ADVANCED IDLE SCANNING

by Demetris Papapetrou

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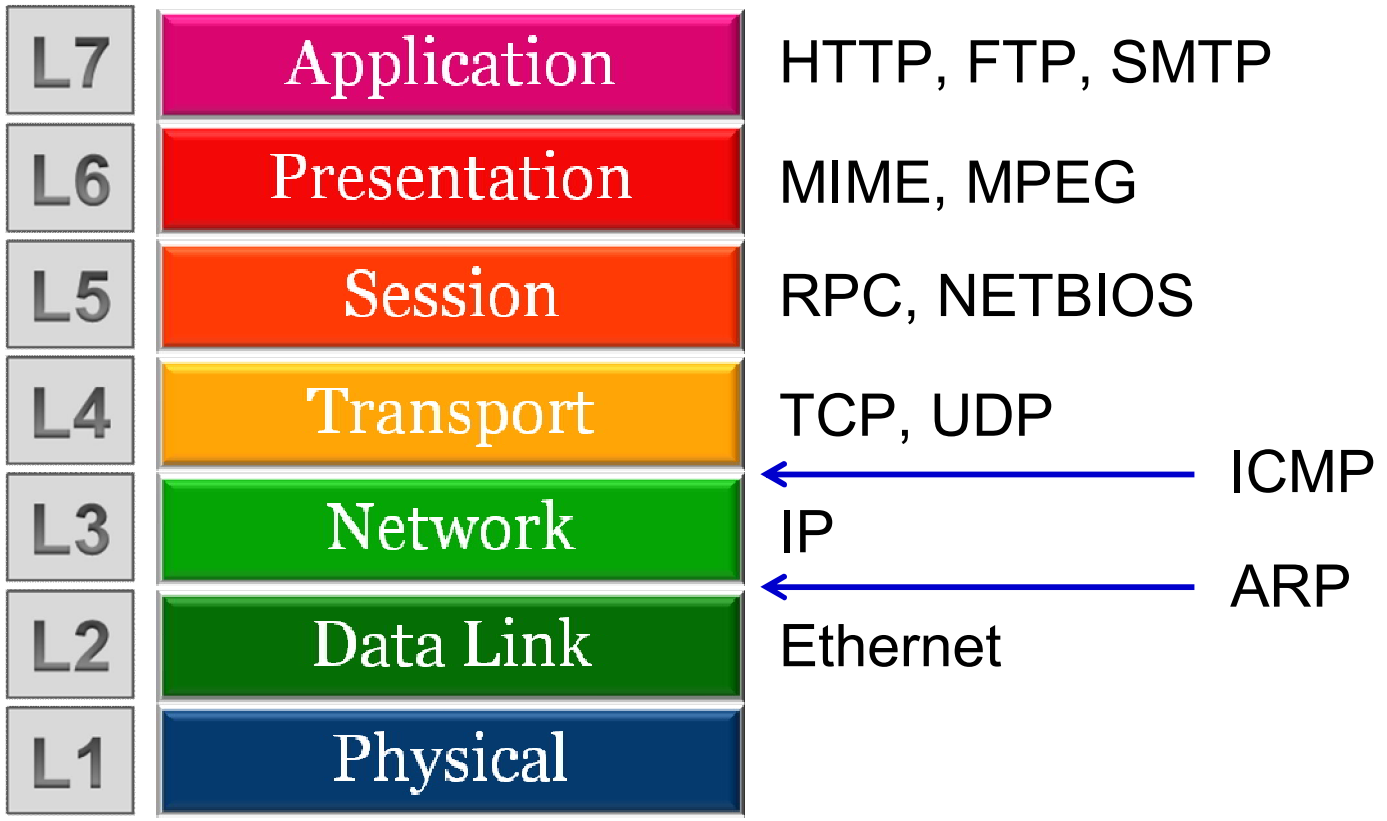
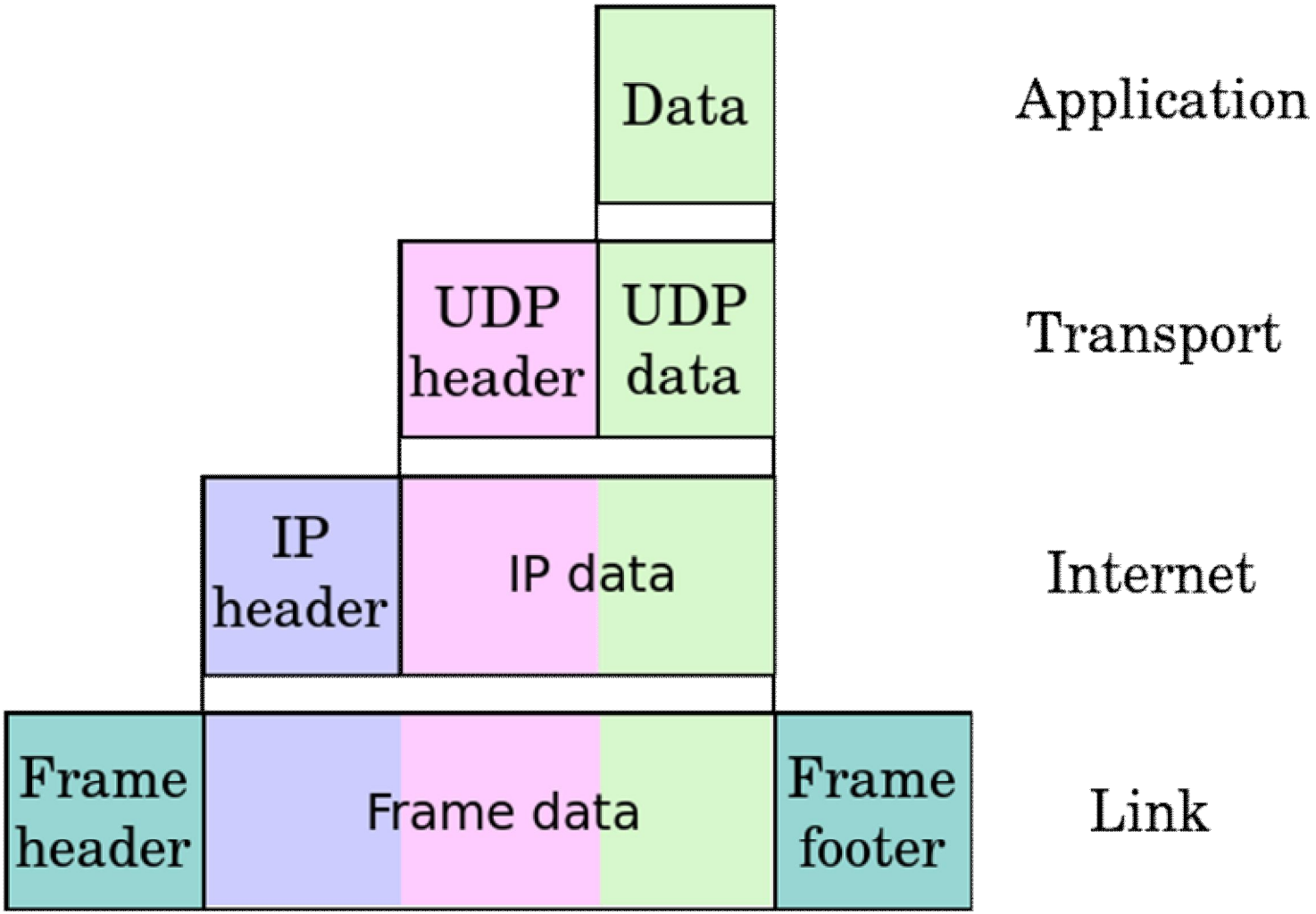
- Introduction to TCP/IP Networks
- Port Scanning Techniques
- Idle Scanning
- Advanced Idle Scanning
- Revealing Trust Relationships

INTRODUCTION TO TCP/IP NETWORKS

OSI 7 Layer Model



Encapsulation



IP Header

IP Header Format

Offsets	Octet	0								1								2								3							
Octet	Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	0	Version				IHL				DSCP						ECN		Total Length															
4	32	Identification																Flags			Fragment Offset											
8	64	Time To Live								Protocol								Header Checksum															
12	96	Source IP Address																															
16	128	Destination IP Address																															
20	160	Options (if IHL > 5)																															

TCP Header

TCP Header Format

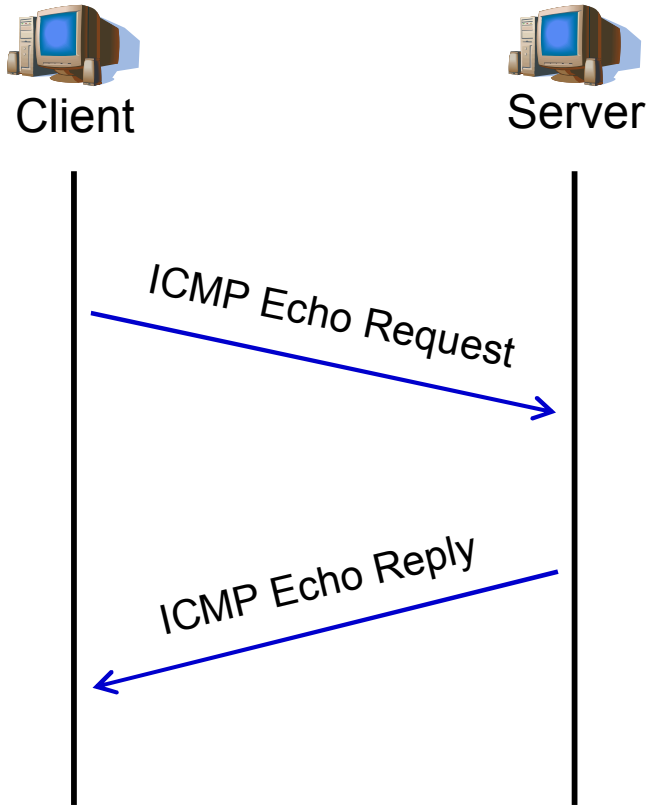
Offsets	Octet	0								1								2								3							
Octet	Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	0	Source port																Destination port															
4	32	Sequence number																															
8	64	Acknowledgment number (if ACK set)																															
12	96	Data offset				Reserved 0 0 0				NS	CWR	ECE	URG	ACK	PSH	RST	SYN	FIN	Window Size														
16	128	Checksum																Urgent pointer (if URG set)															
20 ...	160 ...	Options (if *data offset* > 5. Padded at the end with "0" bytes if necessary.) ...																															

Ping Sweep

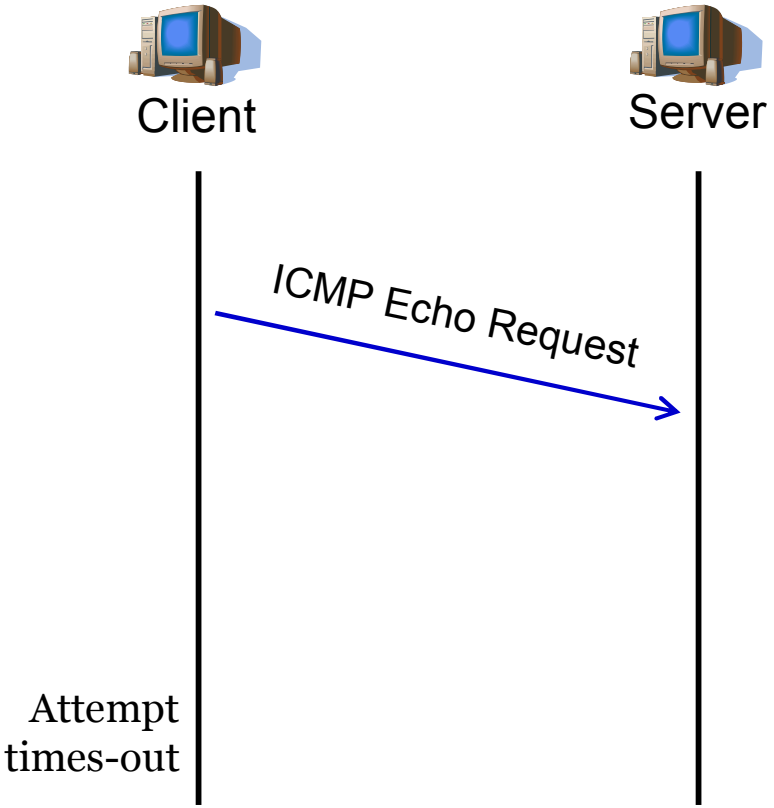
- It is a technique to detect live hosts
- Pings are not 100% reliable
  - On LANs we can use ARP pings
- They use ICMP Echo Requests and Echo Replies
- They can be blocked by firewalls very easily

Ping Sweep

Host is up and replies to Pings



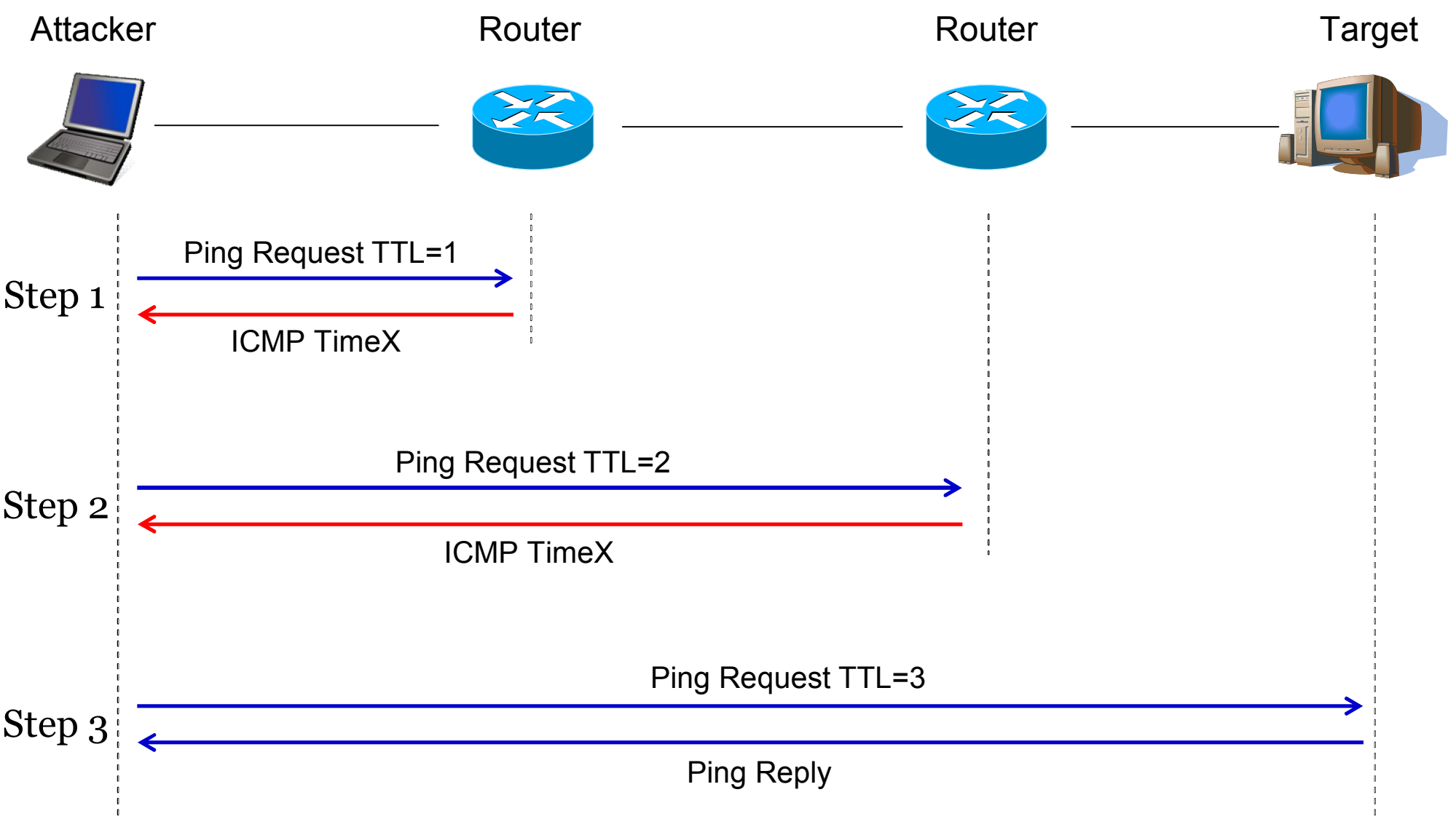
Host is down or Pings are blocked by a Firewall



