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Tommy McNeela, CISSP

How Denial of Service Attacks Work

Internet Access

Network: ???

Password: ???

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Tommy McNeela, CISSP

How Denial of Service Attacks Work

Welcome

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Disclaimer

Don’t try to hack into other companies or other people’s personal accounts.

It is illegal and you will be arrested.

Use your own lab.

Following Along

- Download and install Oracle VirtualBox (https://www.virtualbox.org/wiki/Downloads)
- Download the two virtual appliances below, and import them into VirtualBox:
  - https://drive.google.com/open?id=0B2Vs-EwZxkS1dHVXeVFFZkxaM3M (DoS target)
  - https://drive.google.com/open?id=0B2Vs-EwZxkS1SWJkcjl5d0tTWGM (DoS attacker)

- Work together with your neighbors and collaborate

What is a DoS attack?

- A denial of service attack is any attack intended to disrupt the availability of a resource to legitimate users.

Real-world DoS mitigation

Why are we talking about DoS? It is the easiest and most common network attack used today.

Real-world DoS mitigation

Why are we talking about DoS? It is the easiest and most common network attack used today.

I am a network security engineer for US Cellular, and we detect and mitigate an average of more than 2200 DDoS attacks per day on the customer data network.

What is a DDoS attack?

- A Distributed Denial of Service attack is a coordinated DoS attack that uses many different hosts or attack vectors simultaneously to carry out the attack against the target.

How does an attacker have so many hosts to use?

- Usually, the attack originates from a botnet.

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- Usually, the attack originates from a botnet.
- A botnet is a group of many hosts that are under an attacker’s control, usually gained through compromise by infections from malware such as Mirai.

Basic networking concepts

- Transmission Control Protocol (TCP)

Basic networking concepts

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  - Connection-based

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- User Datagram Protocol (UDP)

Basic networking concepts

- Transmission Control Protocol (TCP)
  - Connection-based
- User Datagram Protocol (UDP)
  - Connectionless

How does a TCP connection occur?

- TCP Handshake process

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TCP Handshake

Client
Server
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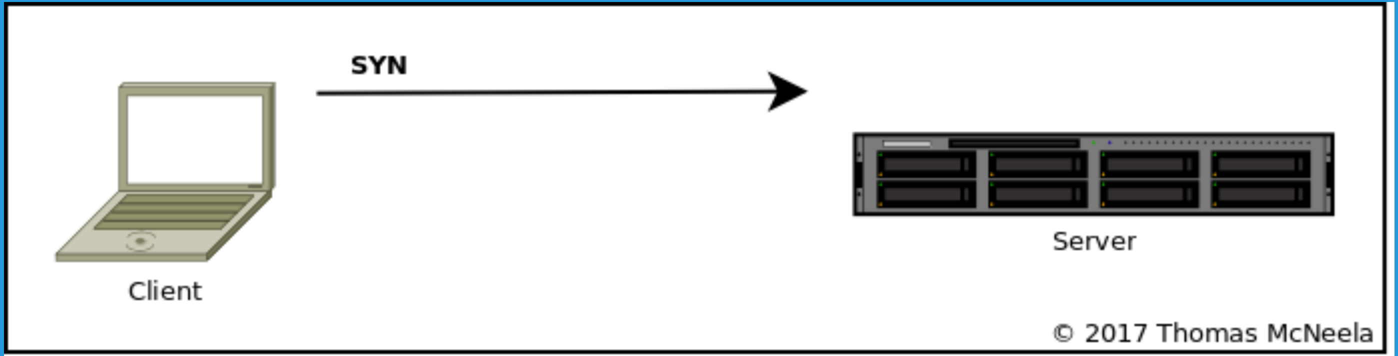
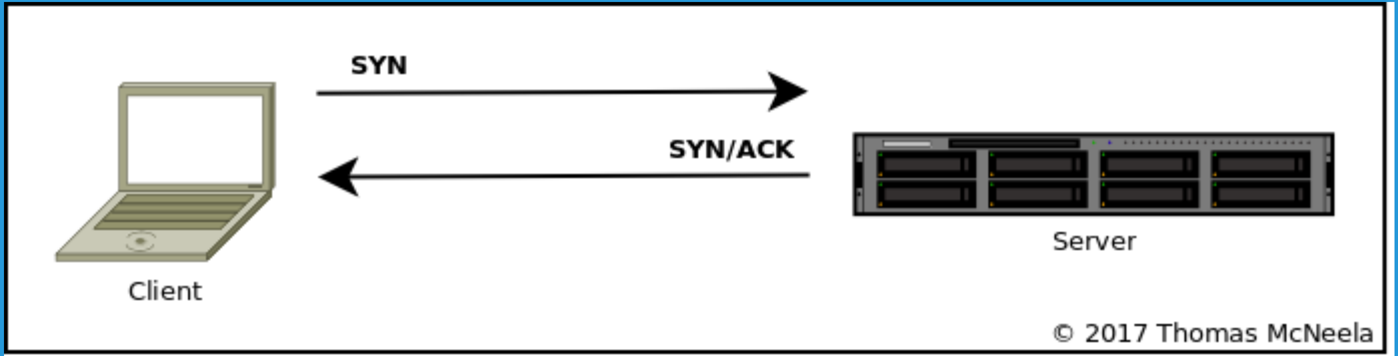
TCP Handshake (Step 1)



TCP Handshake (Step 2)



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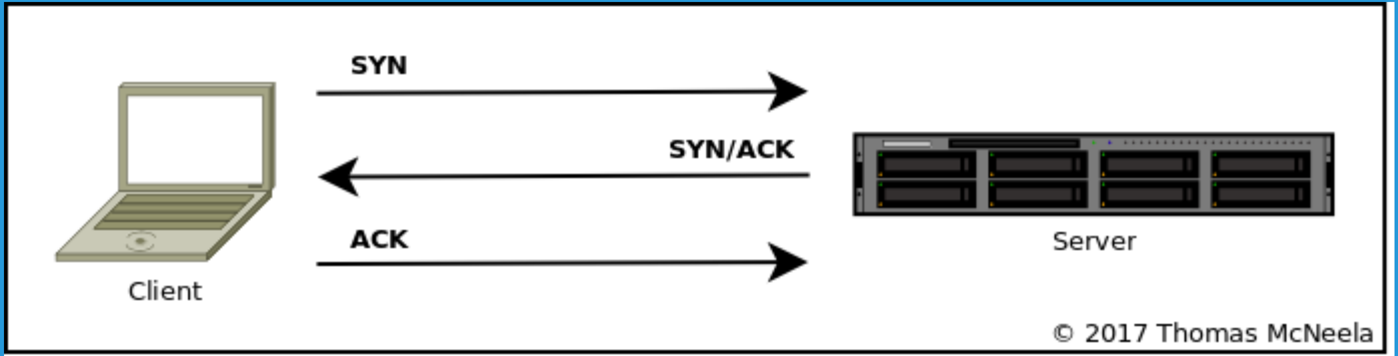
TCP Handshake (Step 3)



Connection established!

