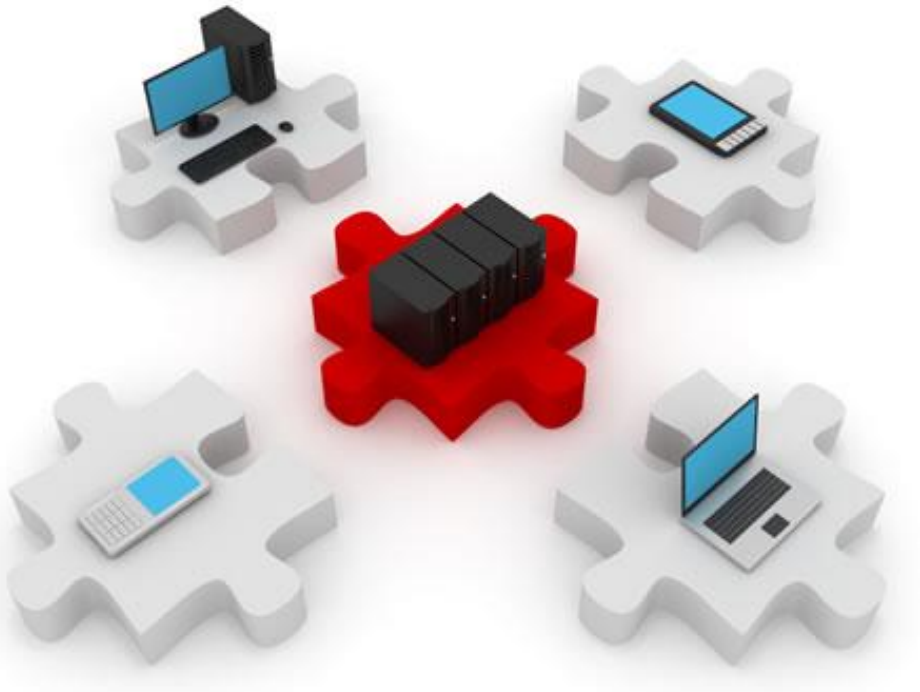