Traceroute

- It is a technique to trace the network nodes/hops that our packets traverse until they reach their destination
- A clever replacement of IP Record Route
- We usually send ICMP or UDP packets
  - Hackers use TCP as well
- And receive ICMP Time Exceeded in Transit messages
- They are used by hackers to map the target network
- To block them drop outbound ICMP Time Exceeded

Traceroute


Attacker
Router
Router
Target
Step 1
Ping Request TTL=1
ICMP TimeX
Step 2
Ping Request TTL=2
ICMP TimeX
Step 3
Ping Request TTL=3
Ping Reply

Sample Traceroute Output

Command Prompt

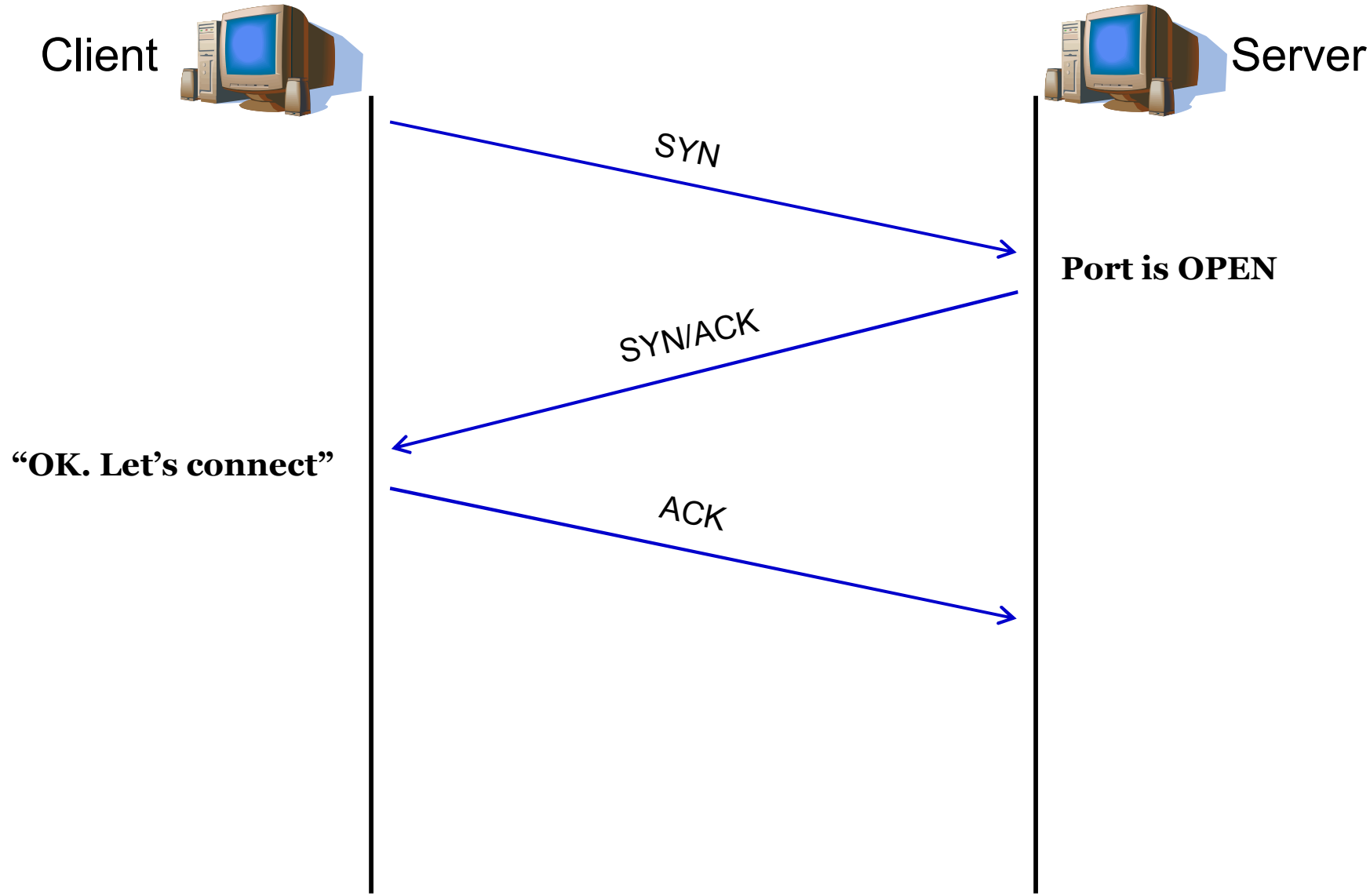
```
C:\>tracert mediacollege.com

Tracing route to mediacollege.com [66.246.3.197]
over a maximum of 30 hops:

  1    <10 ms    <10 ms    <10 ms  192.168.1.1
  2    240 ms    421 ms     70 ms  219-88-164-1.jetstream.xtra.co.nz [219.88.164.1]
  3     20 ms     30 ms     30 ms  210.55.205.123
  4      *         *         *     Request timed out.
  5     30 ms     30 ms     40 ms  202.50.245.197
  6     30 ms     40 ms     40 ms  g2-0-3.tkbr3.global-gateway.net.nz [202.37.245.140]
  7     30 ms     30 ms     40 ms  so-1-2-1-0.akbr3.global-gateway.net.nz [202.50.116.161]
  8    160 ms    161 ms    160 ms  p1-3.sjbr1.global-gateway.net.nz [202.50.116.178]
  9    160 ms    171 ms    160 ms  so-1-3-0-0.pabr3.global-gateway.net.nz [202.37.245.230]
 10    160 ms    161 ms    170 ms  pao1-br1-g2-1-101.gnaps.net [198.32.176.165]
 11    180 ms    181 ms    180 ms  lax1-br1-p2-1.gnaps.net [199.232.44.5]
 12    170 ms    170 ms    171 ms  lax1-br1-ge-0-1-0.gnaps.net [199.232.44.50]
 13    240 ms    241 ms    240 ms  nyc-m20-ge2-2-0.gnaps.net [199.232.44.21]
 14    240 ms    251 ms    250 ms  ash-m20-ge1-0-0.gnaps.net [199.232.131.36]
 15    241 ms    240 ms    250 ms  0503.ge-0-0-0.gbr1.ash.nac.net [207.99.39.157]
 16    251 ms    260 ms    250 ms  0.so-2-2-0.gbr2.nwr.nac.net [209.123.11.29]
 17    250 ms    260 ms    261 ms  0.so-0-3-0.gbr1.oct.nac.net [209.123.11.233]
 18    250 ms    260 ms    261 ms  209.123.182.243
 19    250 ms    260 ms    261 ms  sol.yourhost.co.nz [66.246.3.197]

Trace complete.

C:\>
```

PORT SCANNING TECHNIQUES

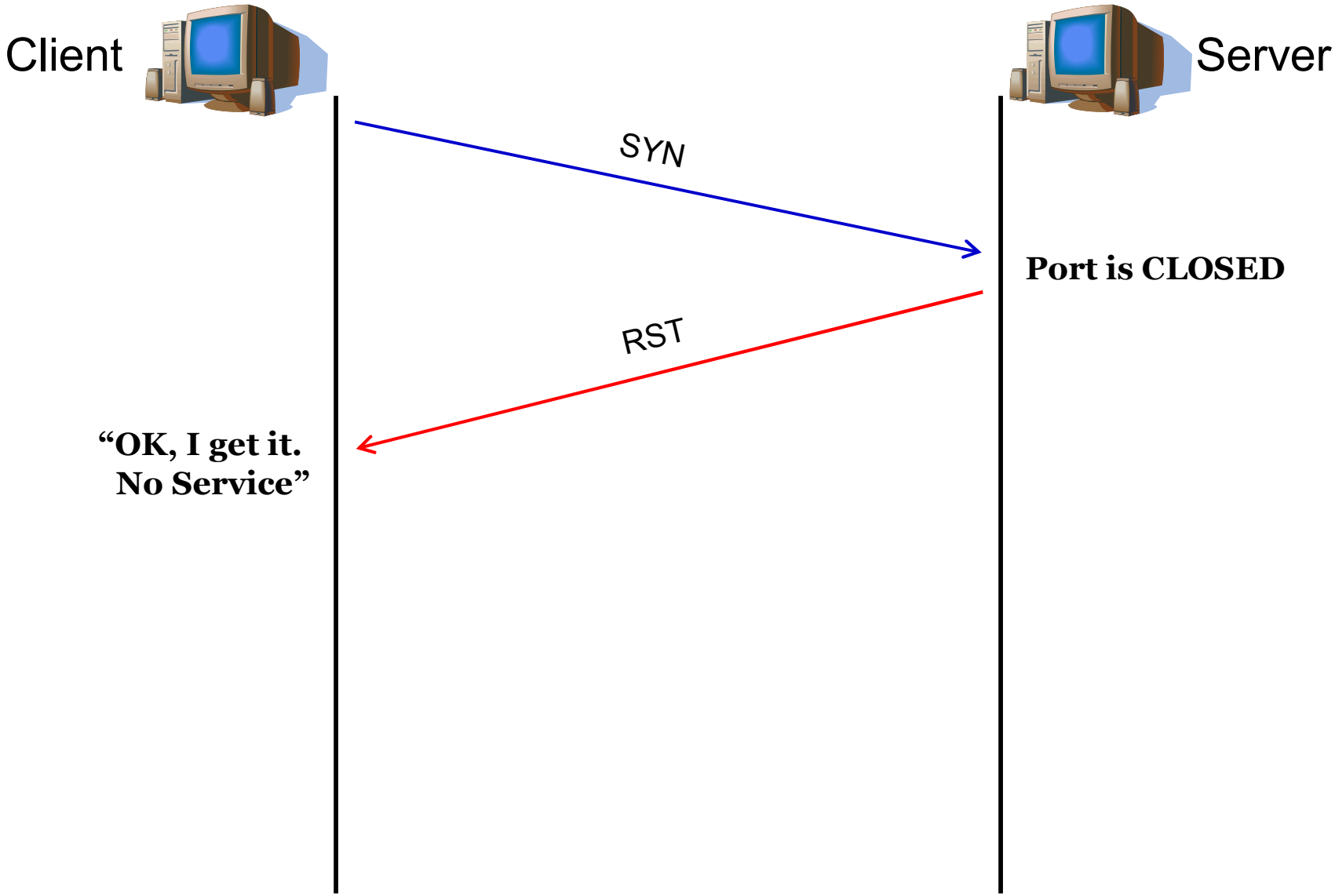
TCP Port Scanning

- It is a technique to detect which TCP enabled services are running/listening on the target host
- Based on the Three-Way-Handshake and TCP Flags
  - SYN, FIN, URG, PSH, RST, ACK
- A port can be:
  - Open
  - Closed
  - Filtered