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IP Spoofing

- IP spoofing refers to modifying an IP packet header before sending it by replacing the source or destination IP address with a different address.

Common Network-Based DoS Attack Methods

Common Network-Based DoS Attack Methods

- Volume-based

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- Volume-based
  - –UDP flood

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Common Network-Based DoS Attack Methods

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  - Connection flood
  - HTTP flood

Common Network-Based DoS Attack Methods

- Volume-based
  - –UDP flood
  - –ICMP flood
- Protocol/application-based
  - –SYN flood
  - –Connection flood
  - –HTTP flood
  - –Ping of Death

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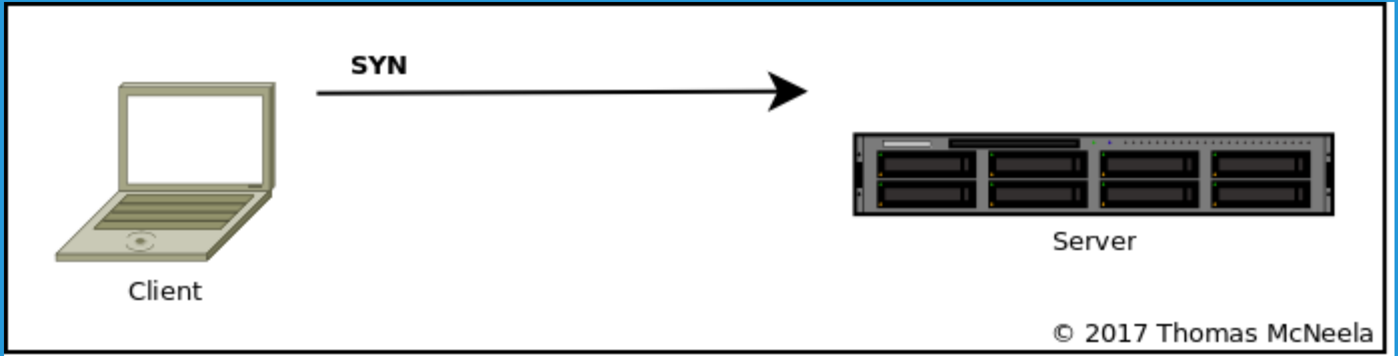
SYN Flood



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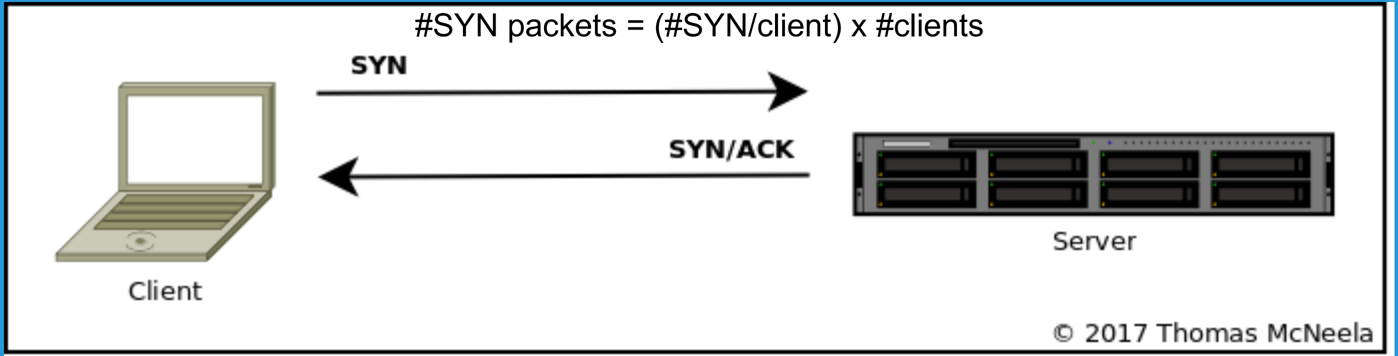
SYN Flood


#SYN packets = (#SYN/client) x #clients

No ACK response sent

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Connection Flood

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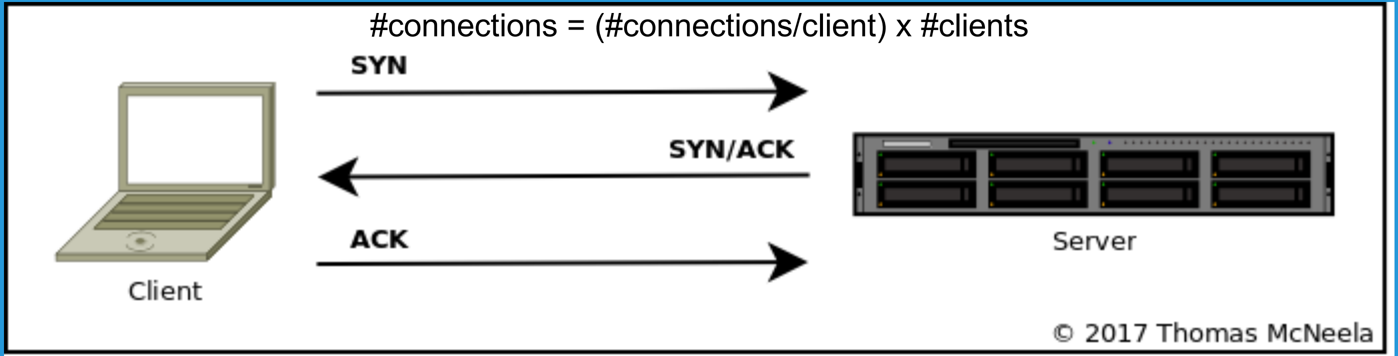

No data sent by client after TCP connection is established

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HTTP Flood

- After a TCP connection is made over port 80 (HTTP) or 443 (HTTPS), the attacking machine attempts to hold the connection open as long as possible and use as many resources as possible, reducing available resources to legitimate requests

Ping of Death

- Source IP is spoofed to be the IP address of the target machine, or the local loopback address.

