

# Hacking Exposed 7

## Network Security Secrets & Solutions

### Chapter 2 Scanning

# Scanning

- Determining if the system is alive
- Determining which services are running or listening
- Detecting the operating system
- Processing and storing scan data

# Determining If the System is Alive

- Network ping sweeps
  - ARP host discovery: on the same subnet
    - **Arp-scan**: run as root by **sudo** to list IP-MAC
    - **Nmap** (Network Mapper): host and service discovery with various options (host only: -PR -sn)
    - **Cain** (Windows-only): beyond host and service discovery

# Address Resolution Protocol (ARP)

```
root@kali:~# arp-scan --interface=wlan0 -localnet
Interface: wlan0, datalink type: EN10MB (Ethernet)
Starting arp-scan 1.9 with 256 hosts
(http://www.nta-monitor.com/tools/arp-scan/)
10.0.1.3 0 b:1a:a0:c2:94:c0 Dell Inc
10.0.1.57 0b:0c:29:34:f9:6a VMware, Inc.
10.0.1.253 0b:19:55:9d:60:c1 CISCO SYSTEMS, INC.
29 packets received by filter, 0 packets dropped by
kernel Ending arp-scan 1.9: 256 hosts scanned in
2.259 seconds (113.32 hosts/sec). 29 responded
```

```
Nmap -sn -PR -send-IP <IP-range>
```

- NMAP not only sends an ICMP ECHO REQUEST packet it also performs an ARP ping, some TCP pinging.
- **Understanding what tools do, is really important.** If the target network is being monitored by an IDS, you may inadvertently trigger an alert because of all of the extra traffic being generated
- -Pn option probes only port 22, -sn to probe ports, -PE skip ARP resolution

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    - Cain (Windows-only): beyond host and service discovery
  - ICMP host discovery: remote host/router
    - ICMP ECHO REQUEST, ICMP ECHO REPLY, ICMP TIMESTAMP, ICMP ADDRESS MASK, etc.
    - **Ping**: OS utilities for ECHO REQUEST/REPLY
    - **Nmap**: ICMP ping/address mask/timestamp, ARP ping, TCP ping (ports 80 and 443)
    - **Hping3** and **nping**: any combinations of flags on any combinations of packet types, spoofing MAC/IP
    - **Superscan**: multiple ICMP in parallel

```
user@hax: ~$ ping -c 2 192.168.1.1
```

```
PING 192.168.1.1 (192.168.1.1) 56(84) bytes Of data.
```

```
64 bytes from 192.168.1.1: icmp_req=1 ttl=64 time=0.149 ms
```

```
64 bytes from 192.168.1.1: icmp_req=2 ttl=64 time=0.091 ms
```

```
--- 192.168.1.1 ping statistics ---
```

```
2 packets transmitted, 2 received, 0% packet loss, time 999ms
```

```
rtt min/avg/max/mdev = 0.091/0.120/0.149/0.029
```

```
user@hax:~$ sudo nmap -sn -PE --send-ip 192.168.1.1
```

```
Starting Nmap 5.51 (http://nmap.org) at 2011-09-24 10:06 PDT
```

```
Nmap scan report for 192.168.1.1
```

```
Host is up (0.060s latency).
```

```
MAC Address: 5F:8D:09:F4:07:43 (Unknown)
```

```
Nmap done: 1 IP address (1 host up) scanned in 0.19 seconds
```

- sn: skip port scanning
- PE skip ARP resolution



# Determining If the System is Alive

- Network ping sweeps
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    - Superscan: multiple ICMP in parallel
  - TCP/UDP host discovery: when internal and/or external ICMP is not permitted
    - Servers: TCP/UDP service ports (port 80 for HTTP in webserver)
    - Desktops: local firewall to ban inbound connections, but accessible through remote desktop, file sharing, and disabled local firewall
    - **Nmap/Superscan/Nping**: all ports (slow and noisy) or specific ports

# Ping Sweeps Countermeasures

- Detection
  - IDS: **snort**
  - Commercial firewall: network or desktop
    - Detect ICMP, TCP, UDP ping sweeps
      - A pattern of ICMP/TCP/UDP packets from a particular system or network
  - Host based tools: **Scanlogd, courtney, ippl, protolog**
  - **Not just tools, eyeballs count.**
- Prevention
  - ACL in firewall: limit ICMP traffic into your networks or systems
  - Allow only ECHO\_REPLY, HOST\_UNREACHABLE, TIME\_EXCEEDED into specific hosts in DMZ; allow only ISP's specific IP addresses
    - **Loki2**: hackers use it to backdoor the OS and tunnel data in ICMP ECHO
  - **Pingd**: move ICMP from kernel to user space