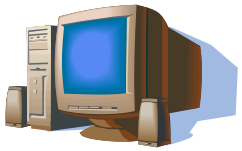
TCP Connect Scan – Open Port

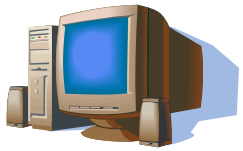


TCP Connect Scan – Closed Port



TCP Connect Scan – Filtered Port





SYN

Port is FILTERED

SYN

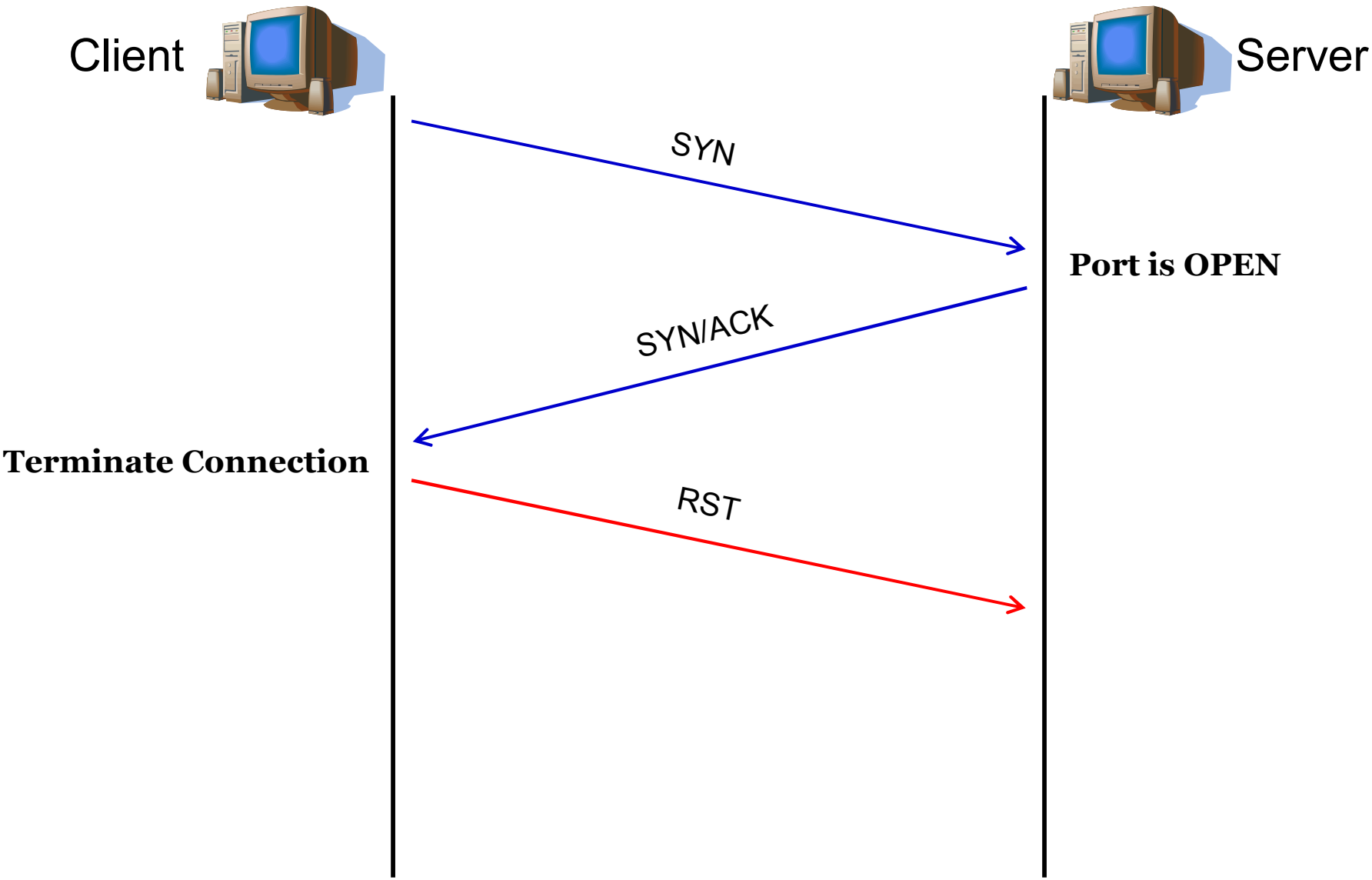
Port is FILTERED

SYN

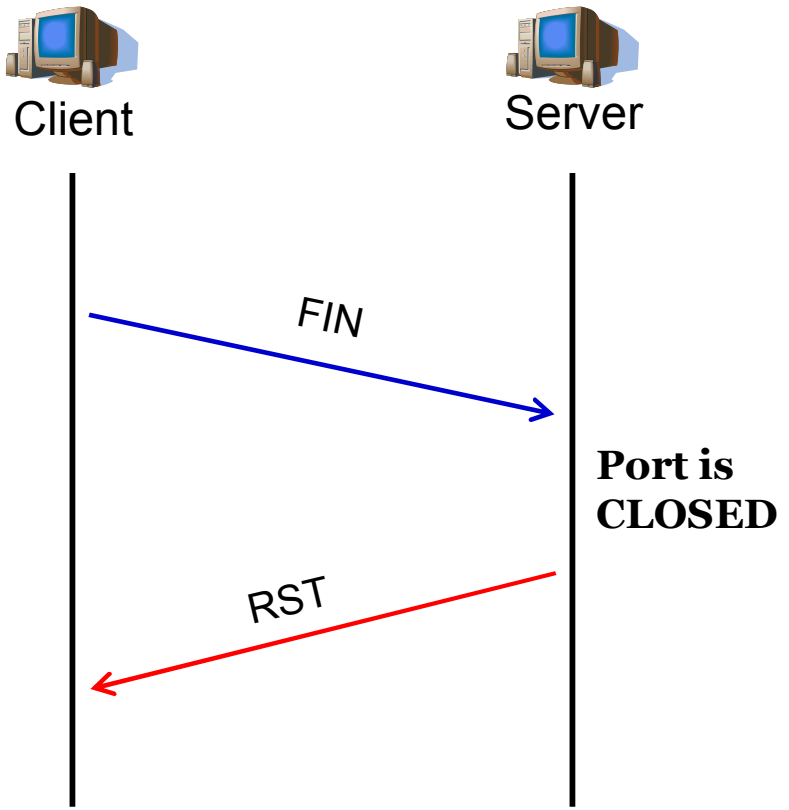
Port is FILTERED

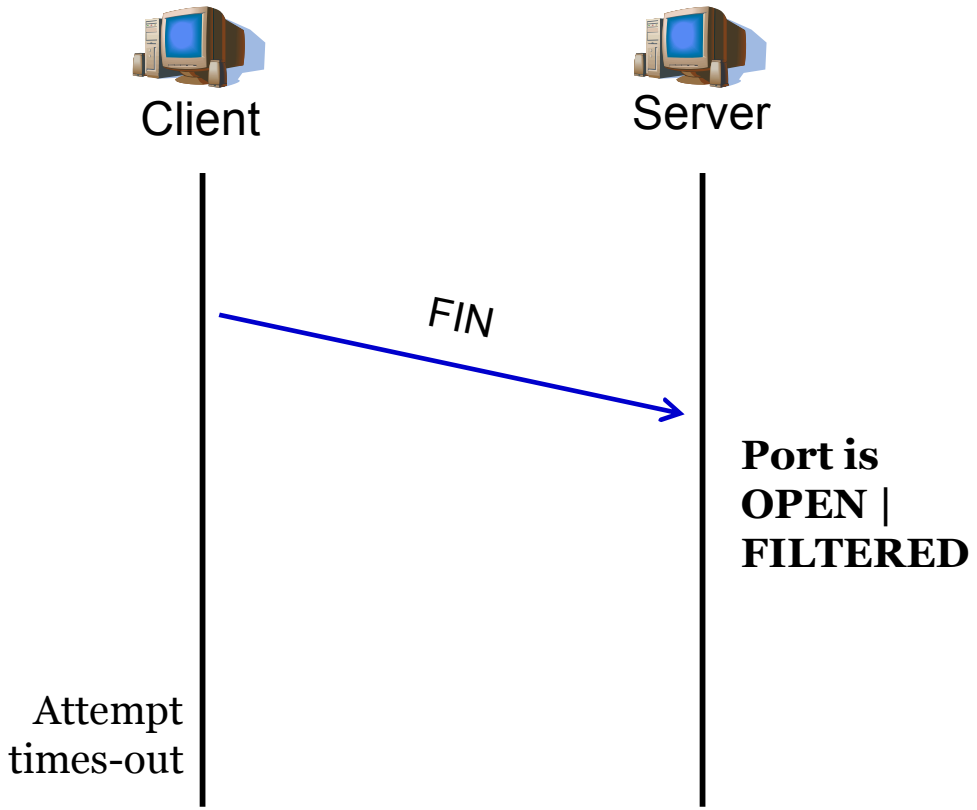
Connection times-out

TCP SYN Scan – Open Port



TCP FIN Scan


CLOSED
Client
Server
FIN
Port is
CLOSED
RST


OPEN | FILTERED
Client
Server
FIN
Port is
OPEN |
FILTERED
Attempt
times-out

TCP XMAS Scan

CLOSED

Client

Server

FIN/PSH/URG

Port is CLOSED

RST

OPEN | FILTERED

Client

Server

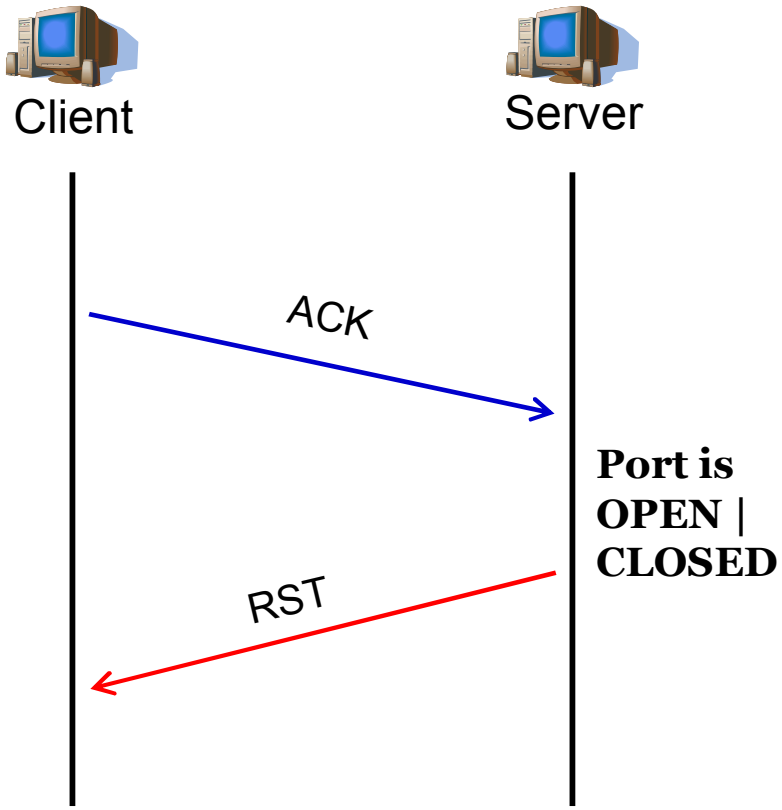
FIN/PSH/URG

Port is OPEN | FILTERED

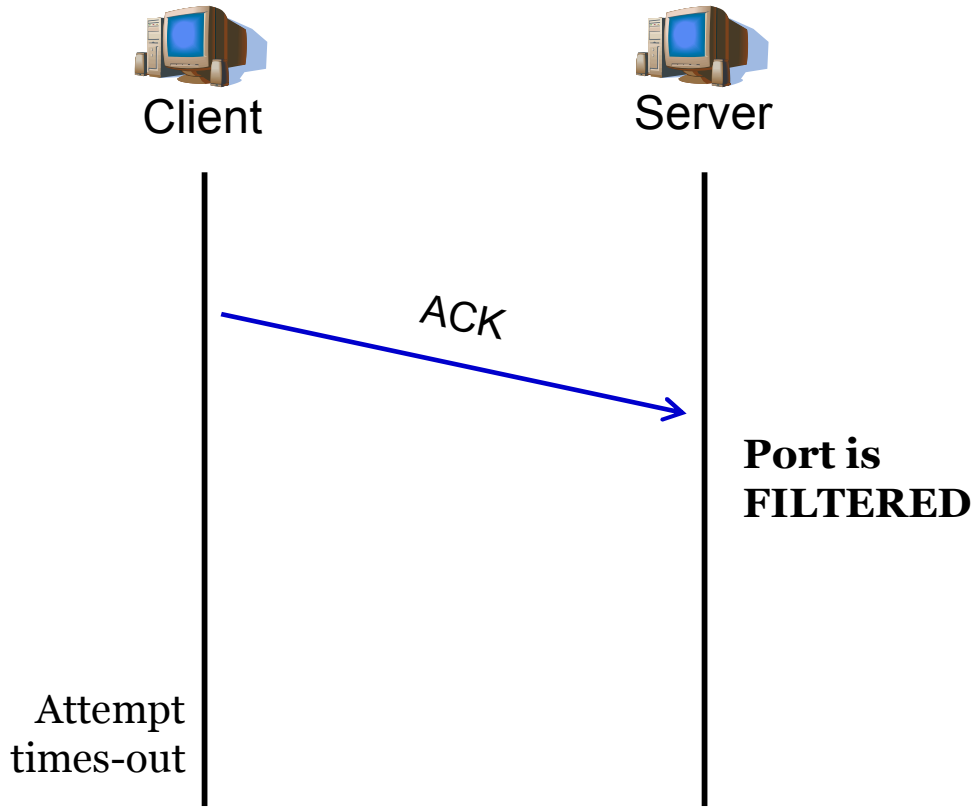
Attempt times-out

TCP ACK Scan

UNFILTERED
Stateless Inspection or
No Firewall



FILTERED
Stateful Inspection



UDP Port Scanning

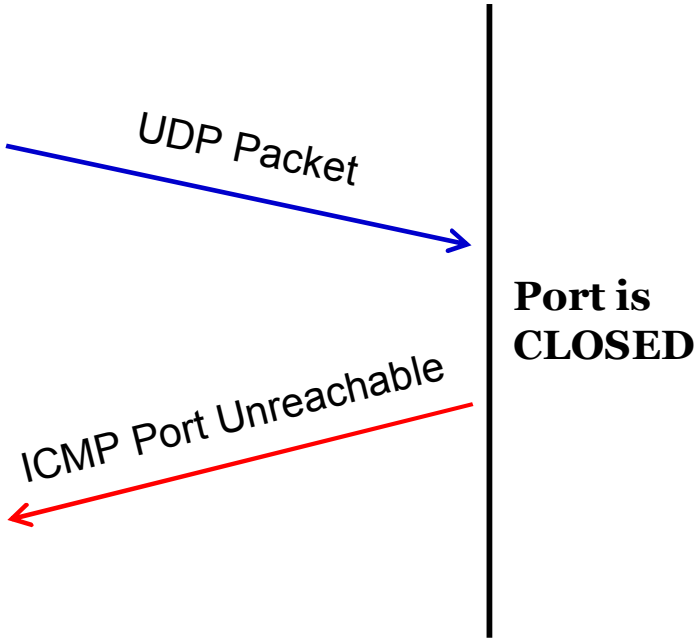
- It is a technique to detect which UDP enabled services are running/listening on the target host
- UDP is a connectionless protocol, hence there is no Three-Way-Handshake and no flags
- The protocol is not responsible to indicate whether a connection has been established. This is the job of upper layer protocols
- Therefore we don’t detect open ports but closed ones
- We can also use application protocols to find open ports

