notification
    Questions: 28791
    Answer RRs: 28192
    Authority RRs: 18516
    Additional RRs: 21584
  ▷ Queries
▷ [Malformed Packet: DNS]
◢ Domain Name System (query)
    Length: 53
    Transaction ID: 0xc2a0
  ▷ Flags: 0x0120 Standard query
    Questions: 1
    Answer RRs: 0
    Authority RRs: 0
    Additional RRs: 1
  ◢ Queries
    ▷ 41414141.fun: type NS, class IN
  ▷ Additional records
    [Response In: 30]

0000  50 4f 53 54 20 2f 70 77  6e 20 48 54 54 50 2f 31   POST /pw n HTTP/1
0010  2e 31 0d 0a 41 63 63 65  70 74 3a 20 2a 2f 2a 0d   .1··Acce pt: */*·
0020  0a 52 65 66 65 72 65 72  3a 20 68 74 74 70 3a 2f   ·Referer : http:/
```

Playing with Tcpreplay and Suricata

Create a simple Suricata rule

- In a file called "mydns.rule":

```
alert dns any any -> any any (msg:"DNS Query Red Team"; dns_query;
content:"redteamvillage"; nocase; sid:20200809; rev:1;)
```

- Run Suricata:

```
suricata -S mydns.rule -i eth0
```

Add this rule into a pcraft scenario

```
start: suricata
suricata:
  _plugin: Suricata
  ip-src: 172.17.0.2
  ip-dst: 185.199.108.153
  rule: |
    alert dns any any -> any any (msg:"DNS Query Red Team"; dns_query;
content:"redteamvillage"; nocase; sid:20200809; rev:1;)
  _next: done
```

Tcpreplay and monitor the Suricata log

```
tcpreplay -i eth0 suricata.pcap
Actual: 2 packets (178 bytes) sent
in 0.000880 seconds
Rated: 202272.7 Bps, 1.61 Mbps,
2272.72 pps
Flows: 2 flows, 2272.72 fps, 2 flow
packets, 0 non-flow
Statistics for network device: eth0
    Successful packets:        2
    Failed packets:            0
    Truncated packets:         0
    Retried packets (ENOBUFS): 0
    Retried packets (EAGAIN):  0
```

```
tail -f /var/log/suricata/fast.log

08/08/2020-05:35:02.696600  [**]
[1:20200809:1] DNS query alert [**]
[Classification: (null)] [Priority:
3] {PROTO:017} 172.17.0.2:4096 ->
1.1.1.1:53
```

\o\ \o/ /o/

Thank you!

Reach out to me on twitter: @tricaud
Via email: sebastien.tricaud@devo.com
Contribute! https://github.com/devoinc/pcraft