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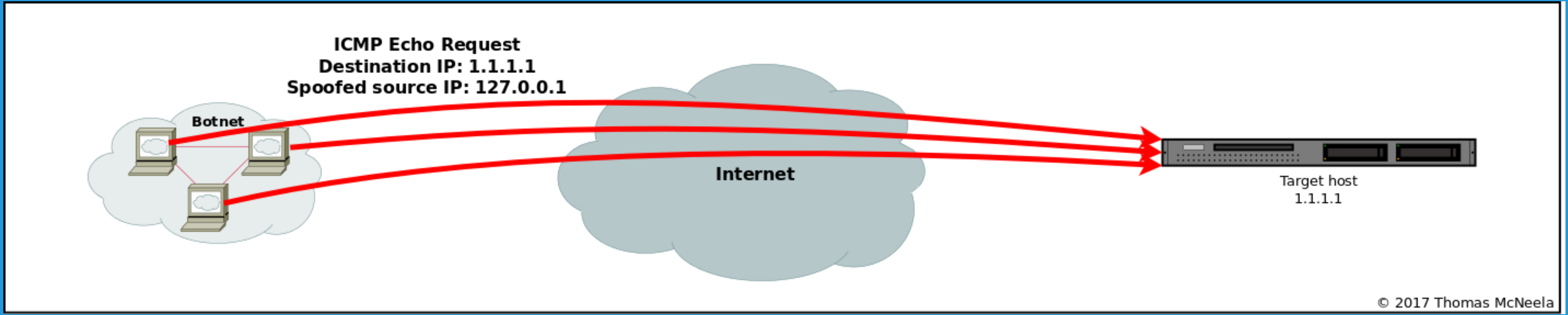
Ping of Death



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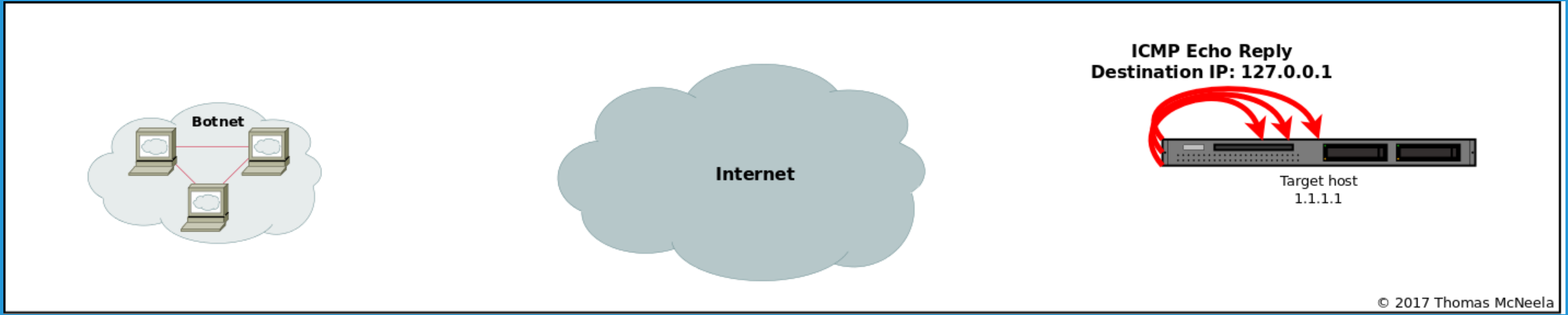
Ping of Death



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Common Network-Based DoS Attack Methods (continued)

- Reflected and amplified

Common Network-Based DoS Attack Methods (continued)

- Reflected and amplified
  - DNS amplification

Common Network-Based DoS Attack Methods (continued)

- Reflected and amplified
  - –DNS amplification
  - –Smurf

DNS Amplification

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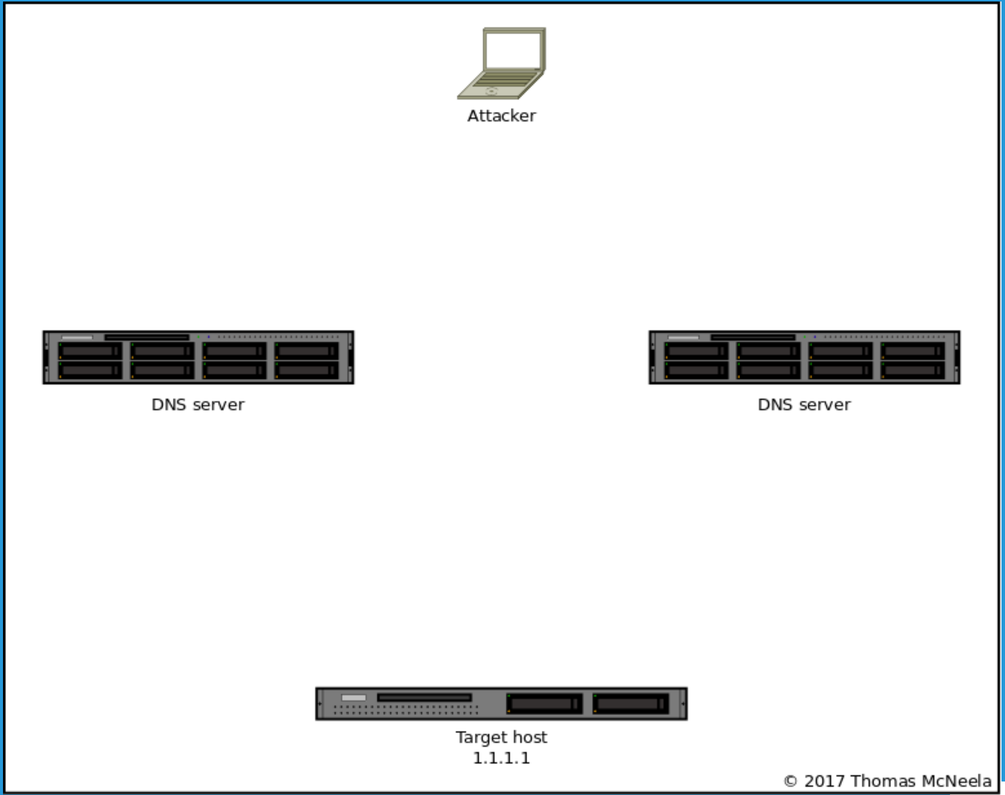