UDP Scan – Regular

CLOSED

Client

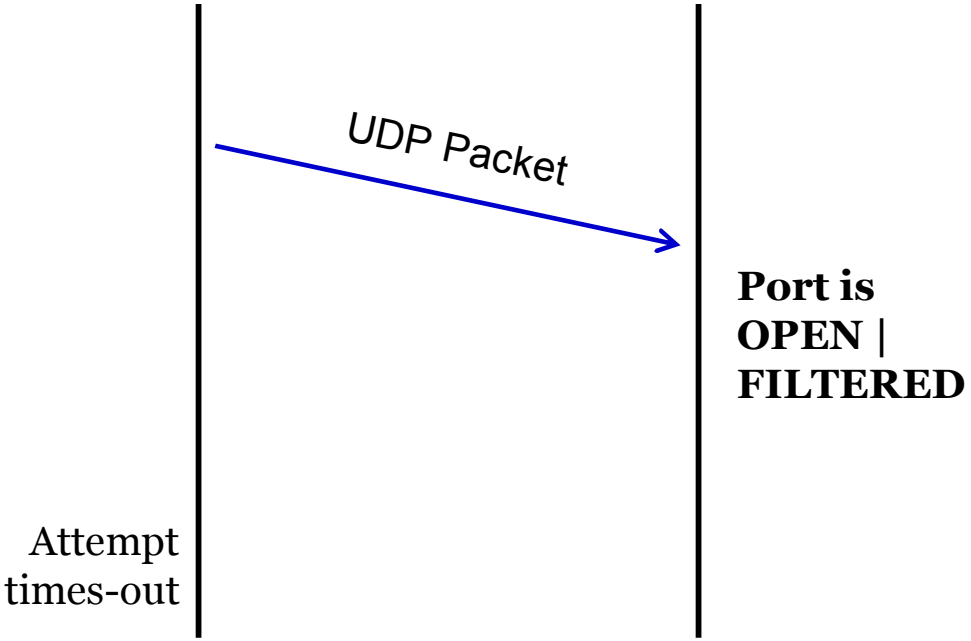
Server



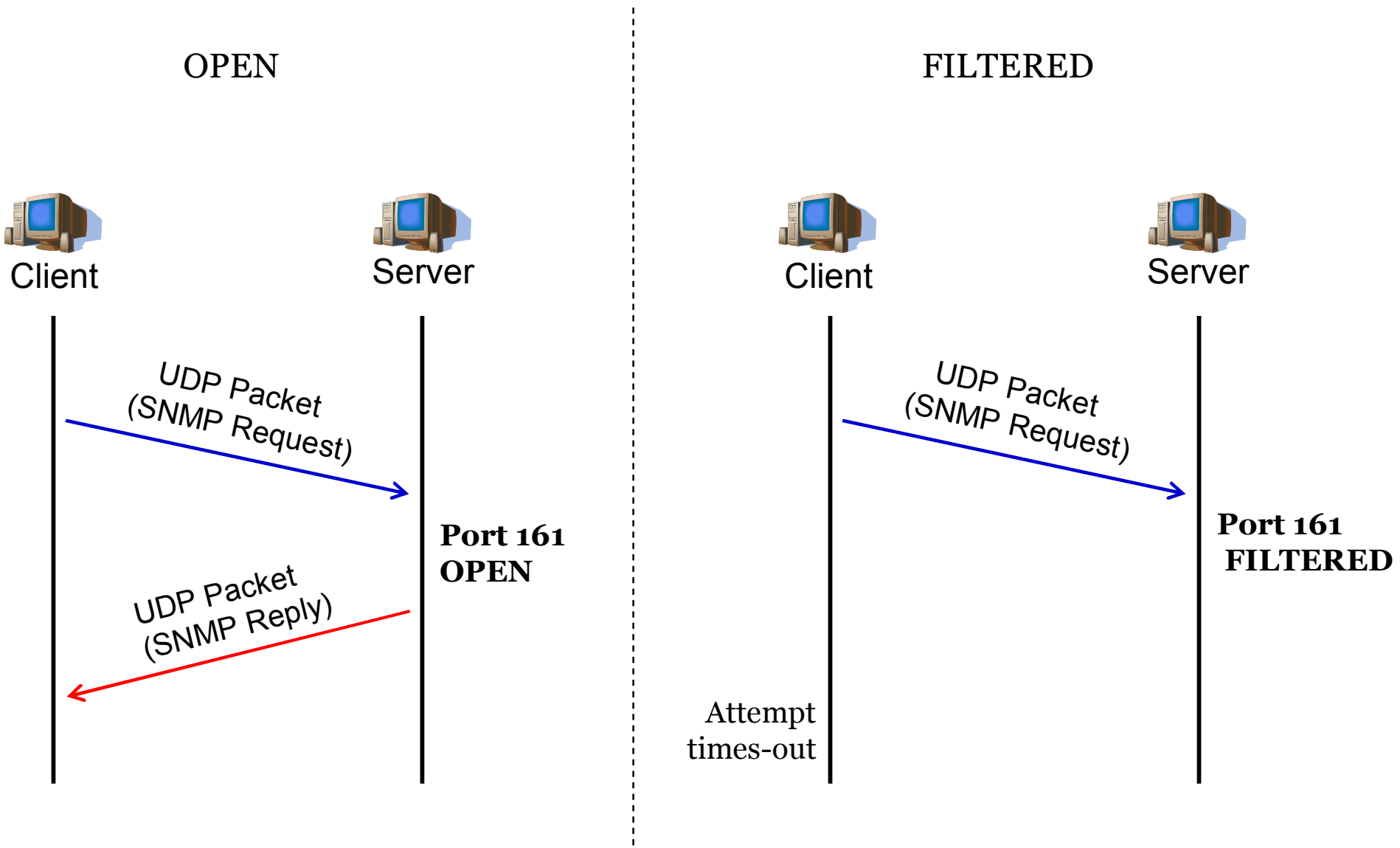
OPEN | FILTERED

Client

Server



UDP Scan – Protocol Specific



IDLE SCANNING

What is it?

- The most stealthy scan technique so far…
  - The attacker never sends traffic to the target using his/her real IP address, but instead..
  - “Instructs” a victim machine (zombie) to do it for him/her
  - If a security administrator or an IPS takes action against the “attacker”, it is the poor zombie who will take the blame (blacklisted or reported to the authorities)
  - The scan traverses the target’s firewall based on the rules that apply for the zombie host (not the attacker’s host)

Prerequisites

- In order for the scan to work properly:
  - The zombie must generate incremental IP IDs globally (not per session/host)
  - The zombie must accept TCP SYN/ACK packets (no stateful filtering for incoming packets)
  - The zombie must be idle (no traffic generated)
  - The attacker must be able to spoof his IP address (no NATing)
  - The attacker must be able to send TCP SYN/ACK packets (no stateful filtering on his end, for outgoing packets)

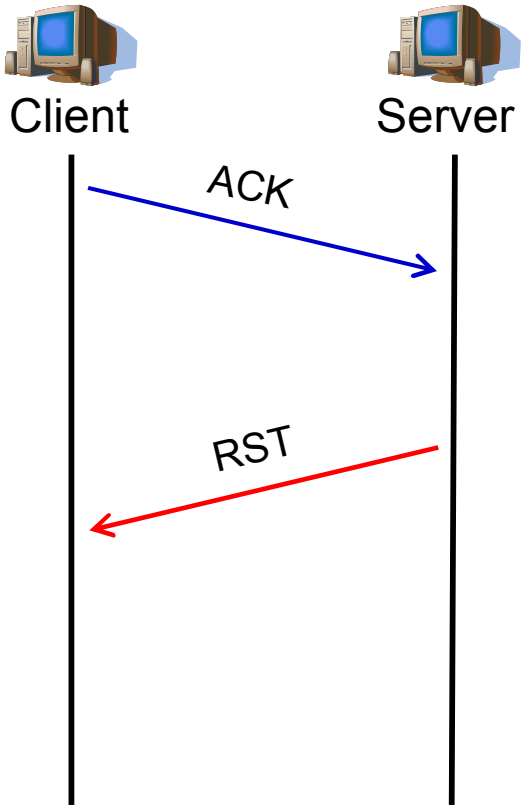
IP Header

IP Header Format

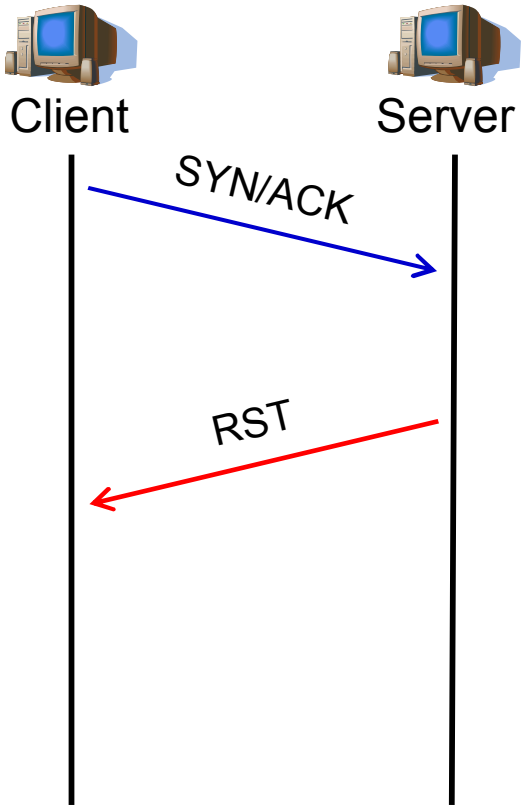
Offsets	Octet	0								1								2								3							
Octet	Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	0	Version				IHL				DSCP						ECN		Total Length															
4	32	Identification																Flags			Fragment Offset											
8	64	Time To Live								Protocol								Header Checksum															
12	96	Source IP Address																															
16	128	Destination IP Address																															
20	160	Options (if IHL > 5)																															

TCP Behavior

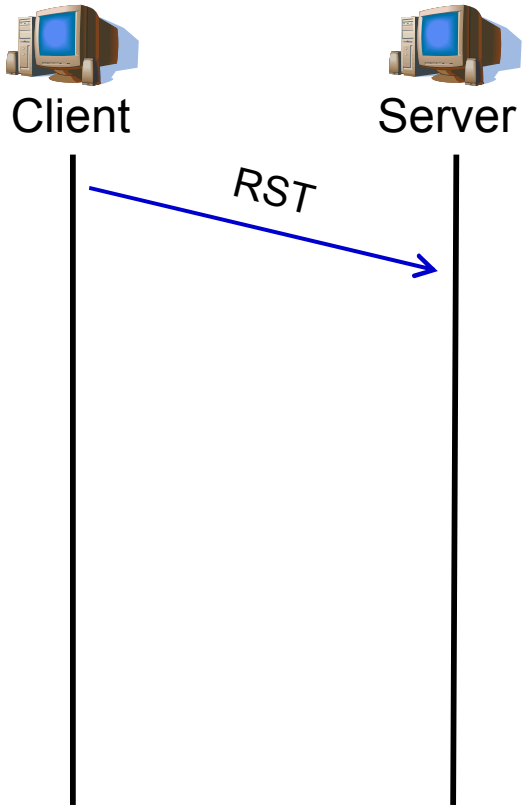
Unexpected packet that doesn't belong to any session



Unexpected packet with no associated SYN



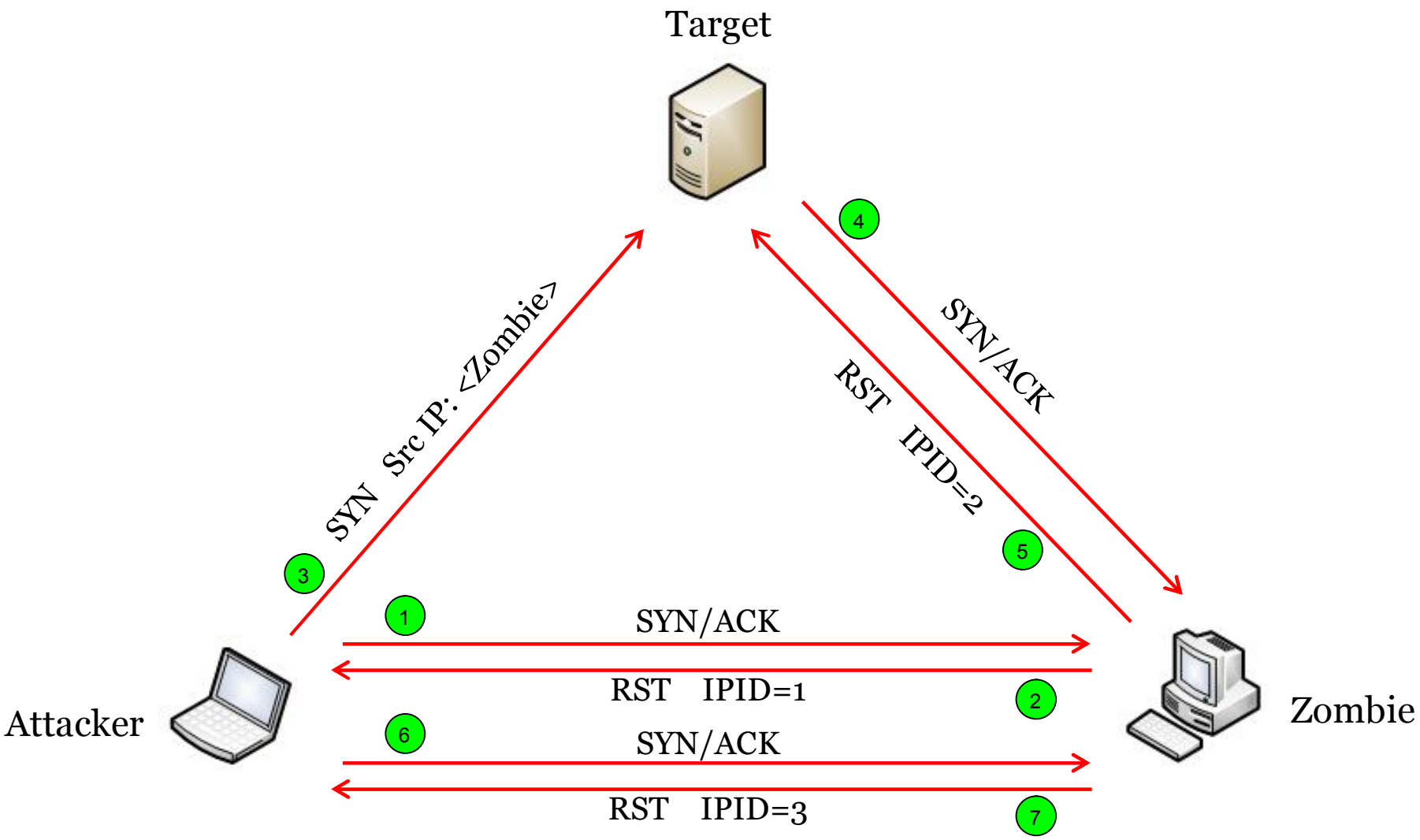
Packet that immediately terminates a connection