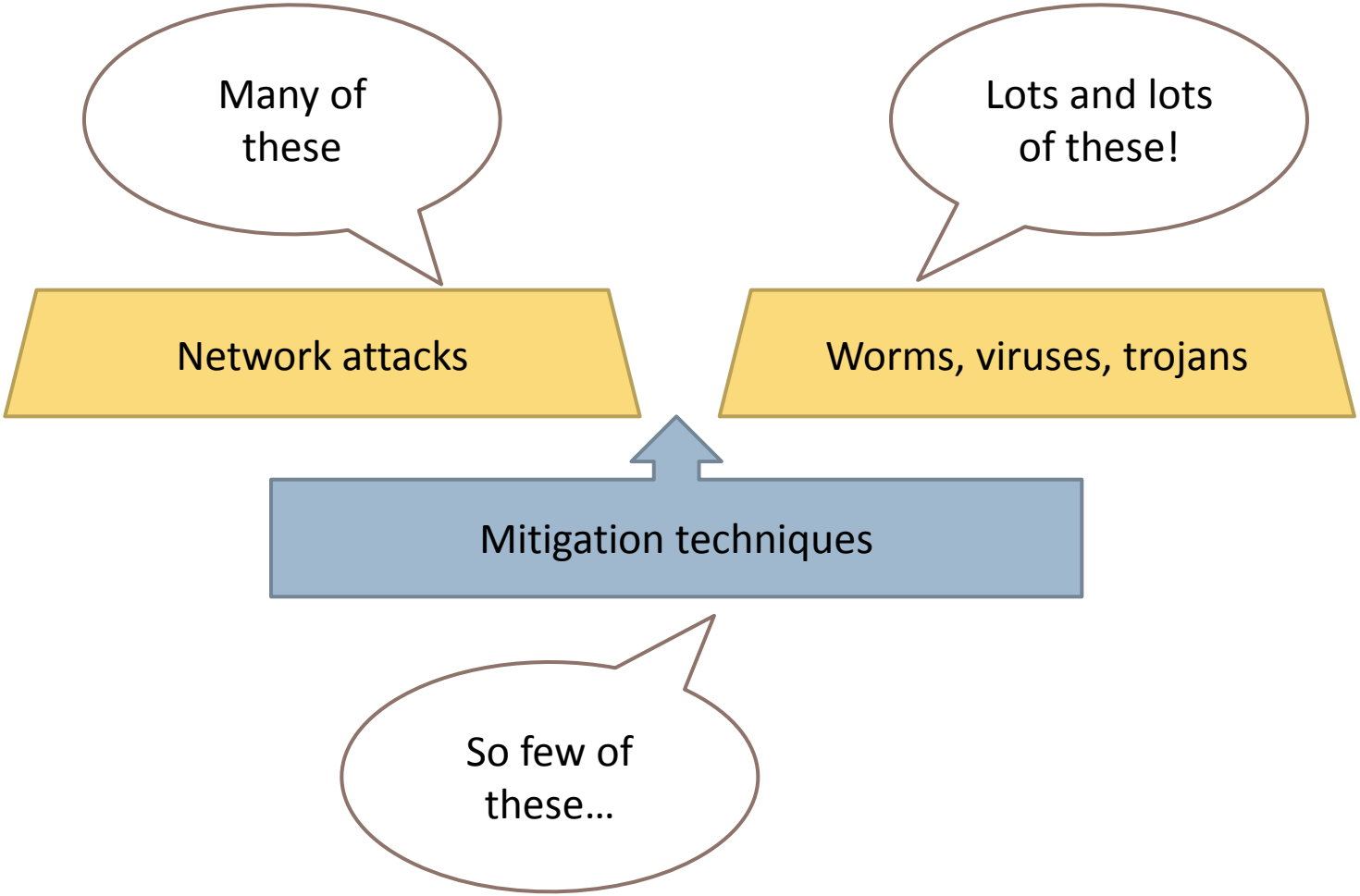