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DNS Amplification

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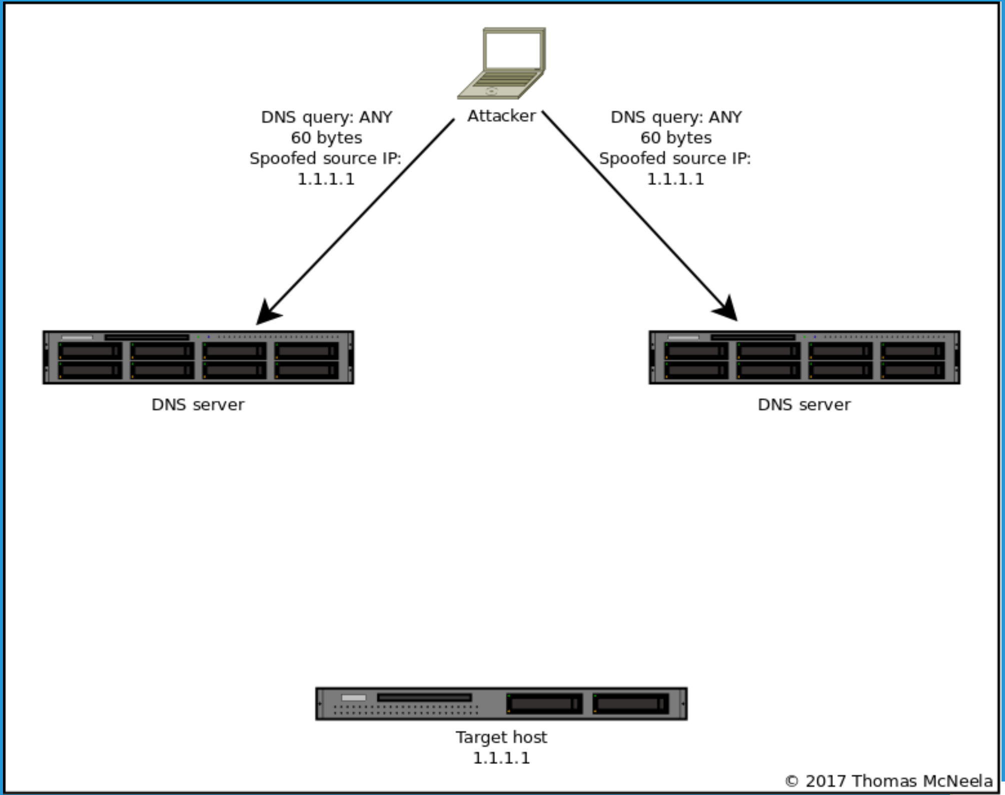

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DNS Amplification

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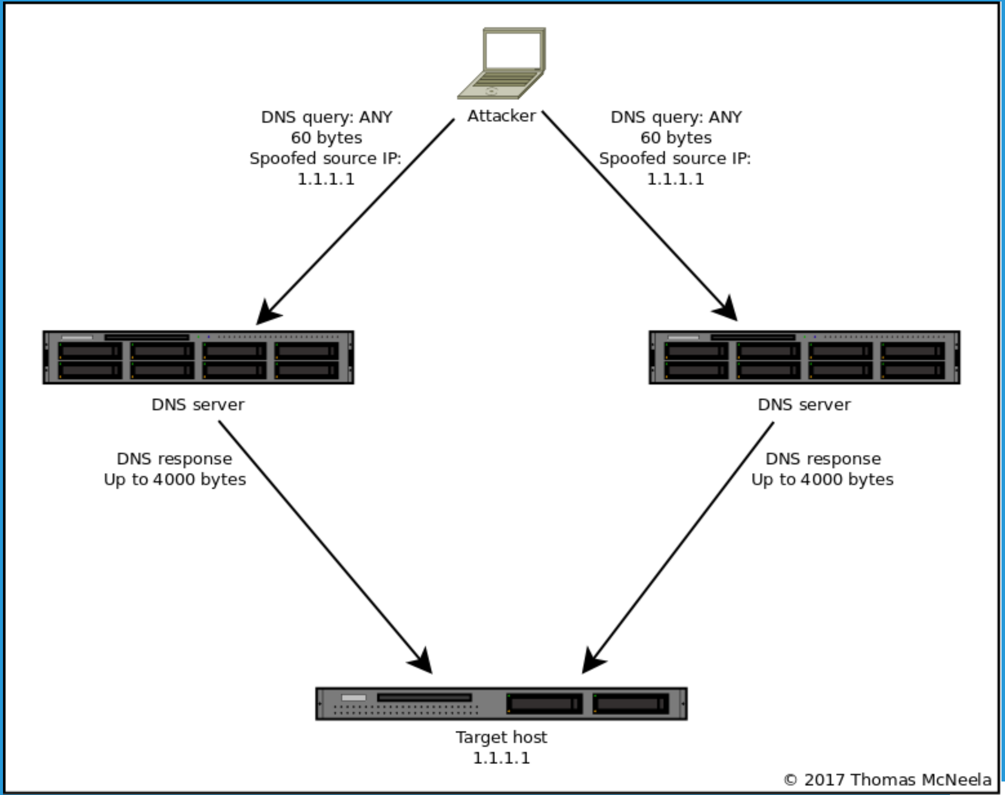