TCP Behavior

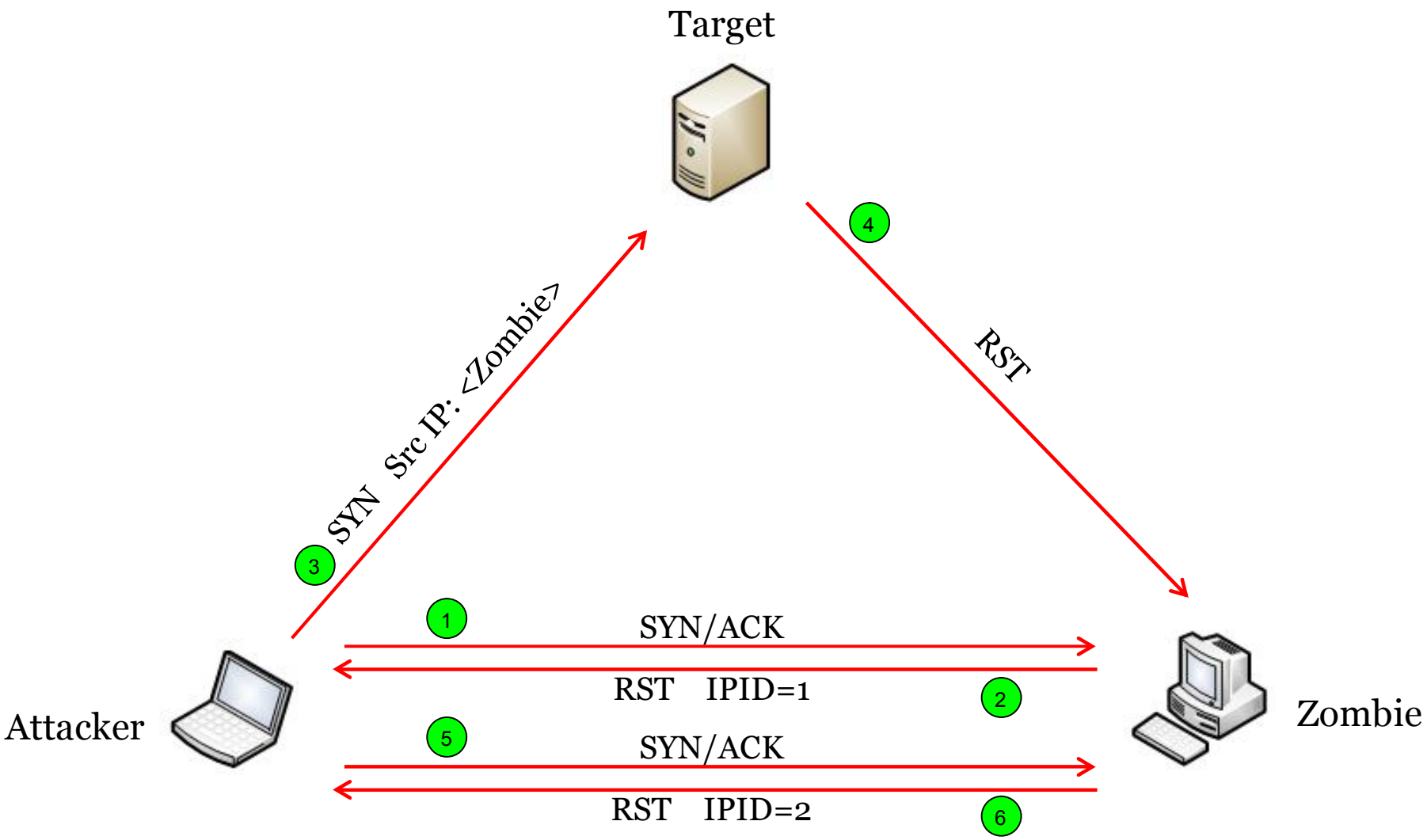
- The basic TCP rule illustrated above is:
  - Most TCP packets (e.g. SYN, FIN, ACK, SYN/ACK, etc) cause the receiving host to send a reply back to the sender (e.g. SYN/ACK, FIN/ACK, RST, etc)
  - RST packets don't cause a reply to be generated

TCP Idle Scan – Open Port

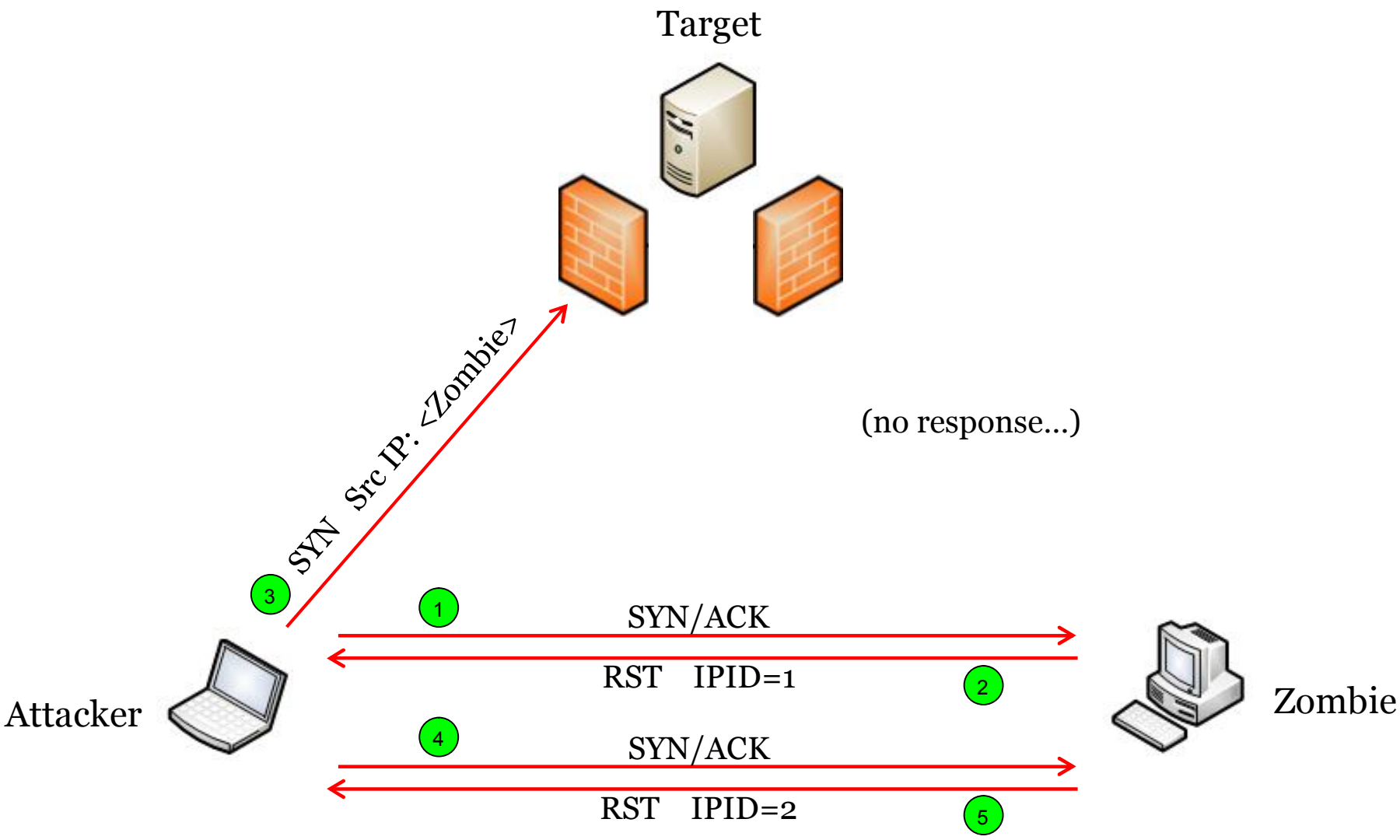


* IPID increments by 2 on newer OSes

TCP Idle Scan – Closed Port



TCP Idle Scan – Filtered Port



Possible Issues

- Certain things can render regular Idle Scans ineffective or hard to perform:
  - Some Operating Systems randomize or set the IP ID to zero until a connection has been established (completion of 3-Way-Handshake)
  - Busy/talkative zombie hosts
  - Stateful firewalls placed near or installed on zombie hosts
  - The Internet is moving from IPv4 to IPv6

ADVANCED IDLE SCANNING

Research Backgound

- Not a new scanning technique but an enhancement of the existing Idle scan
- Some of the ideas implemented have been previously suggested by people on the Bugtraq mailing list but no research work was ever published or tools created (besides *hping*)
- Our research work was performed in 2009 - 2010, hence the listed examples are old but still applicable to newer Operating Systems

Overcoming Obstacle 1

- Obstacle
  - Some Operating Systems randomize or set the IP ID to zero until a connection has been established (completion of 3-Way-Handshake)
- Observation
  - Popular tools send SYN/ACK packets to zombies. This is a clever trick which serves two purposes:
    - to check for incremental IP IDs
    - to check if there is a stateful firewall protecting the zombie

Overcoming Obstacle 1

- Solution 1
  - Why only use SYN/ACK packets? We should test different TCP Flags and check if any of them cause the zombie machine to reply with incremental IP IDs
- Solution 2
  - Since the IP ID field is part of the IP and not the TCP header, we can use other Layer 4 protocols (TCP, UDP, ICMP, etc) to check for incremental IP IDs

IP IDentifier Tool

```
Usage: identifier.py   [options]   target

Options:
  -h, --help            show this help message and exit
  -T TCP                use TCP scan mode with one or more of the following flags
                        S=Syn, A=Ack, F=Fin, X=Xmas, N=Null
  -U                    use UDP scan mode
  -I ICMP               use ICMP scan mode P=Ping (default) T=Timestamp
                        A=Address Mask
  -P                    use IP Protocol scan mode
  -t TCP_PORT           TCP port to use for scanning
  -u UDP_PORT           UDP port to use for scanning
  -p IP_PROTO           IP protocol number to use for scanning
  --ttl=TTL             how many hops the packet will traverse
  --tracert             detect IPID for every hop in the path
  --max_hops=MAX_HOPS       terminate traceroute at hop N. (use with –tracert only)
  --max_noresp=MAX_NORESP           terminate traceroute after N irresponsive hops.
                                    (use with --tracert only)
  -c PACKET_COUNT       number of packets to send
```

Open Port 23/tcp

 # ./identifier.py -TSAFXN -t23 -c3 172.16.1.17

```
Scan process initiated...
TCP SYN:  ip=172.16.1.17     id=9899       inc=0
TCP SYN:  ip=172.16.1.17     id=59880      inc=49981
TCP SYN:  ip=172.16.1.17     id=64964      inc=5084
-------------------------------------------------------------------
TCP SYN/ACK: No Response
TCP SYN/ACK: No Response
TCP SYN/ACK: No Response
-------------------------------------------------------------------
TCP ACK:  ip=172.16.1.17     id=37149      inc=0
TCP ACK:  ip=172.16.1.17     id=40149      inc=3000
TCP ACK:  ip=172.16.1.17     id=50986      inc=10837
-------------------------------------------------------------------
TCP FIN: No Response
-------------------------------------------------------------------
TCP XMAS: No Response
-------------------------------------------------------------------
TCP NULL: No Response
-------------------------------------------------------------------
```

Closed Port 80/tcp

#./identifier.py -TSAFXN –t80 -c3 172.16.1.17

```
Scan process initiated...
TCP SYN:  ip=172.16.1.17     id=38072       inc=0
TCP SYN:  ip=172.16.1.17     id=38073       inc=1
TCP SYN:  ip=172.16.1.17     id=38074       inc=1
-------------------------------------------------------------------
TCP SYN/ACK:  ip=172.16.1.17  id=38075       inc=0
TCP SYN/ACK:  ip=172.16.1.17  id=38076       inc=1
TCP SYN/ACK:  ip=172.16.1.17  id=38079       inc=3
-------------------------------------------------------------------
TCP ACK:  ip=172.16.1.17     id=38080       inc=0
TCP ACK:  ip=172.16.1.17     id=38082       inc=2
TCP ACK:  ip=172.16.1.17     id=38084       inc=2
-------------------------------------------------------------------
TCP FIN: No Response
-------------------------------------------------------------------
TCP XMAS: No Response
-------------------------------------------------------------------
TCP NULL: No Response
-------------------------------------------------------------------
```

Open Port 137/udp

 # unicornscan -mU 192.168.10.9

UDP open netbios-ns[137] from 192.168.10.9 ttl 128

 # ./identifier.py -U –u137 –c5 192.168.10.9

Scan process initiated...
UDP Scan: No Response
UDP Scan: No Response
UDP Scan: No Response
UDP Scan: No Response
UDP Scan: No Response

Open Port 137/udp (w/ payload)

 # hping2 192.168.10.9 --udp -p 137 -c 5 -r -d 50 --file ../137.txt

HPING 192.168.10.9 (eth0 192.168.10.9): udp mode set, 28 headers + 50 data bytes
[main] memlockall(): Success
Warning: can't disable memory paging!
len=293 ip=192.168.10.9 ttl=128 id=925 seq=0 rtt=0.4 ms
len=293 ip=192.168.10.9 ttl=128 id=+1 seq=1 rtt=0.3 ms
len=293 ip=192.168.10.9 ttl=128 id=+1 seq=2 rtt=0.4 ms
len=293 ip=192.168.10.9 ttl=128 id=+1 seq=3 rtt=0.4 ms
len=293 ip=192.168.10.9 ttl=128 id=+1 seq=4 rtt=0.4 ms

12:20:19.933615 IP (tos 0x0, ttl 128, id 58360, offset 0, flags [none], proto UDP (17), length 78)
192.168.10.3.4115 > 192.168.10.9.137: **NBT** UDP PACKET(137): **QUERY; REQUEST; BROADCAST**

12:20:19.934388 IP (tos 0x0, ttl 128, id 925, offset 0, flags [DF], proto UDP (17), length 185)
192.168.10.9.137 > 192.168.10.3.4115: **NBT** UDP PACKET(137): **QUERY; POSITIVE; RESPONSE;**

12:20:22.001809 IP (tos 0x0, ttl 128, id 30695, offset 0, flags [none], proto UDP (17), length 78)
192.168.10.3.34471 > 192.168.10.9.137: **NBT** UDP PACKET(137): **QUERY; REQUEST; BROADCAST**

12:20:22.002602 IP (tos 0x0, ttl 128, id 926, offset 0, flags [DF], proto UDP (17), length 185)
192.168.10.9.137 > 192.168.10.3.34471: **NBT** UDP PACKET(137): **QUERY; POSITIVE; RESPONSE;**

Closed Port 4444/udp

 # nmap -n -sU –p4444 192.168.10.9 –reason

Starting Nmap 5.00 (http://nmap.org) at 2010-05-31 20:01 EEST
Interesting ports on 192.168.10.9:

PORT	STATE	SERVICE	REASON
4444/udp	closed	krb524	port-unreach

 # ./identifier.py -U –u4444 –c5 192.168.10.9

Scan process initiated...