# Network Attacks

October 14, 2014

# What's threatening us?



# What type of network attacks are there?

- Reconnaissance attacks

- Access attacks

- Denial-of-service attacks

# Reconnaissance attacks

- First of all: find what to attack
- Get as much info as possible on your target
- Even public information can be useful.

- Purpose: identifying possible vulnerabilities

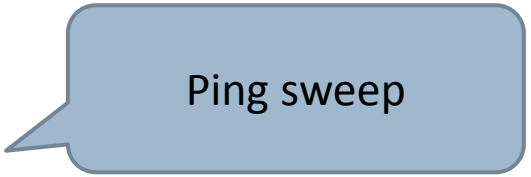
- Similar to a thief surveying a neighborhood for vulnerable homes to break into or cars to steal.

# Reconnaissance attacks – hosts and ports

- First step – identify the vulnerable services
- How?
  - Perform a ping sweep to determine active hosts in a network
  - Obtain information about the operating system running on the active hosts
  - Scan active hosts for open ports to determine what services are running
    - Open ports often provide information about the service's version
- Vulnerable services are identified and can be exploited

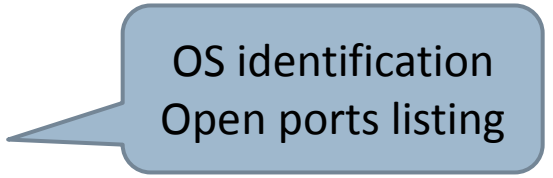
- Port scanners: nmap, nessus

# Nmap example #1




```
linux$ sudo nmap -sP 141.85.37.0/24
Starting Nmap 5.00 ( http://nmap.org ) at 2009-10-09 18:12 EEST
Host csr.cs.pub.ro (141.85.37.1) is up (0.00040s latency).
     MAC Address: 00:09:6B:89:06:67 (IBM)
Host ns.catc.ro (141.85.37.2) is up (0.00097s latency).
     MAC Address: 00:17:31:49:3A:E4 (Asustek Computer)
Host prof.cs.pub.ro (141.85.37.3) is up (0.00043s latency).
     MAC Address: 00:09:6B:89:05:24 (IBM)
Host turing.cs.pub.ro (141.85.37.7) is up (0.00089s latency).
     MAC Address: 00:50:56:9A:33:46 (VMWare)
Host ns.cs.pub.ro (141.85.37.8) is up (0.00028s latency).
     MAC Address: 00:09:6B:89:06:67 (IBM)
Host ef001.cs.pub.ro (141.85.37.9) is up (0.00088s latency).
     MAC Address: 00:15:5D:25:14:00 (Microsoft)
Host dnscache.cs.pub.ro (141.85.37.11) is up (0.00047s latency).
     MAC Address: 00:09:6B:89:06:67 (IBM)
Host xeno.cs.pub.ro (141.85.37.12) is up (0.00088s latency).
     MAC Address: 00:50:56:9A:51:6D (VMWare)
Host nix.cs.pub.ro (141.85.37.13) is up (0.00088s latency).
     MAC Address: 00:EE:B1:03:0A:DE (Unknown)
```

# Nmap example #2



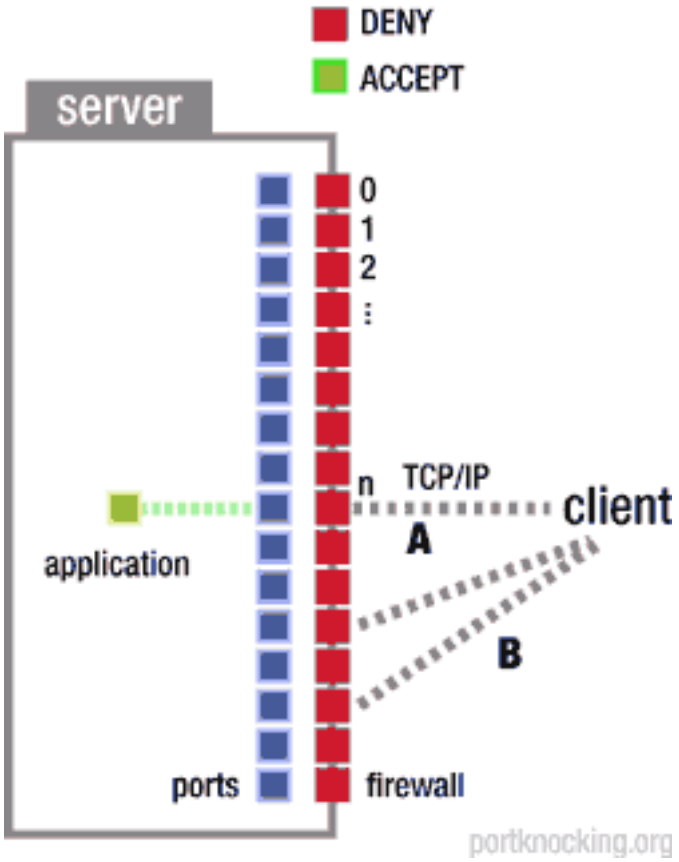

```
linux$ sudo nmap -sS -O 141.85.37.132
Starting Nmap 5.00 ( http://nmap.org ) at 2009-10-09 18:21 EEST
Interesting ports on dhcp-132.cs.pub.ro (141.85.37.132):
Not shown: 996 closed ports
PORT     STATE SERVICE
88/tcp   open  kerberos-sec
139/tcp  open  netbios-ssn
445/tcp  open  microsoft-ds
3323/tcp open  unknown
Device type: general purpose
Running: Apple Mac OS X 10.5.X
OS details: Apple Mac OS X 10.5 - 10.5.6 (Leopard) (Darwin 9.0.0 - 9.6.0)

OS detection performed. Please report any incorrect results at
http://nmap.org/submit/ .
Nmap done: 1 IP address (1 host up) scanned in 11.16 seconds
```