# SANS Institute InfoSec Reading Room

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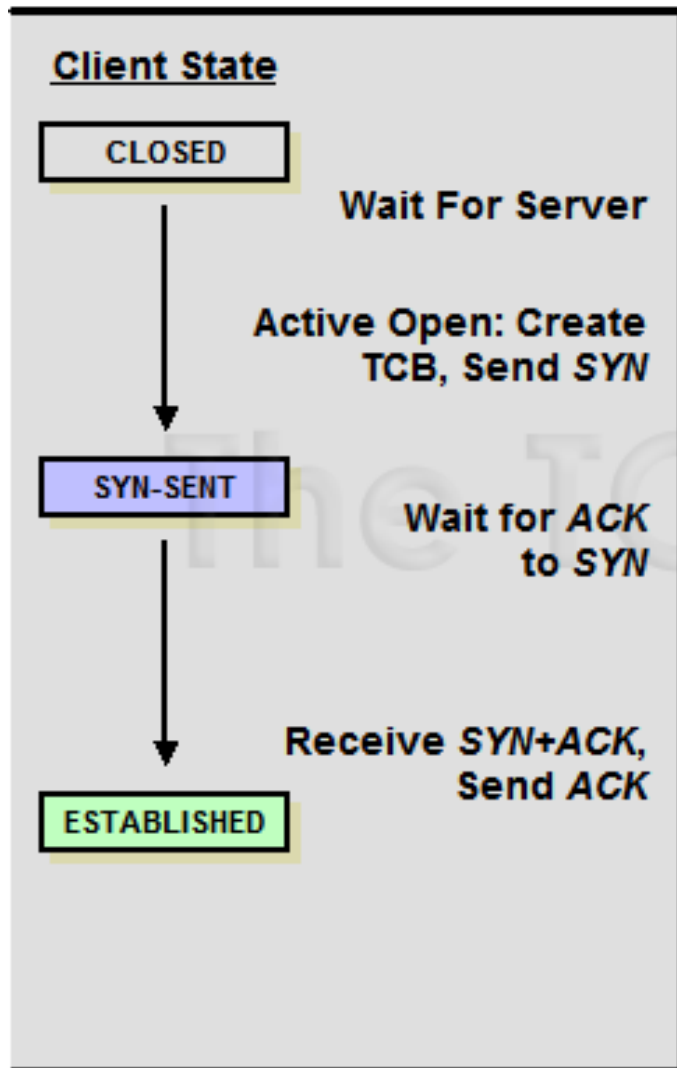
## ICMP Attacks Illustrated

The simplicity of the ICMP protocol and the lack of awareness of security issues related to protocol has led me to put in place this paper to attempt to illustrate some of the possible attacks using ICMP as a tool.

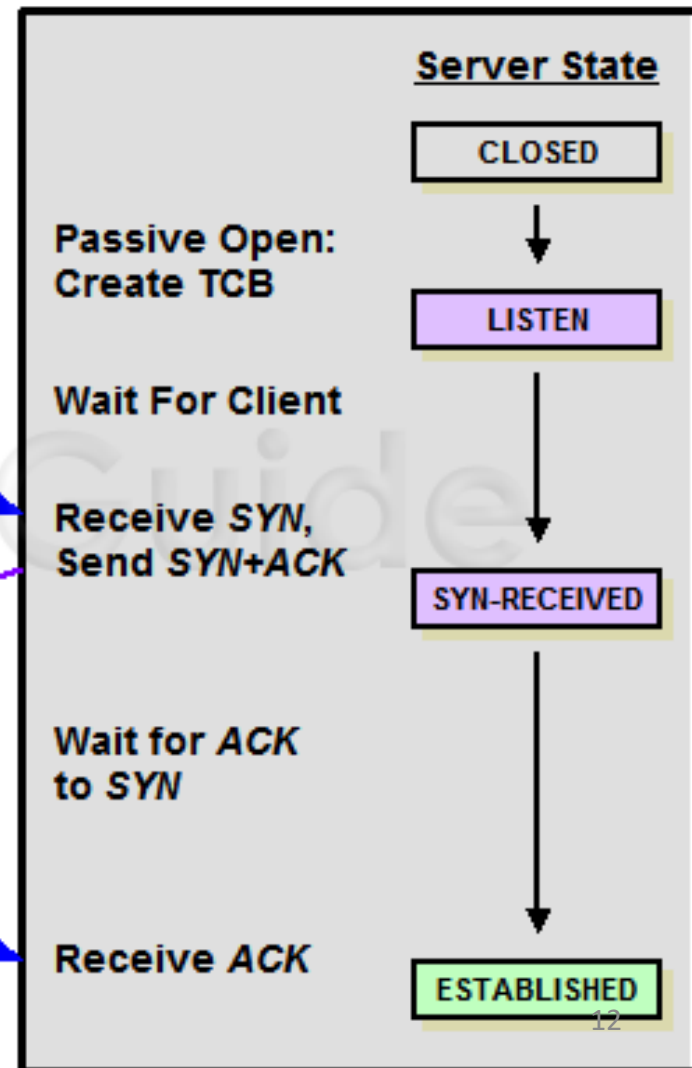
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# 3-way handshake