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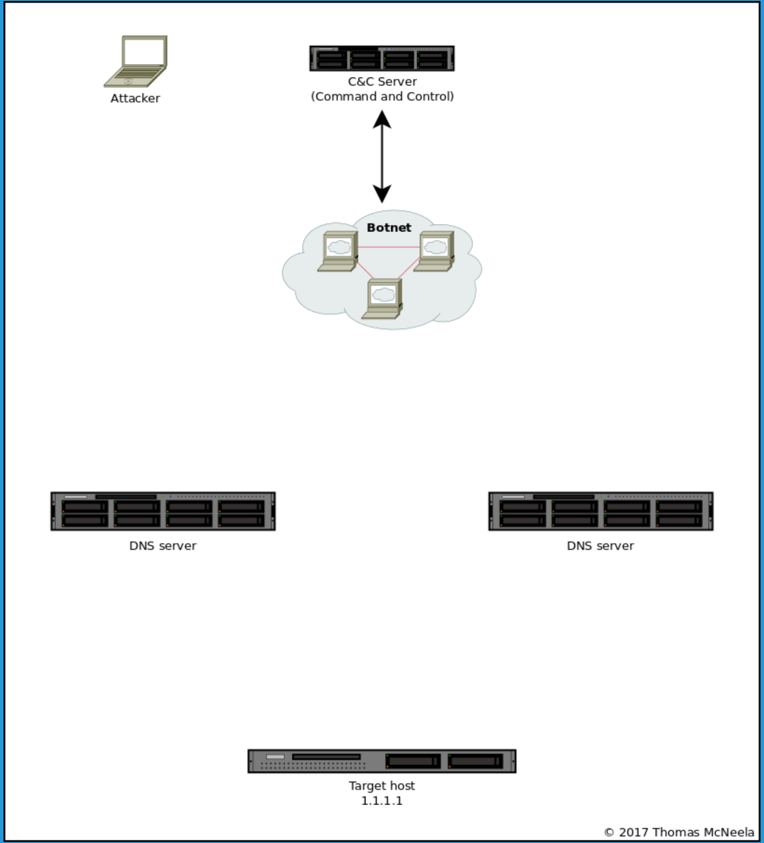
DNS Amplification with Botnet



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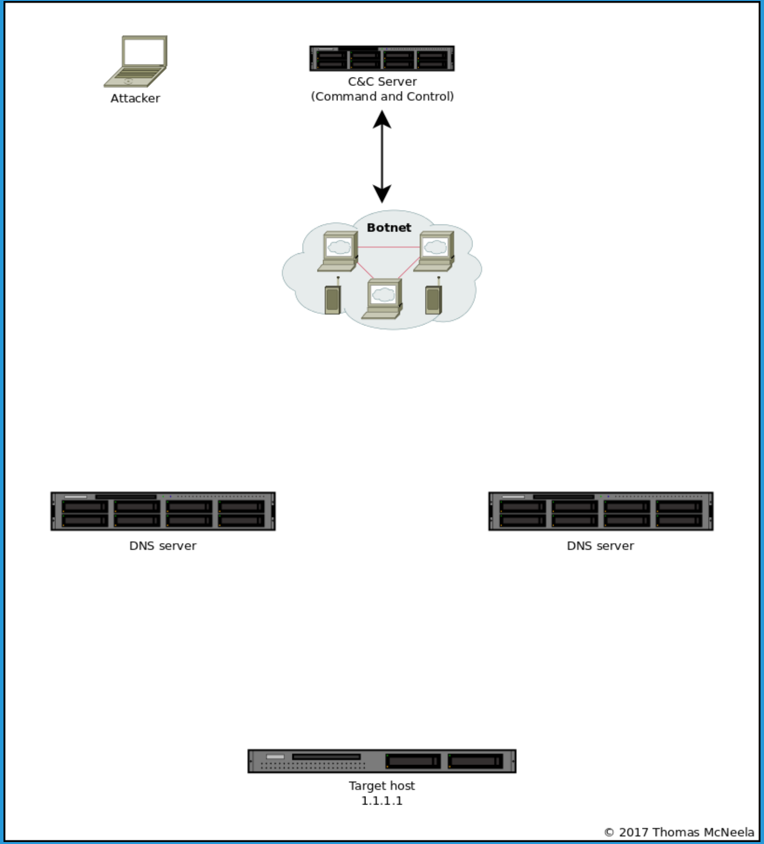
DNS Amplification with Botnet



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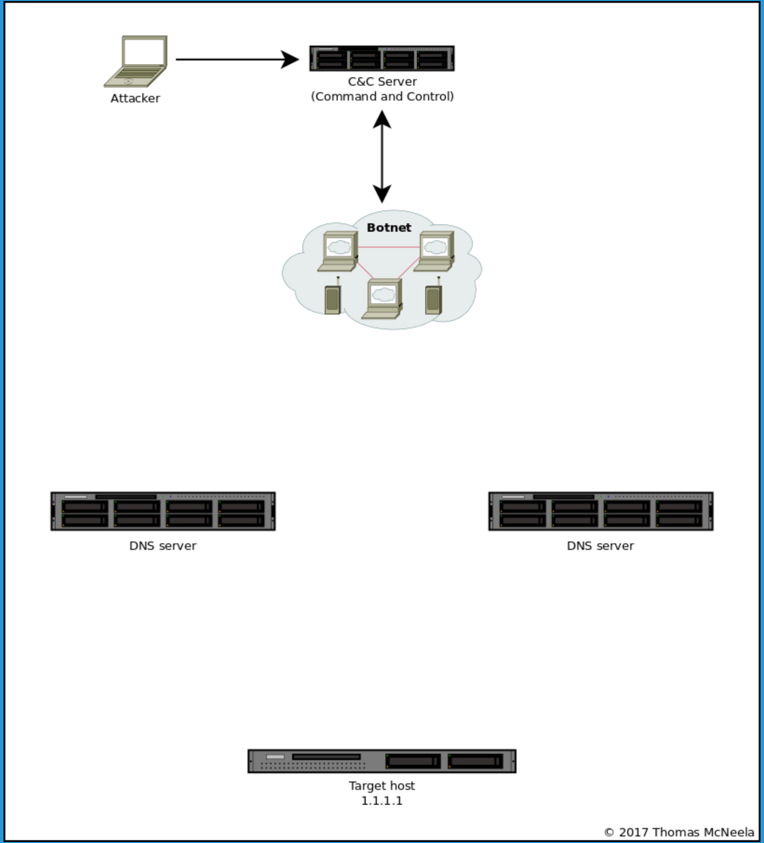
DNS Amplification with Botnet