UDP Scan:	ip=192.168.10.9	id=5272	inc=0	(ICMP_Unreachable)
UDP Scan:	ip=192.168.10.9	id=5273	inc=1	(ICMP_Unreachable)
UDP Scan:	ip=192.168.10.9	id=5274	inc=1	(ICMP_Unreachable)
UDP Scan:	ip=192.168.10.9	id=5275	inc=1	(ICMP_Unreachable)
UDP Scan:	ip=192.168.10.9	id=5276	inc=1	(ICMP_Unreachable)

ICMP Requests & Replies

 # ./identifier.py -IPAT -c3 10.10.10.200

```
Scan process initiated...
ICMP Ping:  ip=10.10.10.200    id=5432        inc=0
ICMP Ping:  ip=10.10.10.200    id=63756       inc=58324
ICMP Ping:  ip=10.10.10.200    id=50910       inc=-12846
---------------------------------------------------------------------
ICMP Timestamp: ip=10.10.10.200    id=62973        inc=0
ICMP Timestamp: ip=10.10.10.200    id=29249        inc=-33724
ICMP Timestamp: ip=10.10.10.200    id=23274        inc=-5975
---------------------------------------------------------------------
ICMP Address Mask:    No Response
ICMP Address Mask:    No Response
ICMP Address Mask:    No Response
---------------------------------------------------------------------
```

ICMP TimeX Messages

 # ./identifier.py -TSA -c3 10.20.20.147 –ttl=1

```
Scan process initiated...
TCP SYN:  ip=10.10.10.200     id=33093      inc=0       (ICMP_TTL_Exceeded)
TCP SYN:  ip=10.10.10.200     id=33106      inc=13      (ICMP_TTL_Exceeded)
TCP SYN:  ip=10.10.10.200     id=33113      inc=7       (ICMP_TTL_Exceeded)
-------------------------------------------------------------------
TCP SYN/ACK: ip=10.10.10.200  id=33116      inc=0       (ICMP_TTL_Exceeded)
TCP SYN/ACK: ip=10.10.10.200  id=33118      inc=2       (ICMP_TTL_Exceeded)
TCP SYN/ACK: ip=10.10.10.200  id=33124      inc=6       (ICMP_TTL_Exceeded)
-------------------------------------------------------------------
TCP ACK:  ip=10.10.10.200     id=33129      inc=0       (ICMP_TTL_Exceeded)
TCP ACK:  ip=10.10.10.200     id=33132      inc=3       (ICMP_TTL_Exceeded)
TCP ACK:  ip=10.10.10.200     id=33139      inc=7       (ICMP_TTL_Exceeded)
-------------------------------------------------------------------
```

Tracing the whole path to a host

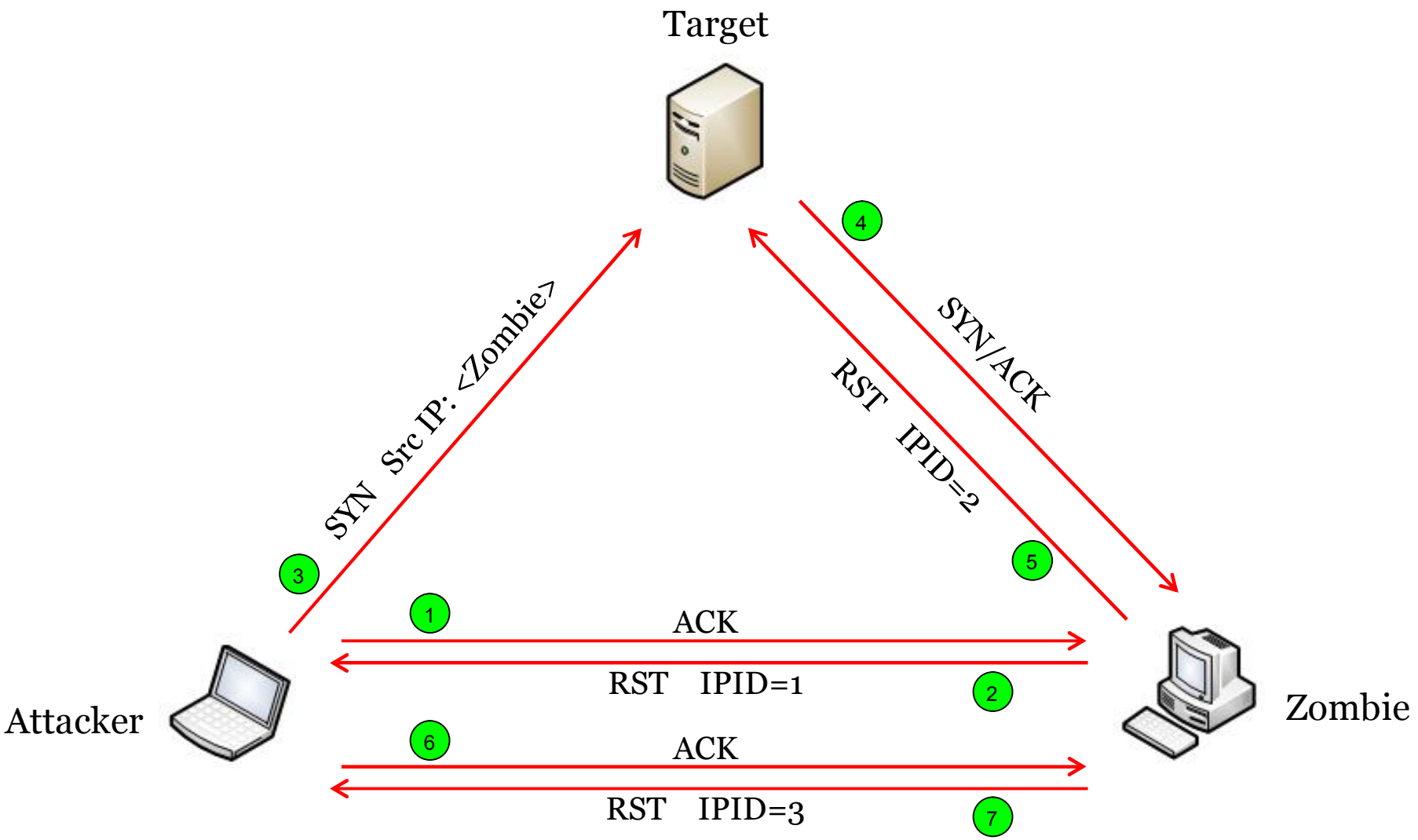
#./identifier.py -TS -t80 194.42.1.1 -c3 --tracert

```
Scan process initiated...
TCP SYN 1: No Response
TCP SYN 1: No Response
TCP SYN 1: No Response
-----------------------------------------------------------------
TCP SYN 2:  ip=91.184.192.49    id=55793       inc=0   (ICMP_TTL_Exceeded)
TCP SYN 2:  ip=91.184.192.49    id=55797       inc=4   (ICMP_TTL_Exceeded)
TCP SYN 2:  ip=91.184.192.49    id=55800       inc=3   (ICMP_TTL_Exceeded)
-----------------------------------------------------------------
TCP SYN 3:  ip=91.184.192.180   id=16742       inc=0   (ICMP_TTL_Exceeded)
TCP SYN 3:  ip=91.184.192.180   id=16747       inc=5   (ICMP_TTL_Exceeded)
TCP SYN 3:  ip=91.184.192.180   id=16752       inc=5   (ICMP_TTL_Exceeded)
-----------------------------------------------------------------
TCP SYN 4:  ip=91.184.192.163   id=39391       inc=0   (ICMP_TTL_Exceeded)
TCP SYN 4:  ip=91.184.192.163   id=39392       inc=1   (ICMP_TTL_Exceeded)
TCP SYN 4:  ip=91.184.192.163   id=39393       inc=1   (ICMP_TTL_Exceeded)
-----------------------------------------------------------------
…snip…
```

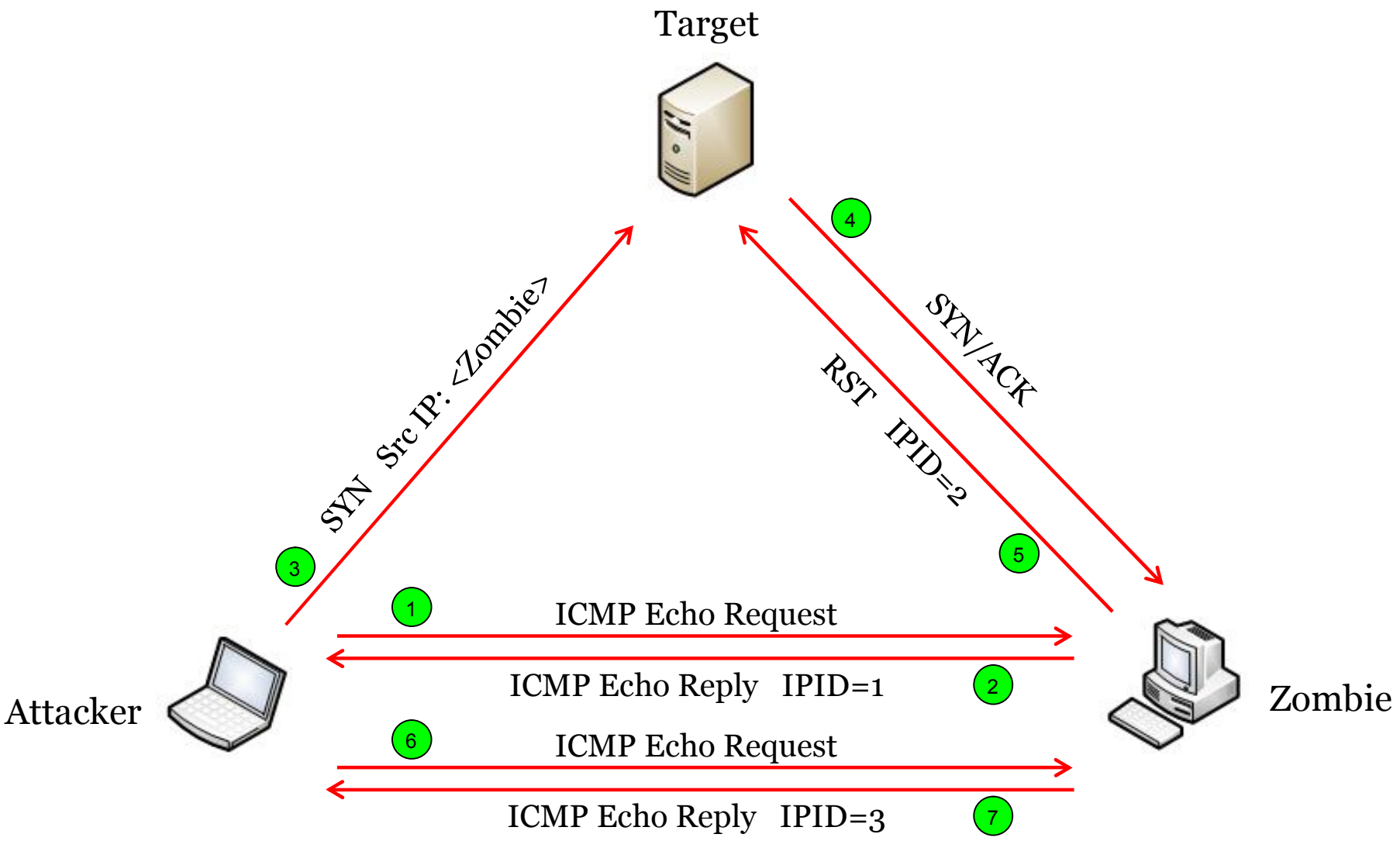
Tracing the whole path (Cont'd)

```
…snip…
------------------------------------------------------------------
TCP SYN 5:  ip=193.22.30.53    id=60650      inc=0   (ICMP_TTL_Exceeded)
TCP SYN 5:  ip=193.22.30.53    id=60651      inc=1   (ICMP_TTL_Exceeded)
TCP SYN 5:  ip=193.22.30.53    id=60652      inc=1   (ICMP_TTL_Exceeded)
------------------------------------------------------------------
TCP SYN 6:  ip=82.116.192.17   id=39113      inc=0   (ICMP_TTL_Exceeded)
TCP SYN 6:  ip=82.116.192.17   id=39114      inc=1   (ICMP_TTL_Exceeded)
TCP SYN 6:  ip=82.116.192.17   id=39116      inc=2   (ICMP_TTL_Exceeded)
------------------------------------------------------------------
TCP SYN 7:  ip=82.116.192.98   id=32316      inc=0   (ICMP_TTL_Exceeded)
TCP SYN 7:  ip=82.116.192.98   id=32317      inc=1   (ICMP_TTL_Exceeded)
TCP SYN 7:  ip=82.116.192.98   id=32318      inc=1   (ICMP_TTL_Exceeded)
------------------------------------------------------------------
TCP SYN 8:  ip=194.42.1.1      id=25476      inc=0
TCP SYN 8:  ip=194.42.1.1      id=25482      inc=6
TCP SYN 8:  ip=194.42.1.1      id=25487      inc=5
------------------------------------------------------------------
```

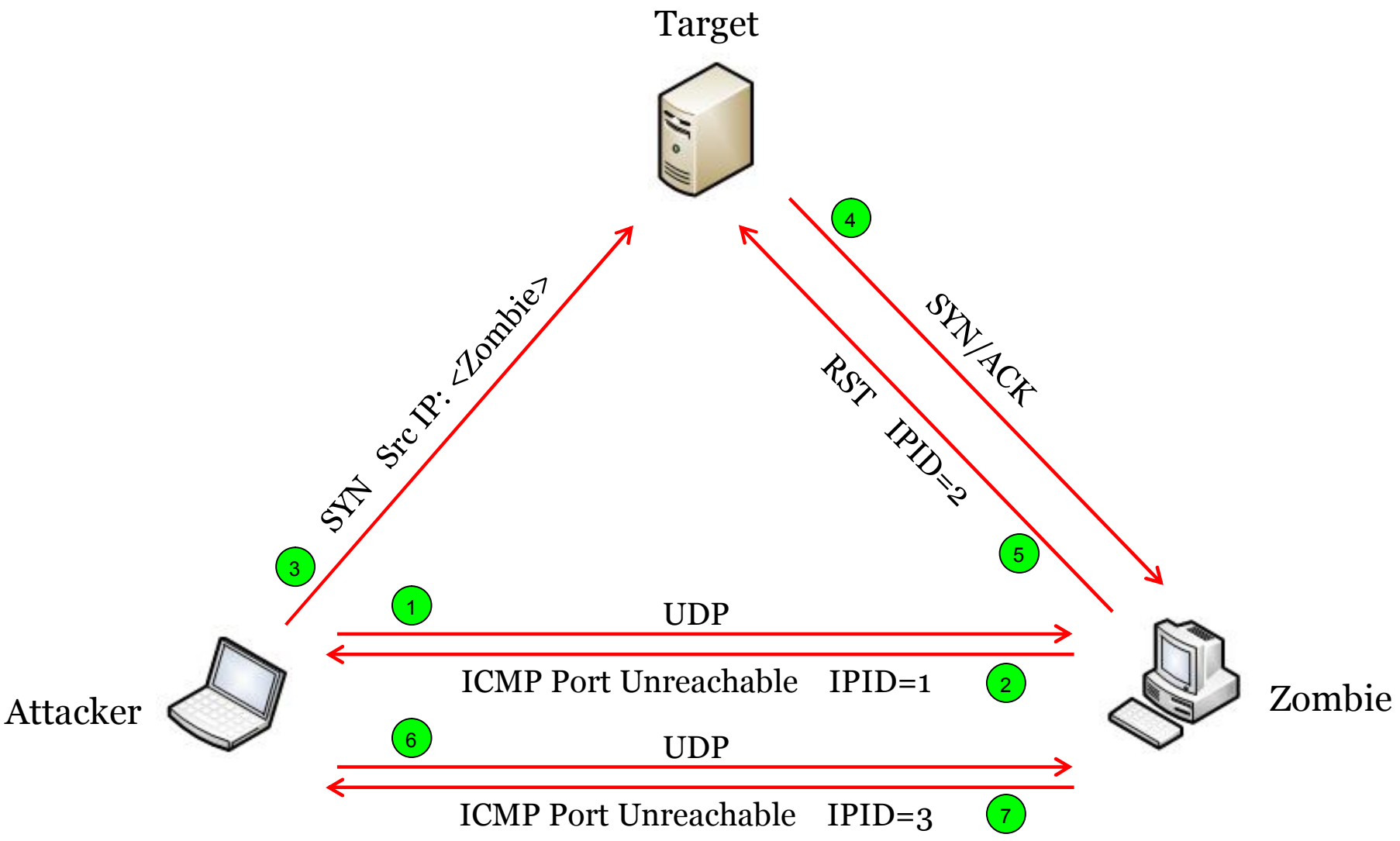
TCP (ACK) Idle Scan



ICMP Idle Scan



UDP Idle Scan



Overcoming Obstacle 2

- Obstacle
  - Busy zombie machines cannot be utilized because extraneous traffic will increment the IP ID and mess-up our scan results
- Solution
  - Send a burst of packets and observe if there is a comparative increase in the IP ID sequence