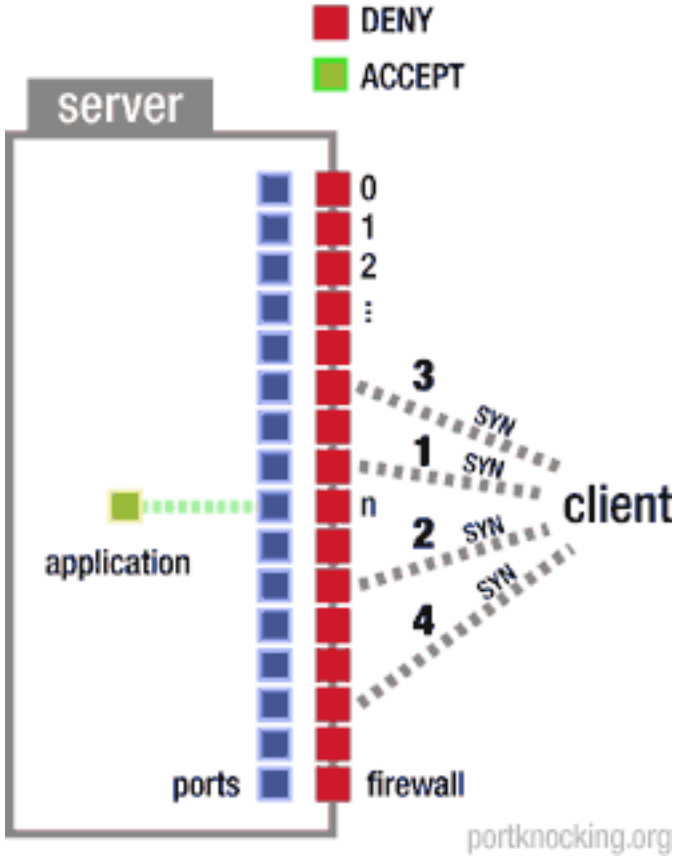
# How to avoid port scanning?

- Theoretically, you cannot
- All open ports **will be detected**
- How can you hide it then?
- Answer: Port Knocking
  - By default, the desired port is closed
  - The client sends a set of SYN packets in a certain order
  - A daemon listens for a specific sequence of SYN packets sent to closed ports
  - If the sequence is correct, the desired port will be open and the “knocker” will be allowed to send data
- Of course, the client has to know the “knock” sequence

# Port knocking phases

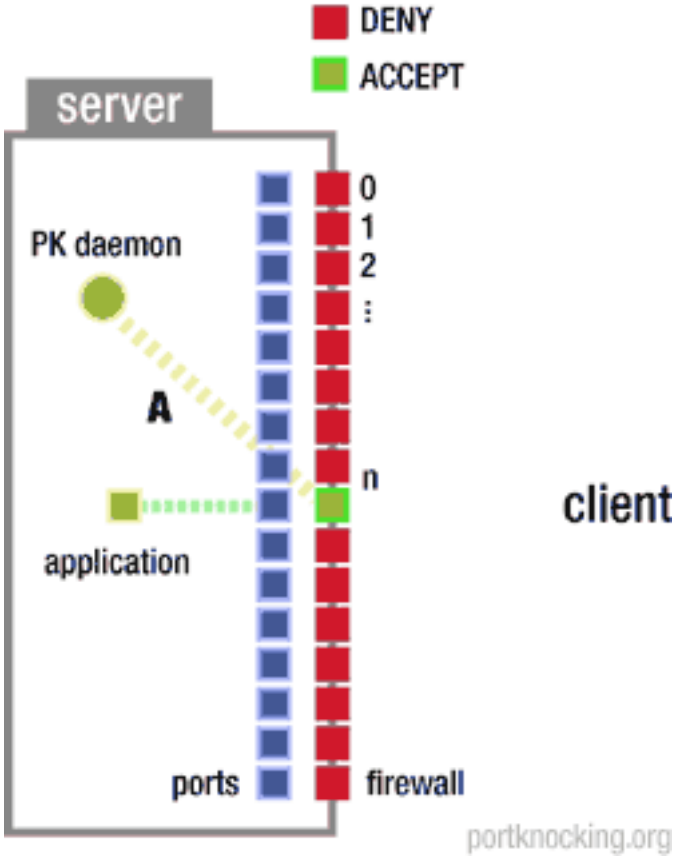



A) The client cannot connect to the application. The client cannot establish a connection to any port.