## Client



## Server



#1

SYN

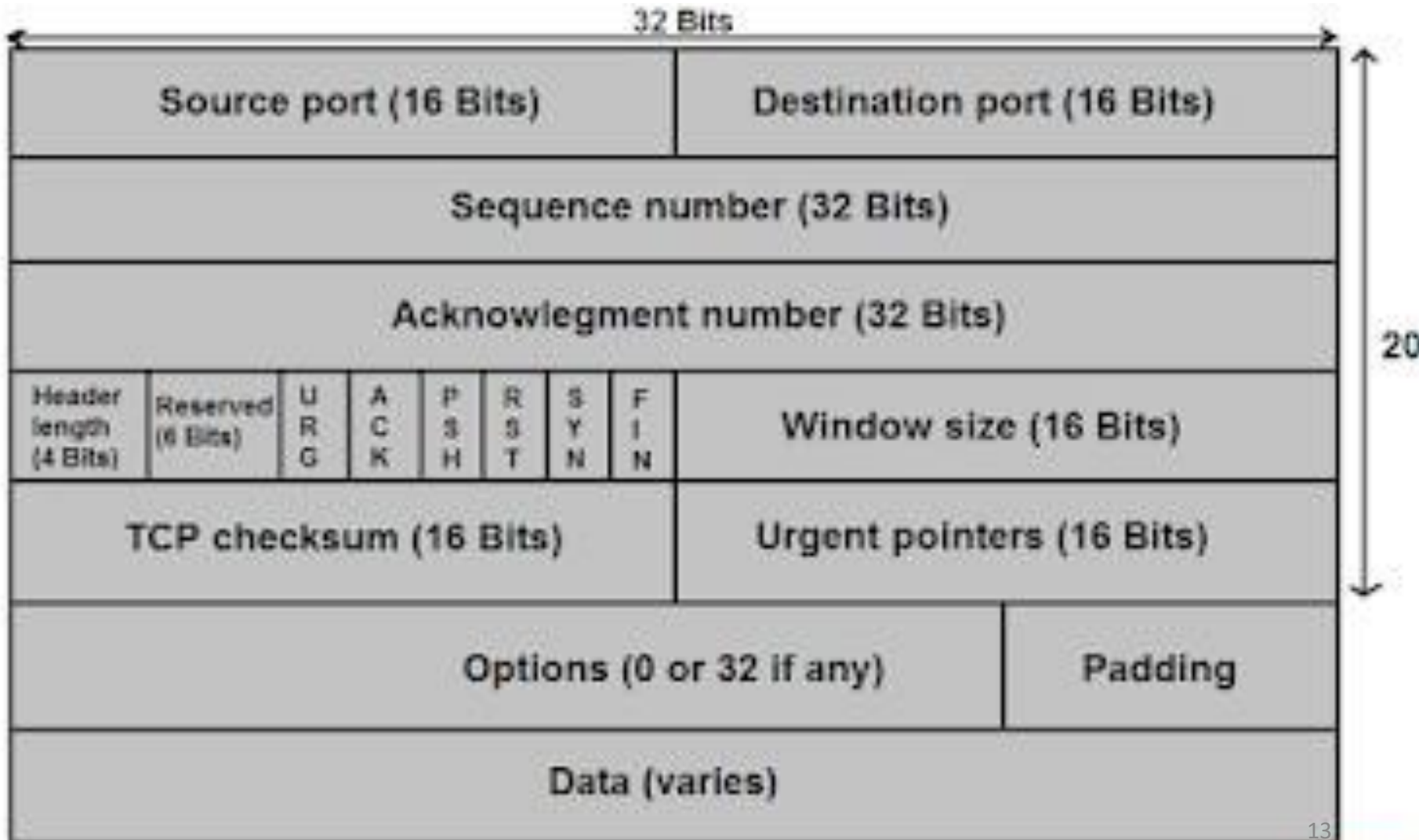
#2

SYN+ACK

#3

ACK

# TCP Header



# TCP FLAG

- URG (1 bit): indicates that the Urgent pointer field is significant
- ACK (1 bit): indicates that the Acknowledgment field is significant. All packets after the initial SYN packet sent by the client should have this flag set.
- PSH (1 bit): Push function. Asks to push the buffered data to the receiving application.
- RST (1 bit): Reset the connection
- SYN (1 bit): Synchronize sequence numbers.
  - Only the first packet sent from each end should have this flag set.
  - Some other flags and fields change meaning based on this flag, and some are only valid for when it is set, and others when it is clear.
- FIN (1 bit): Last packet from sender.

# Determining Which Services Are Running or Listening

- Port scanning
  - Identifying TCP/UDP services running on the target
  - Identifying type of OS of the target
  - Identifying applications or versions of a service
  - Scan types (anomalous TCP packets)
    - TCP connect scan (3-way handshake)
    - TCP SYN scan (half-open scan, SYN then SYN/ACK or RST/ACK) (not traceable)
    - TCP FIN scan (receive RST for all closed ports)
    - TCP Xmas Tree scan (FIN/URG/PUSH) (RST closed ports)
    - TCP null scan (RST closed ports)
    - TCP ACK scan (firewall detection)
    - TCP Windows scan (detect (non-)filtered ports)
    - TCP RPC scan
    - UDP scan (ICMP port unreachable msg, if closed port)

# Determining Which Services Are Running or Listening

```
user@hax:~$ sudo nmap -sS 192.168.1.231
```

```
Starting Nmap 5.51 ( http://nmap.org ) at 2011-09-26 08:20 PDT