Regular Idle Scan - NMAP

 # nmap -vv -n -PN -sI 10.10.10.253:80 10.10.10.200 -p23 --packet-trace

Starting Nmap 4.60 (http://nmap.org) at 2014-09-23 14:47 GMT
Initiating ARP Ping Scan at 14:47
Scanning 10.10.10.200 [1 port]
Completed ARP Ping Scan at 14:47, 0.01s elapsed (1 total hosts)
Initiating idle scan against 10.10.10.200 at 14:47
Interesting ports on 10.10.10.200:

PORT	STATE	SERVICE
23/tcp	open	telnet

…snip…
SENT (0.7200s) TCP 10.50.12.44:63957 > 10.10.10.253:80 SA ttl=42 id=37634 iplen=44 seq=1663218960
RCVD (0.7200s) TCP 10.10.10.253:80 > 10.50.12.44:63957 R ttl=64 id=33865 iplen=40 seq=4101936255
SENT (0.7200s) TCP 10.10.10.253:80 > 10.10.10.200:23 S ttl=43 id=13887 iplen=44 seq=3990003447
SENT (0.7760s) TCP 10.50.12.44:63918 > 10.10.10.253:80 SA ttl=43 id=30888 iplen=44 seq=1663219460
RCVD (0.7760s) TCP 10.10.10.253:80 > 10.50.12.44:63918 R ttl=64 id=33867 iplen=40 seq=4101936255
…snip…

Puppeteer Idle Scanner

```
Usage: puppeteer.py   [options]   target:port

Options:
  -h, --help            show this help message and exit
  -z ZOMBIE             IP address of zombie host (mandatory)
  -T TCP                use TCP to communicate with the zombie. Available flags
                        S/A/F/U/P/R
  -U                    use UDP to communicate with the zombie
  -I ICMP               use ICMP to communicate with the zombie P=Ping (default)
                        T=Timestamp A=Address Mask
  -P                    use IP Protocol to communicate with the zombie
  -t TCP_PORT           TCP port to use when communicating with the zombie
  -u UDP_PORT           UDP port to use when communicating with the zombie
  -p IP_PROTO           IP protocol number to use when communicating with the zombie
  --ttl=TTL             how many hops the packet will traverse
  -c PACKET_COUNT               number of packets to send to zombie host
  -b BURST              number of packets to send to the target as a quick burst
  --fast                send zombie probes faster than 1pps
```

Regular Idle Scan - Puppeteer

 # ./puppeteer.py –z 10.10.10.253 -TS –t80 –c10 –b1 10.10.10.200:23

```
Scan process initiated...
TCP:  ip=10.10.10.253   id=30231  inc=0
TCP:  ip=10.10.10.253   id=30232  inc=1
TCP:  ip=10.10.10.253   id=30233  inc=1
TCP:  ip=10.10.10.253   id=30234  inc=1
TCP:  ip=10.10.10.253   id=30235  inc=1
TCP: sending 1 spoofed packet(s)...
TCP:  ip=10.10.10.253   id=30237  inc=2
TCP:  ip=10.10.10.253   id=30238  inc=1
TCP:  ip=10.10.10.253   id=30239  inc=1
TCP:  ip=10.10.10.253   id=30240  inc=1
TCP:  ip=10.10.10.253   id=30241  inc=1
------------------------------------------------------------------------
```

Regular Idle Scan - Busy Zombie

 # ./puppeteer.py –z 10.10.10.253 -TS –t80 –c10 –b1 10.10.10.200:23

```
Scan process initiated...
TCP:  ip=10.10.10.253   id=36532       inc=0
TCP:  ip=10.10.10.253   id=36539       inc=7
TCP:  ip=10.10.10.253   id=36545       inc=6
TCP:  ip=10.10.10.253   id=36551       inc=6
TCP:  ip=10.10.10.253   id=36558       inc=7
TCP: sending 1 spoofed packet(s)...
TCP:  ip=10.10.10.253   id=36565       inc=7
TCP:  ip=10.10.10.253   id=36571       inc=6
TCP:  ip=10.10.10.253   id=36577       inc=6
TCP:  ip=10.10.10.253   id=36584       inc=7
TCP:  ip=10.10.10.253   id=36590       inc=6
------------------------------------------------------------------------
```

Busy Zombie vs Burst of Packet

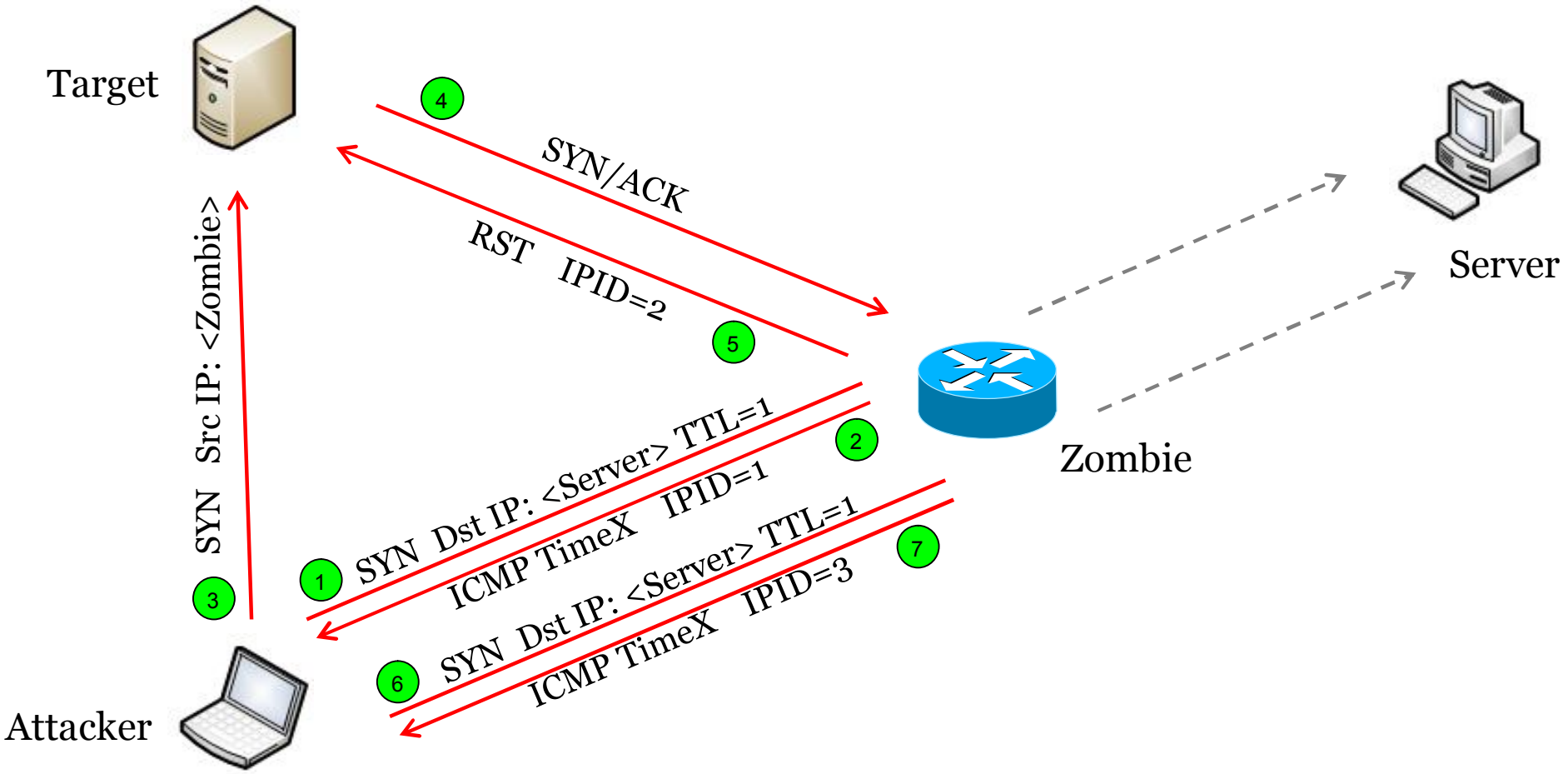
 # ./puppeteer.py –z 10.10.10.253 -TS –t80 –c10 –b5 10.10.10.200:23

```
Scan process initiated...
TCP:  ip=10.10.10.253   id=33493       inc=0
TCP:  ip=10.10.10.253   id=33499       inc=6
TCP:  ip=10.10.10.253   id=33505       inc=6
TCP:  ip=10.10.10.253   id=33512       inc=7
TCP:  ip=10.10.10.253   id=33518       inc=6
TCP: sending 5 spoofed packet(s)...
TCP:  ip=10.10.10.253   id=33529       inc=11
TCP:  ip=10.10.10.253   id=33535       inc=6
TCP:  ip=10.10.10.253   id=33542       inc=7
TCP:  ip=10.10.10.253   id=33548       inc=6
TCP:  ip=10.10.10.253   id=33554       inc=6
------------------------------------------------------------------------
```

Overcoming Obstacle 3

- Obstacle
  - Stateful firewalls are placed on the perimeter of a network or on the OSes, and as a results they render good zombie candidates useless to us
- Solution
  - To solve this problem we can utilize idle or moderately busy routers as our zombies, which are less likely to be protected by stateful firewalls
  - And with routers we can use ICMP Time Exceeded messages that are more likely to carry incremental IP IDs

ICMP TimeX Idle Scan



ICMP TimeX Idle Scan – Open Port

 # ./puppeteer.py -c16 -TS -b10 --ttl=5 -z 194.42.1.1 78.158.146.182:80

```
Scan process initiated...
TCP SYN:  ip=193.22.30.53     id=56987     inc=0     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=56989     inc=2     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=56990     inc=1     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=56992     inc=2     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=56995     inc=3     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=56997     inc=2     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57003     inc=6     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57005     inc=2     (ICMP_TTL_Exceeded)
TCP SYN: sending 10 spoofed packet(s)...
TCP SYN:  ip=193.22.30.53     id=57017     inc=12    (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57021     inc=4     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57026     inc=5     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57028     inc=2     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57031     inc=3     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57033     inc=2     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57035     inc=2     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57037     inc=2     (ICMP_TTL_Exceeded)
------------------------------------------------------------------
```

ICMP TimeX Idle Scan – Closed Port

 # ./puppeteer.py -c16 -TS -b10 --ttl=5 -z 194.42.1.1 78.158.146.182:4444

```
Scan process initiated...
TCP SYN:  ip=193.22.30.53     id=57424     inc=0     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57425     inc=1     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57427     inc=2     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57429     inc=2     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57430     inc=1     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57433     inc=3     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57435     inc=2     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57438     inc=3     (ICMP_TTL_Exceeded)
TCP SYN: sending 10 spoofed packet(s)...
TCP SYN:  ip=193.22.30.53     id=57439     inc=1     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57441     inc=2     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57446     inc=5     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57447     inc=1     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57450     inc=3     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57451     inc=1     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57454     inc=3     (ICMP_TTL_Exceeded)
TCP SYN:  ip=193.22.30.53     id=57489     inc=35    (ICMP_TTL_Exceeded)
------------------------------------------------------------------
```

Overcoming Obstacle 4

- Obstacle
  - The Internet is moving from IPv4 to IPv6 and IPv6 is not vulnerable to IPv4 Idle Scans
- Solution
  - IPv6 Idle Scanning is still possible (see Mathias Morbitzer's presentation at HACK.LU 2013)
  - The best thing is that many of the principles discussed so far are applicable in IPv6 Idle Scanning

REVEALING TRUST RELATIONSHIPS

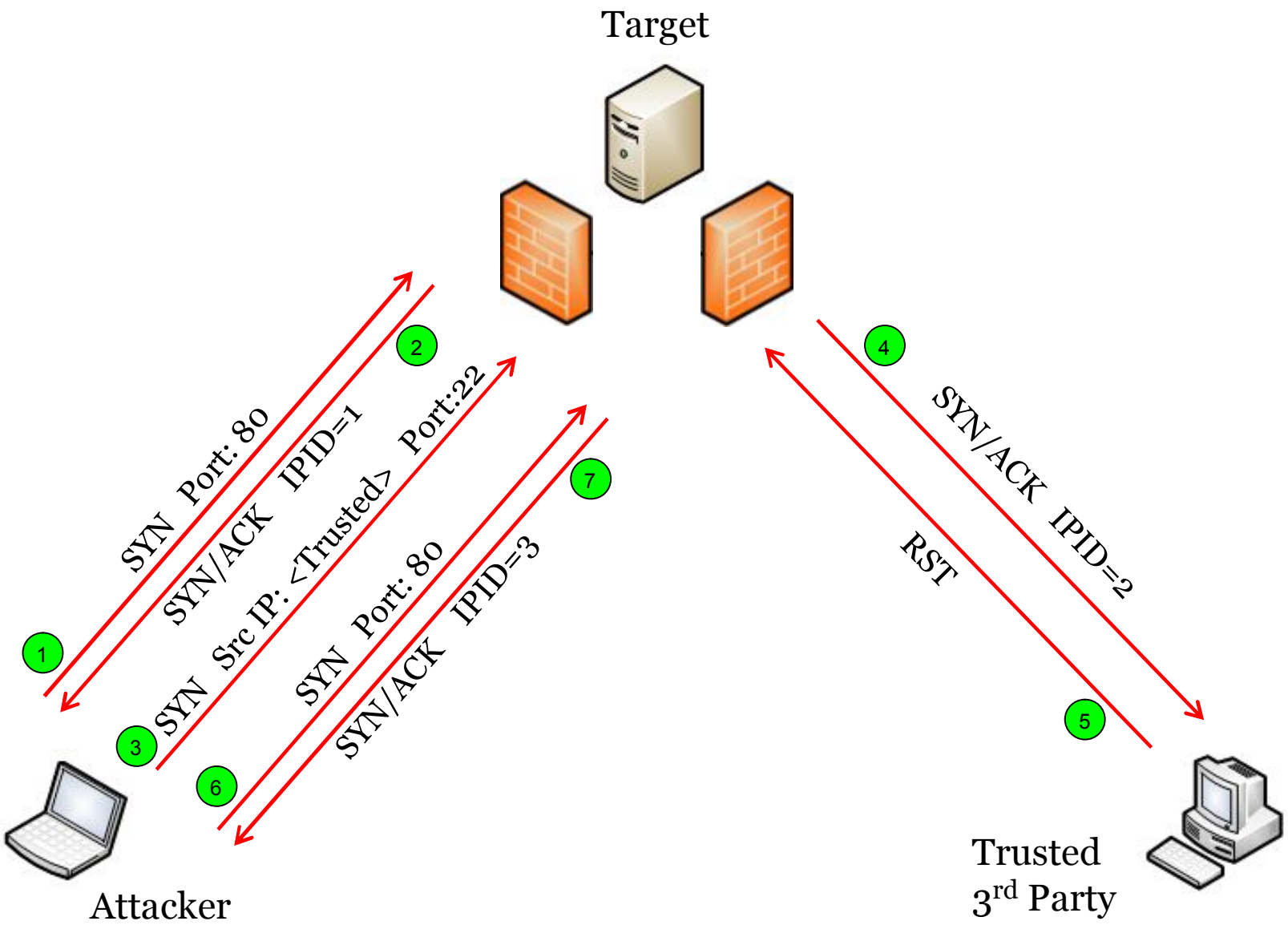
Introduction

- Regular Idle scans expose trust relationships between the zombie and the target, but…
- An improved technique can be used to reveal permissive firewall rules for trusted 3rd party networks / IP addresses
- The technique follows the same principles as Idle Scanning but with a few changes
  - We don't "ask" the zombie to reveal open/closed ports on the target,
  - …but instead we "ask" the target to reveal trusted IP addresses