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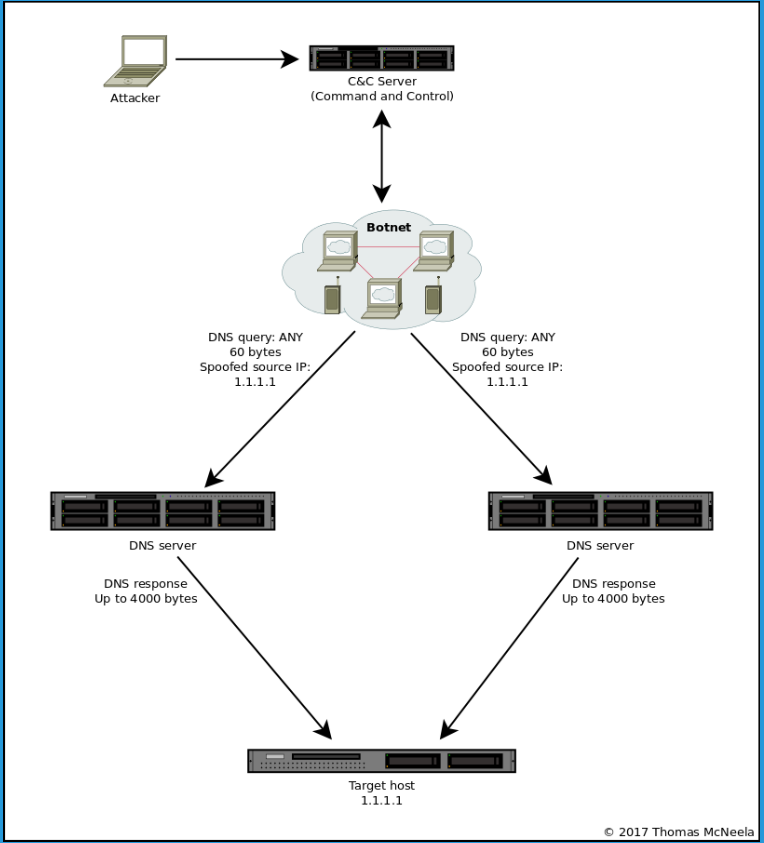
DNS Amplification with Botnet



Smurf

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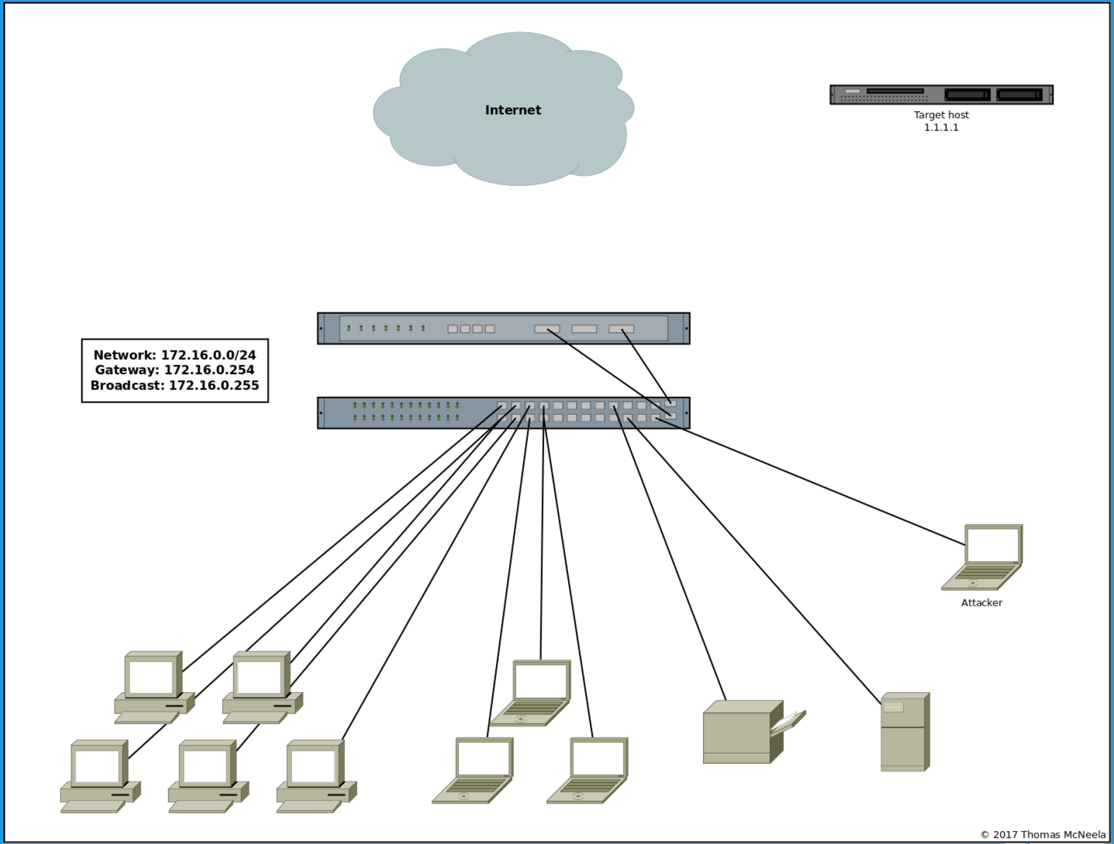

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Smurf

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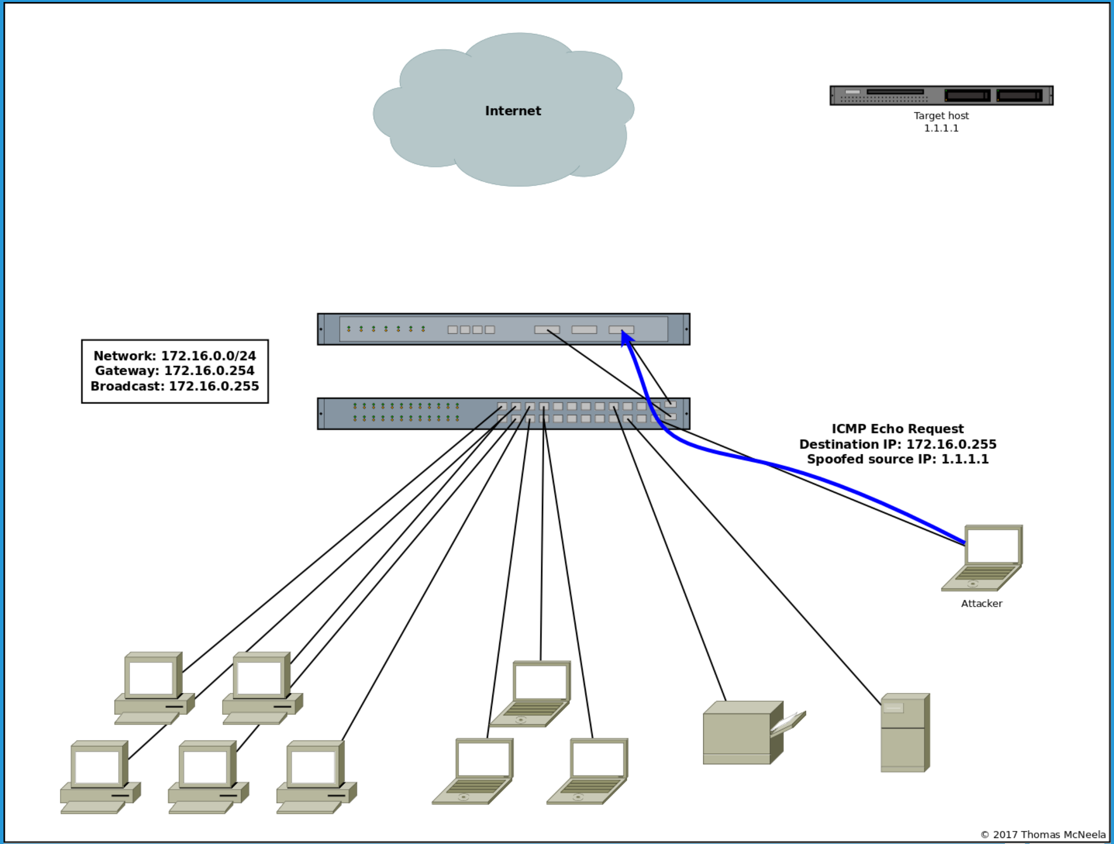