```

```
Nmap scan report for 192.168.1.231
```

```
Host is up (0.00071s latency).
```

```
Not shown: 994 closed ports
```

PORT	STATE	SERVICE
------	-------	---------

80/tcp	open	http
--------	------	------

139/tcp	open	netbios-ssn
---------	------	-------------

445/tcp	open	microsoft-ds
---------	------	--------------

515/tcp	open	printer
---------	------	---------

631/tcp	open	ipp
---------	------	-----

9100/tcp	open	jetdirect
----------	------	-----------

```
MAC Address: 08:00:37:AD:D3:62 (Fuji-xerox CO.)
```

```
Nmap done: 1 IP address (1 host up) scanned in 6.77 seconds
```



# Detecting The Operating System

## Active Operating System Detection

- Useful info for vulnerability mapping
  - Banner grabbing: some applications tell it all
    - FTP, telnet, SMTP, HTTP, POP, and other
  - Scanning available ports: some services are OS specific!
  - Stack fingerprinting: TCP/IP stack implementation

# Detecting The Operating System

## Active Operating System Detection

- Making guess from available ports
  - Windows: ports 135, 139, 445 (139 only for Windows 95/98); 3389 for RDP (Remote Desktop Protocol)
  - UNIX: TCP 22 (SSH), TCP 111 (RPC portmapper=port 135), TCP 512-514 (Berkeley Remote services, rlogin), TCP 2049 (NFS, Network File System), high number ports 3277x (**RPC, Remote Procedure Call in Solaris**)

# Port 135, 139, 445

- Port 135 Microsoft EPMAP, end-point mapper. Microsoft relies upon DCE RPC to remotely manage services. Some services that use port 135 of end-point mapping are: DHCP server, DNS server, WINS server
- Port 139 NetBIOS
- Port 445 MS Server Message Block (SMB), SAMBA-compatible