What's Needed

- Prerequisites
  - The target host must generate global incremental IP IDs
  - At least one open/closed TCP or UDP port on the target or an ICMP responsive target
  - The attacker must be able to spoof his IP address (no NATing)

Basic Concept



Target Information

```
Starting Nmap 5.00 ( http://nmap.org ) at 2010-03-11 23:58 EET
Interesting ports on 192.168.1.13:
PORT      STATE     SERVICE
4444/tcp  open      krb524
4445/tcp  closed    unknown
4446/tcp  filtered  unknown
```

#./identifier.py -TS -t 4445 -c5 192.168.1.13

```
Scan process initiated...
TCP SYN:  ip=192.168.1.13      id=506  inc=0
TCP SYN:  ip=192.168.1.13      id=507  inc=1
TCP SYN:  ip=192.168.1.13      id=508  inc=1
TCP SYN:  ip=192.168.1.13      id=509  inc=1
TCP SYN:  ip=192.168.1.13      id=510  inc=1
---------------------------------------------------------------------
```

Trust Revealer Tool

Usage: revealer.py [options] target:port:protocol

Options:

-h, --help	show this help message and exit
-a SPOOFED	spoofed IP address and source port to be used to bypass ACL (mandatory) Acceptable format <IP_Address:Port>
-T TCP	use TCP to gather IPIDs from the target. Available flags S/A/F/U/P/R
-U	use UDP to gather IPIDs from the target
-I ICMP	use ICMP to gather IPIDs from the target P=Ping (default) T=Timestamp A=Address Mask
-P	use IP Protocol to gather IPIDs from the target
-t TCP_PORT	TCP port to use when gathering IPIDs from the target
-u UDP_PORT	UDP port to use when gathering IPIDs from the target
-p IP_PROTO	IP protocol number to use when gathering IPIDs from the target
--ttl=TTL	how many hops the packet will traverse
-c PACKET_COUNT	number of IPID probe packets to send to the target
-b BURST	number of spoofed packets to send to the target as a quick burst
--fast	send IPID probes to target faster than 1pps

Trust Revealer – Open Port

 # ./revealer.py -TS -t4445 -a 192.168.1.3 192.168.1.13:4444:T -c10 -b5

```
Scan process initiated...
TCP:  ip=192.168.1.13   id=541  inc=0
TCP:  ip=192.168.1.13   id=542  inc=1
TCP:  ip=192.168.1.13   id=543  inc=1
TCP:  ip=192.168.1.13   id=544  inc=1
TCP:  ip=192.168.1.13   id=545  inc=1
TCP: sending 5 spoofed packet(s)... to port 4444
TCP:  ip=192.168.1.13   id=551  inc=6
TCP:  ip=192.168.1.13   id=552  inc=1
TCP:  ip=192.168.1.13   id=553  inc=1
TCP:  ip=192.168.1.13   id=554  inc=1
TCP:  ip=192.168.1.13   id=555  inc=1
------------------------------------------------------------------
```

Trust Revealer – Closed Port

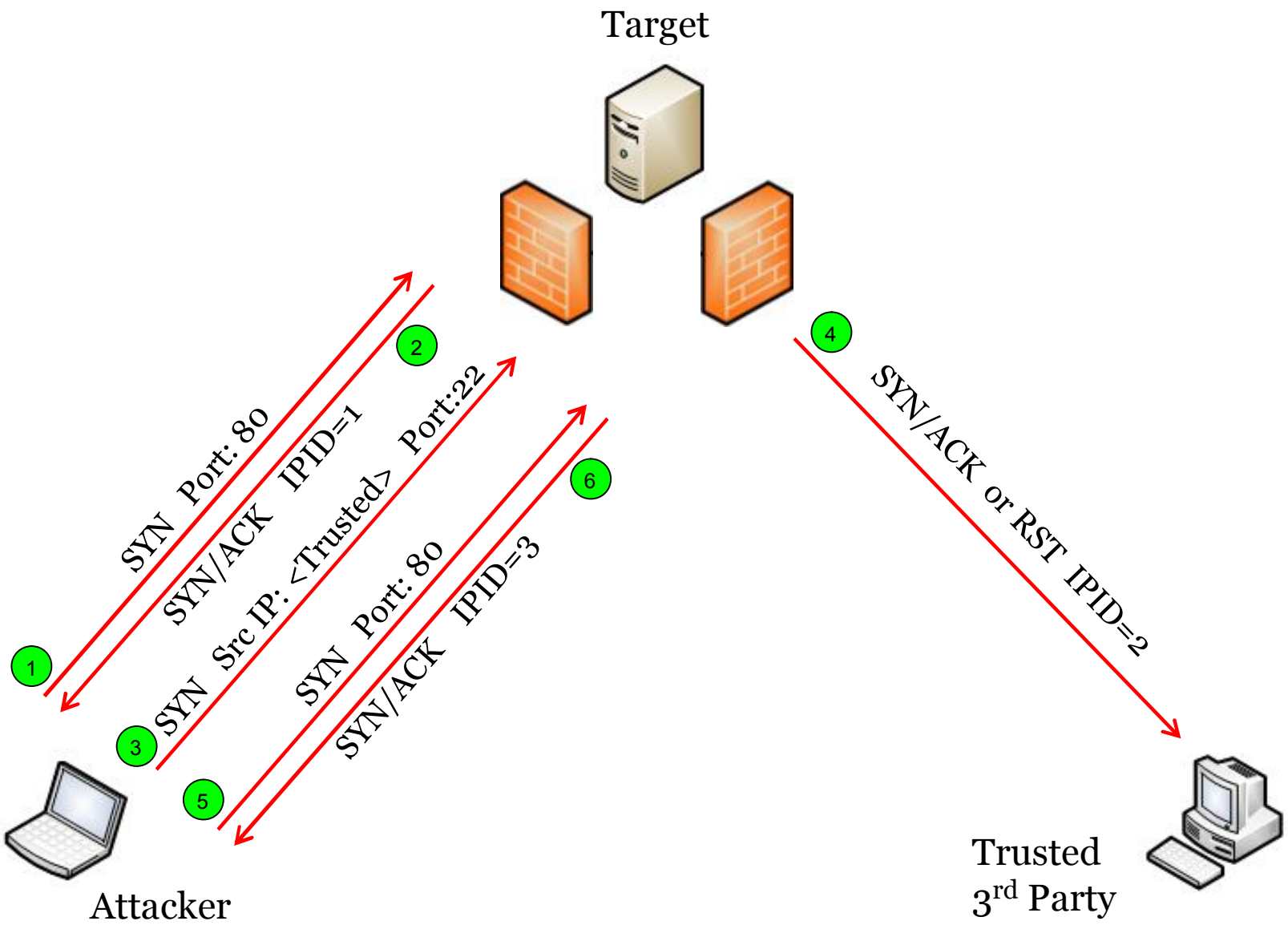
 # ./revealer.py -TS -t4444 -a 192.168.1.3 192.168.1.13:4445:T -c10 -b5

```
Scan process initiated...
TCP:  ip=192.168.1.13   id=556  inc=0
TCP:  ip=192.168.1.13   id=557  inc=1
TCP:  ip=192.168.1.13   id=558  inc=1
TCP:  ip=192.168.1.13   id=559  inc=1
TCP:  ip=192.168.1.13   id=560  inc=1
TCP: sending 5 spoofed packet(s)... to port 4445
TCP:  ip=192.168.1.13   id=566  inc=6
TCP:  ip=192.168.1.13   id=567  inc=1
TCP:  ip=192.168.1.13   id=568  inc=1
TCP:  ip=192.168.1.13   id=569  inc=1
TCP:  ip=192.168.1.13   id=570  inc=1
------------------------------------------------------------------
```

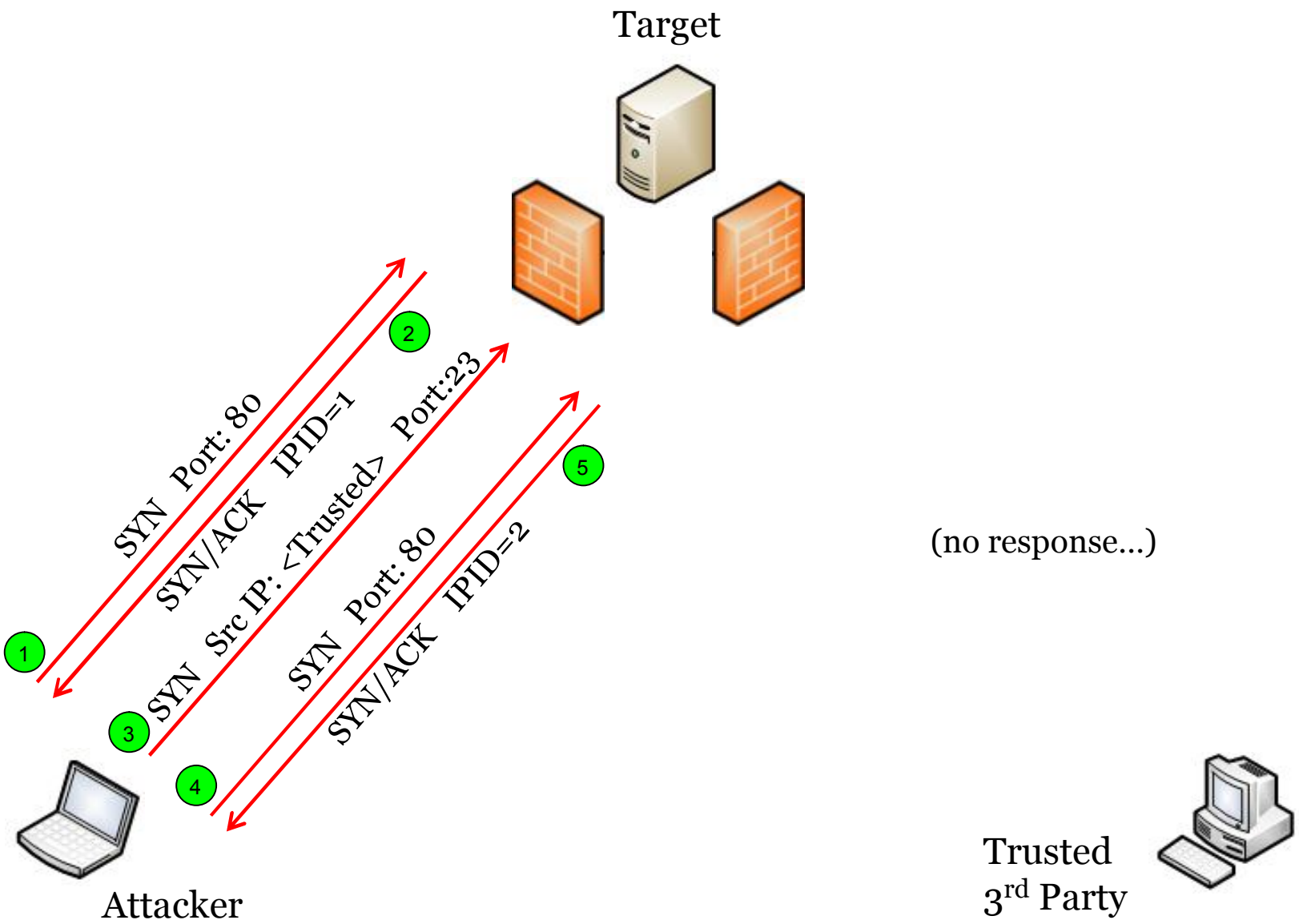
Observation

- We can only detect if a port is filtered or unfiltered, not if it's open or closed

Unfiltered Open|Closed Port



Filtered Port



Trust Revealer – Filtered Port

 # ./revealer.py -TS -t4445 -a 192.168.1.3 192.168.1.13:4446:T -c10 -b5

```
Scan process initiated...
TCP:  ip=192.168.1.13   id=1861        inc=0
TCP:  ip=192.168.1.13   id=1862        inc=1
TCP:  ip=192.168.1.13   id=1863        inc=1
TCP:  ip=192.168.1.13   id=1864        inc=1
TCP:  ip=192.168.1.13   id=1865        inc=1
TCP: sending 5 spoofed packet(s)... to port 4446
TCP:  ip=192.168.1.13   id=1866        inc=1
TCP:  ip=192.168.1.13   id=1867        inc=1
TCP:  ip=192.168.1.13   id=1868        inc=1
TCP:  ip=192.168.1.13   id=1869        inc=1
TCP:  ip=192.168.1.13   id=1870        inc=1
------------------------------------------------------------------
```

Trust Revealer – Filtered Port - Spoofed

 # ./revealer.py -TS -t4445 -a 192.168.1.2 192.168.1.13:4446:T -c10 -b5

```
Scan process initiated...
TCP:  ip=192.168.1.13   id=571  inc=0
TCP:  ip=192.168.1.13   id=572  inc=1
TCP:  ip=192.168.1.13   id=573  inc=1
TCP:  ip=192.168.1.13   id=574  inc=1
TCP:  ip=192.168.1.13   id=575  inc=1
TCP: sending 5 spoofed packet(s)... to port 4446
TCP:  ip=192.168.1.13   id=581  inc=6
TCP:  ip=192.168.1.13   id=582  inc=1
TCP:  ip=192.168.1.13   id=583  inc=1
TCP:  ip=192.168.1.13   id=584  inc=1
TCP:  ip=192.168.1.13   id=585  inc=1
------------------------------------------------------------------
```

Summary

- Enhancements to current Idle Scan techniques
  - Use of different protocols (e.g. IP, TCP, UDP, ICMP)
  - Use of different TCP Flags (e.g. SYN, ACK, FIN)
  - Use of ICMP Time Exceeded messages from routers
  - Use of packets bursts
- Improved technique for identifying firewall rules that allow connections from trusted 3rd parties based on source IP addresses.

Do You Have Any Questions?

We would be happy to help.

Presented

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