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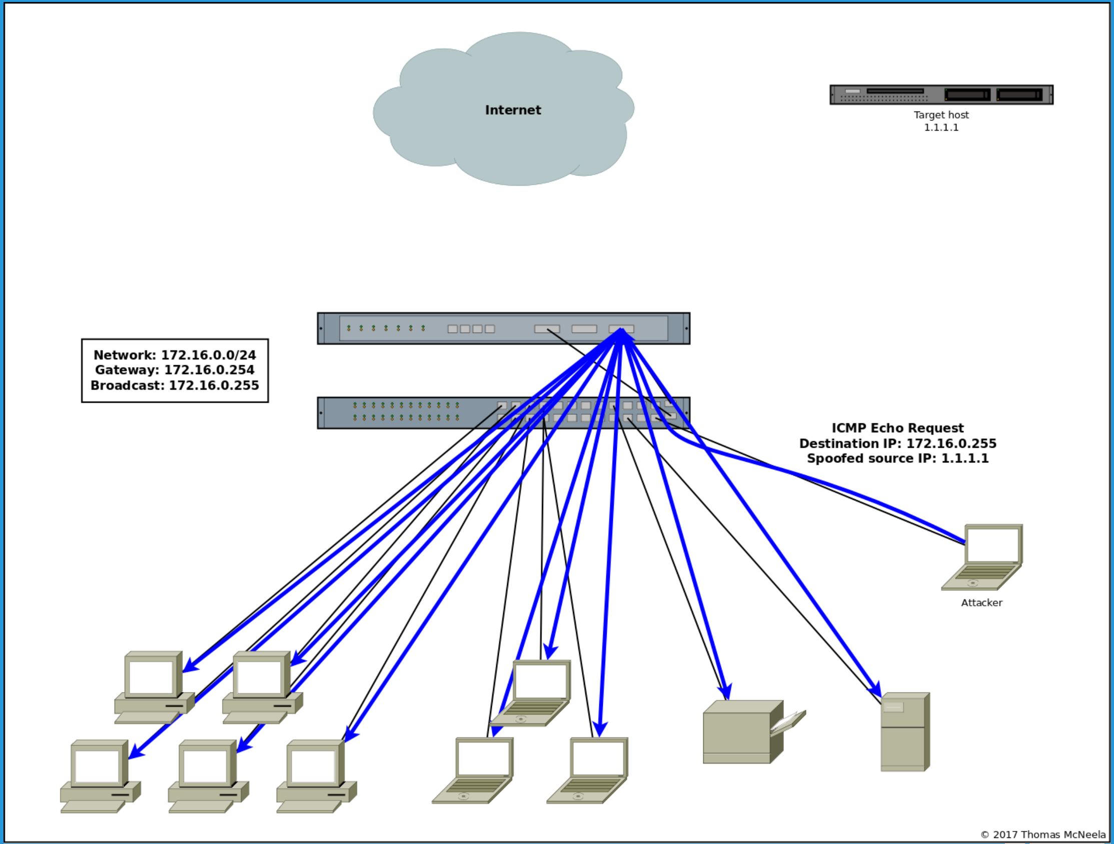

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Smurf

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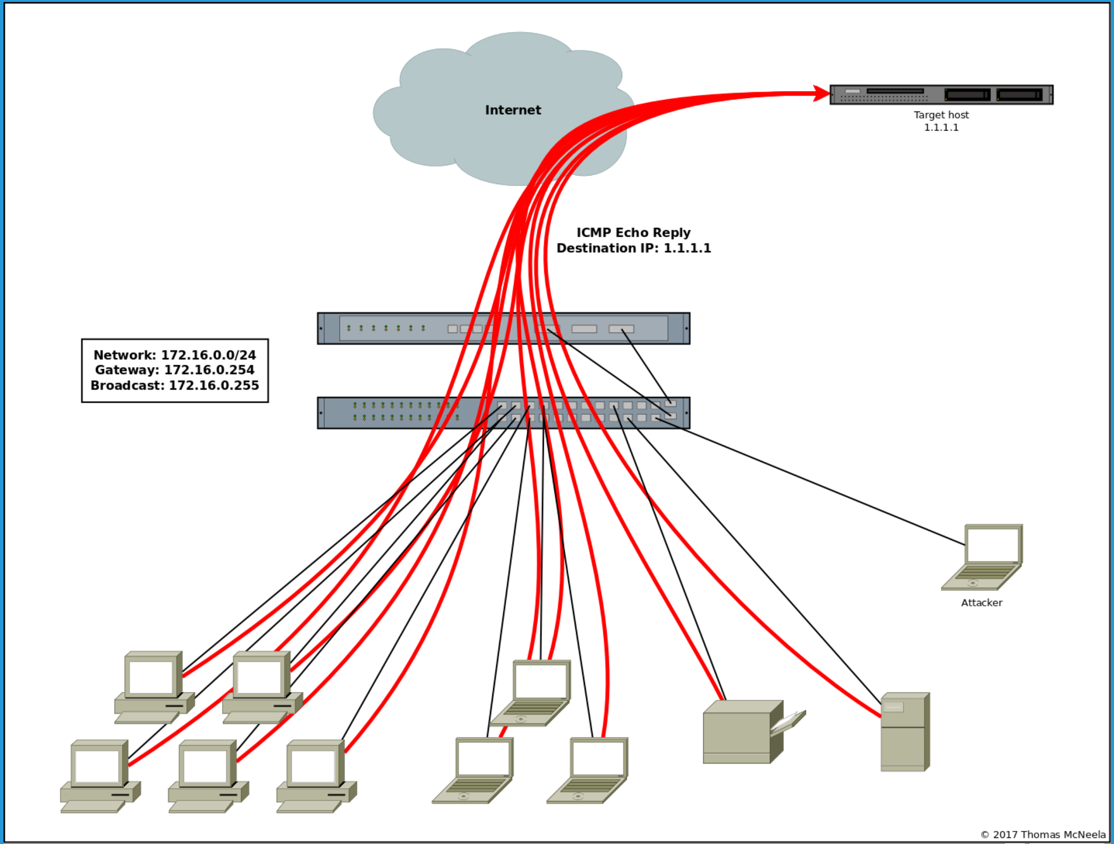