# Detecting The Operating System

## Active Operating System Detection

- Active stack fingerprinting (Phrack Magazine)
  - Vendors interpret RFCs differently when writing TCP/IP stack
  - **Nmap** –O: signature listing at **Nmap-os-fingerprints**
    - **FIN probe** (Windows 7/200x/Vista respond with FIN/ACK)
    - **Bogus flag probe** (Linux responds with the same undefined flag)
    - **Initial Sequence Number sampling** (find pattern in the ISSN)
    - **“Don’t fragment bit” monitoring** (some OS have it set)
    - **TCP initial window size** (tracked on returned packets)
    - **ACK value** (same number sent +0 or +1)
    - **ICMP message quenching** (RFC 1812 limit rate of error messages)
    - **ICMP message quoting** (# of quoted info in errors)
    - **ICMP message echoing integrity** (IP headers changed in ICMP errors)
    - **Type of service (TOS)** (most implementation use 0, but can vary)
    - **fragmentation handling**
    - **TCP options**

```
user@hax:~$ sudo nmap -O 192.168.1.17
```

```
Starting Nmap 5.51 ( http://nmap.org ) at 2011-09-26 11:35 PDT
```

```
Nmap scan report for 192.168.1.17
```

```
Host is up (0.0015s latency).
```

```
Not shown: 994 closed ports
```

```
PORT      STATE SERVICE
```

```
135/tcp    open  msrpc
```

```
139/tcp    open  netbios-ssn
```

```
445/tcp    open  microsoft-ds
```

```
3389/tcp   open  ms-term-serv
```

```
4445/tcp   open  upnotifyp
```

```
14000/tcp  open  scotty-ft
```

```
Device type: general purpose
```

```
Running: Microsoft Windows XP
```

```
OS details: Microsoft Windows XP SP2 or SP3
```

```
Network Distance: 1 hop
```

```
OS detection performed. Please report any incorrect results at http://nmap.org/submit/.
```

```
Nmap done: 1 IP address (1 host up) scanned in 3.64 seconds
```



# Detecting The Operating System

## Active Operating System Detection

- Countermeasures
  - **Detection**
    - They can detect scan with an option set (e.g. SYN)
    - Use Snort, Scanlogd, ecc.
  - **Prevention**
    - Change unique stack characteristic (not recommended)
    - secure proxy or firewall, Active Defence

# Detecting The Operating System

## Active Operating System Detection

- Useful info for vulnerability mapping
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  - Scanning available ports: some services are OS specific!
  - Stack fingerprinting: TCP/IP stack implementation
- Making guess from available ports
  - Windows: ports 135, 139, 445 (139 only for Windows 95/98); 3389 for RDP (Remote Desktop Protocol)
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- Active stack fingerprinting (Phrack Magazine)
  - Vendors interpret RFCs differently when writing TCP/IP stack
  - **Nmap** -O: signature listing at [Nmap-os-fingerprints](#)
    - FIN probe (Windows 7/200x/Vista respond with FIN/ACK), Bogus flag probe, Initial Sequence Number sampling, “Don’t fragment bit” monitoring, TCP initial window size, ACK value (+0 or +1), ICMP message quenching, ICMP message quoting, ICMP message echoing integrity, TOS, fragmentation handling, TCP options
- Countermeasures
  - Detection: same detection tools: Snort, Scanlogd, ecc.
  - Prevention: secure proxy or firewall, Active Defence



# PHRACK

::: Project Loki: ICMP Tunneling :::

Issues: [ 1 ] [ 2 ] [ 3 ] [ 4 ] [ 5 ] [ 6 ] [ 7 ] [ 8 ] [ 9 ] [ 10 ] [ 11 ] [ 12 ] [ 13 ] [ 14 ] [ 15 ] [ 16 ] [ 17 ] [ 18 ] [ 19 ] [ 20 ] [ 21 ] [ 22 ] [ 23 ]  
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# TCP/IP Stack Fingerprint

The TCP/IP fields that may vary include the following:

- Initial packet size (16 bits)
- Initial TTL (8 bits)
- Window size (16 bits)
- Max segment size (16 bits)
- Window scaling value (8 bits)
- "don't fragment" flag (1 bit)
- "sackOK" flag (1 bit)
- "nop" flag (1 bit)

These values may be combined to form a 67-bit signature, or fingerprint, for the target machine. Just automatically checking the Initial TTL and window size fields is often enough in order to successfully identify an operating system.