Lab 1

- In this lab, we will attempt several types of DoS attacks against a web server.
- We will monitor traffic on the server and observe the effects of the attack in real time.

Following Along

- Download and install Oracle VirtualBox (https://www.virtualbox.org/wiki/Downloads)
- Download the two virtual appliances below, and import them into VirtualBox:
  - https://drive.google.com/open?id=0B2Vs-EwZxkS1dHVXeVFFZkxaM3M (DoS target)
  - https://drive.google.com/open?id=0B2Vs-EwZxkS1SWJkcjl5d0tTWGM (DoS attacker)

- Work together with your neighbors and collaborate

Lab 1

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1. Launch VirtualBox
2. If you don't already have one set up, create a host-only network adapter (File -> Preferences -> Network -> Host-only Networks -> + -> OK).
3. Start both virtual machines.
4. Log into both virtual machines.
    a. Username: foobar
    b. Password: abc123

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Lab 1

5. On the target machine, issue the command:
   ifconfig
   a. In the output, note the IP address on the second line after “inet addr:” -- this is the IP address of the target machine.
6. Open a web browser on your local machine, and navigate to the IP address of the target machine.

Lab 1

7. On the target VM, issue the command: sudo tcptrack -fi enp0s3
8. Let's start with a UDP flood attack. On the attacker VM, issue the command: udp_flood.sh <target_vm_ip> 20
9. Observe any activity on the target VM, and try refreshing your browser.
10. Stop the attack with the command: udp_flood.sh STOP

Lab 1

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11. Let’s try a SYN flood attack. On the attacker VM, issue the command: syn_flood.sh <target_vm_ip> 20
12. Observe any activity on the target VM, and try refreshing your browser.
13. Stop the attack with the command: syn_flood.sh STOP

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Lab 1

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14. Let’s try a TCP connection flood attack. On the attacker VM, issue the command: conn_flood.sh <target_vm_ip> 50
15. Observe any activity on the target VM, and try refreshing your browser.
16. Stop the attack with the command: conn_flood.sh STOP

Lab 2

- In this lab, we will attempt to mitigate the DoS attacks we performed in lab one. We will be using the Linux local firewall application iptables.
- Again, we will monitor traffic on the server and observe the effects of the attack in real time.

Lab 2

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1. On the target VM, press the q key.
2. Issue the command: cat bin/iptables.save
3. These are the actual firewall rules we are going to implement. Let’s go over some of the most significant ones.

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Lab 2

```
-A PREROUTING -m conntrack --ctstate INVALID -j DROP
-A PREROUTING -p tcp -m tcp ! --tcp-flags FIN,SYN,RST,ACK SYN -m conntrack --ctstate NEW -j DROP
-A PREROUTING -p tcp -m tcp --tcp-flags FIN,SYN,RST,PSH,ACK,URG NONE -j DROP
-A PREROUTING -p tcp -m tcp --tcp-flags FIN,SYN FIN,SYN -j DROP
-A PREROUTING -p tcp -m tcp --tcp-flags SYN,RST SYN,RST -j DROP
-A PREROUTING -p tcp -m tcp --tcp-flags FIN,SYN FIN,SYN -j DROP
-A PREROUTING -p tcp -m tcp --tcp-flags FIN,RST FIN,RST -j DROP
-A PREROUTING -p tcp -m tcp --tcp-flags FIN,ACK FIN -j DROP
-A PREROUTING -p tcp -m tcp --tcp-flags ACK,URG URG -j DROP
-A PREROUTING -p tcp -m tcp --tcp-flags FIN,ACK FIN -j DROP
-A PREROUTING -p tcp -m tcp --tcp-flags PSH,ACK PSH -j DROP
-A PREROUTING -p tcp -m tcp --tcp-flags FIN,SYN,RST,PSH,ACK,URG FIN,SYN,RST,PSH,ACK,URG -j DROP
-A PREROUTING -p tcp -m tcp --tcp-flags FIN,SYN,RST,PSH,ACK,URG NONE -j DROP
-A PREROUTING -p tcp -m tcp --tcp-flags FIN,SYN,RST,PSH,ACK,URG FIN,PSH,URG -j DROP
-A PREROUTING -p tcp -m tcp --tcp-flags FIN,SYN,RST,PSH,ACK,URG FIN,SYN,PSH,URG -j DROP
-A PREROUTING -p tcp -m tcp --tcp-flags FIN,SYN,RST,PSH,ACK,URG FIN,SYN,RST,ACK,URG -j DROP
```

Lab 2

```
-A INPUT -p tcp -m connlimit --connlimit-above 4 --connlimit-mask 32 --connlimit-saddr -j REJECT --reject-with tcp-reset
```

Lab 2

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```
-A INPUT -p tcp -m conntrack --ctstate NEW -m limit --limit 5/sec --limit-burst 3 -j ACCEPT

-A INPUT -p tcp -m conntrack --ctstate NEW -j DROP
```

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Lab 2

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4. Implement the firewall rules with the command: sudo iptables-restore bin/iptables.save
5. Resume monitoring the TCP traffic with the command: sudo tcptrack -fi enp0s3

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Lab 2

6. Since the only attack that actually succeeded in lab 1 was the TCP connection flood, let's try it again. On the attacker VM, issue the command: conn_flood.sh <target_vm_ip> 50
7. Observe any activity on the target VM, and try refreshing your browser.
8. Stop the attack with the command: conn_flood.sh STOP

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Thank you.

Q&A

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- Andrew Hamilton
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