# Detecting The Operating System

## Passive Operating System Detection

- To be stealthy to IDS: passive
- Passive stack fingerprinting
  - At a central location or a port with packet capture (by port mirroring)
  - **Siphon**: a passive port-mapping, OS identification, and network topology tool
    - Passive signatures in **osprints.conf**
      - TCP/IP session: TTL, window size, DF (Don't Fragment), etc.
  - Tend to fail if: (1) applications build their own packets, (2) not able to capture packets, (3) a remote host changes the connection attributes (active detection also fails on this)
- Countermeasures
  - Same as OS detection countermeasures

# Attack Example

- First, we telnet from the system shadow (192.168.1.10) to quake (192.168.1.11)

```
[shadow]# telnet 192.168.1.11
```

- Then, sniff packet using **snort**

```
06/04-11:23:48.297976 192.168.1.11:23 →> 192.168.1.10:2295  
TCP TTL:255 TOS:0x0 ID:58934 DF  
**S***A* Seq: 0xD3B709A4 Ack: 0xBE09B2B7 Win: 0x2798  
TCP Options => NOP NOP TS: 9688775 9682347 NOP WS: 0 MSS: 1460
```

- Let us look at the siphon signature fingerprinting database

```
[shadow] # grep -i solaris osprints.conf  
# Window:TTL:DE: Operating System DE = 1 for ON, 0 for OFF.  
2328:255:1:Solaris 2.6 - 2.7  
2238:255:1:Solaris 2.6 - 2.7  
2400:255:1:Solaris 2.6 - 2.7  
2798:255:1:Solaris 2.6 - 2.7  
FE88:255:1:Solaris 2.6 - 2.7  
87C0:255:1:Solaris 2.6 - 2.7  
FAFO:255:0: Solaris 2.6 - 2.7  
FEFF:255:1:Solaris 2.6 - 2.7
```

- If we use **siphon**, we can see the OS matching as Solaris

```
[crush]# siphon -v -i x10 -o fingerprint.out  
Running on: 'crush' running FreeBSD 4.0-RELEASE on a(n) i386  
Using Device: x10  


| Host         | Port | TTL | DF | Operating System  |
|--------------|------|-----|----|-------------------|
| 192 168 1 11 | 23   | 255 | ON | Solaris 2.6 - 2.7 |


```

# Processing and Storing Scan Data

- Efficiency in managing scan data → speed to compromise a large number of systems
- **Metasploit**
  - A vast platform of tools, payload, and exploits
  - **PostgreSQL** for database
  - **db\_connect**: tells metasploit how to connect to database and which database to use

```
msf > db connect postgres:<password>@localhost: <port>/msf3
```
  - **db\_nmap** (root required): run Nmap scans
    - Metasploit could scan but slower than Nmap
  - **db\_import**: import Nmap results into database, commands:
    - **hosts**: show hosts and their OS
    - **services**: show all available ports and services
    - Filtering (-s) to see, e.g., all hosts with SSH or running Windows 2008

msI > **db\_nmap 192.168.1.0/24**

[\*] Nmap: Starting Nmap 5.51SVN (<http://nmap.org>) at 2011-09-26 10:47 PDT

[\*] Nmap: 22/tcp open ssh

[\*] Nmap: Nmap done: 256 IP addresses (21 hosts up) scanned in 19.00 seconds

msf

[\*] Nmap: Nmap scan report for 192.168.1.12

[\*] Nmap: Host is up (0.0028s latency).

[\*] Nmap: Not shown: 997 filtered ports

[*] Nmap:	PORT	STATE	SERVICE
-----------	------	-------	---------

[*] Nmap:	80/tcp	open	http
-----------	--------	------	------

[*] Nmap:	443/tcp	open	https
-----------	---------	------	-------

[*] Nmap:	2869/tcp	open	icslap
-----------	----------	------	--------

< Output shortened for brevity >

[\*] Nmap: Nmap scan report for 192.168.1.13

[\*] Nmap: Host is up (0.063s latency).

```
msf > sudo nmap -0 192.168.1.0/24 -oX subnet 192.168.1.0-OS
[*] exec: sudo nmap -0 192.168.1.0/24 -oX subnet 192.168.1.0-OS
[sudo] password for user:
Starting Nmap 5.51 (http://nmap.org) at 2011-09-26 11:00 PDT
Nmap scan report for 192.168.1.12
Host is up (0.0033s latency).
Not shown: 997 filtered ports
PORT      STATE SERVICE
80/tcp    open  http
< Output shortened for brevity >
OS details: Linux 2.6.19 - 2.6.36
Network Distance: 0 hops
msf >
```

```
ms > db import subnet 192.168.1.0-0S
[*] Importing 'Nmap XML' data
[*] Import: Parsing with 'Nokogiri v1.4.3.1'
[*] Importing host 192.168.1.12
< Output shortened for brevity >
[*] Importing host 192.168.1.25
[*] Successfully imported
/home/elec/subnet_192. 168.1.0-0S msf>
```



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