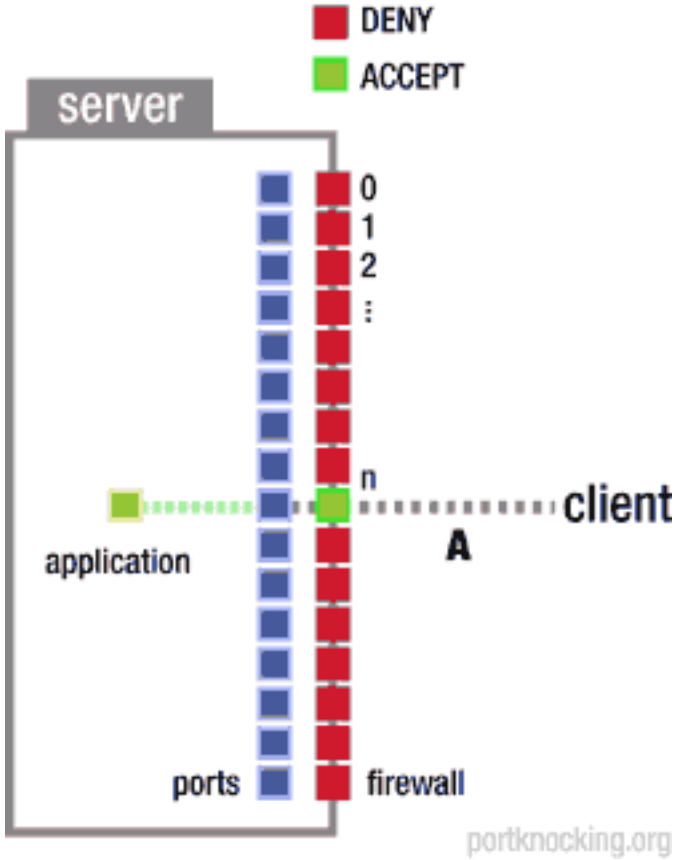



B) The client attempts connection to a number of ports in a predefined sequence. Client receives no ACKs.

# Port knocking phases




C) The PK daemon interprets the attempts and carries out a task. For example, it opens a specific port (n).




D) The client can now connect to port n.

# Reconnaissance attacks – who is running what?

- To sum up: Who is providing the information?
  - Ping sweeps determine which hosts are “alive”
  - Port scanning determines which services are running
    - Well-known services run on well-known ports (TCP and UDP)
  - Telnetting to an open port will most likely return a banner informing you of the service running on that port.

```
linux$ telnet cs.pub.ro 22
Trying 141.85.37.5...
Connected to cs.pub.ro.
Escape character is '^]'.
SSH-2.0-OpenSSH_5.1p1 Debian-5
```

There’s your version

# The version issue

- Hiding the service's version is NOT REALLY helpful…
  - Hackers usually try all the exploits they have
  - If your version has a vulnerability, it's still there

- Not all services allow you to modify it
  - Open SSH doesn't allow it, by default
    - You need to edit and recompile the sources or…

… use a commercial version

- Some services allow it and it's quite simple
  - For example, `vsftpd`'s configuration file:

```
ftpd_banner=....
```

# Reconnaissance attacks – packet sniffing

- Sniffing random traffic can also provide useful information about the network and its services
- **Promiscuous mode** sniffing
  - The network card will process traffic that is normally dropped
  - The OS has to "agree" with this – not all OS'es support it

- Listening:

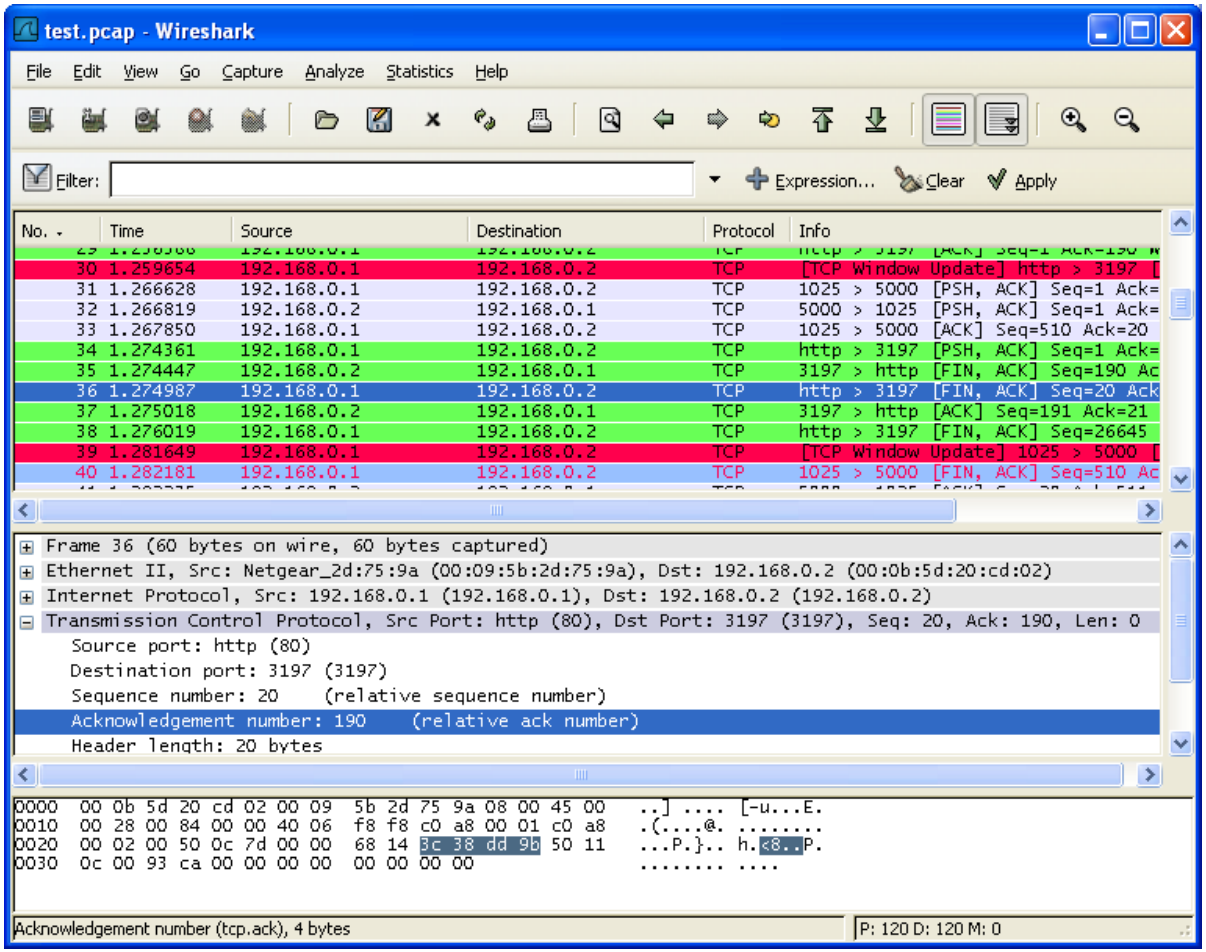
| Shared network (no switches) | Switched network |
|---|---|
| Traffic between any two hosts is seen by all (shared segment, hubs). | Traffic is isolated at switchport level. |

- Packet sniffers: Wireshark, tcpdump

# Wireshark

- General-purpose protocol analyzer
  - Displays the entire content of packets passing through the network adapter.
  - Identifies a great range of protocols: from data link layer to application layer.
  - Can follow streams of data based on TCP sequence numbers.
  - Can define filters, save results.
  - Can perform VoIP analysis.
  - Supports 802.11, PPP, ATM, Bluetooth, etc.
  - Displays IPsec, WEP, WPA(2) as decrypted.
  - Multi-platform

# Wireshark interface

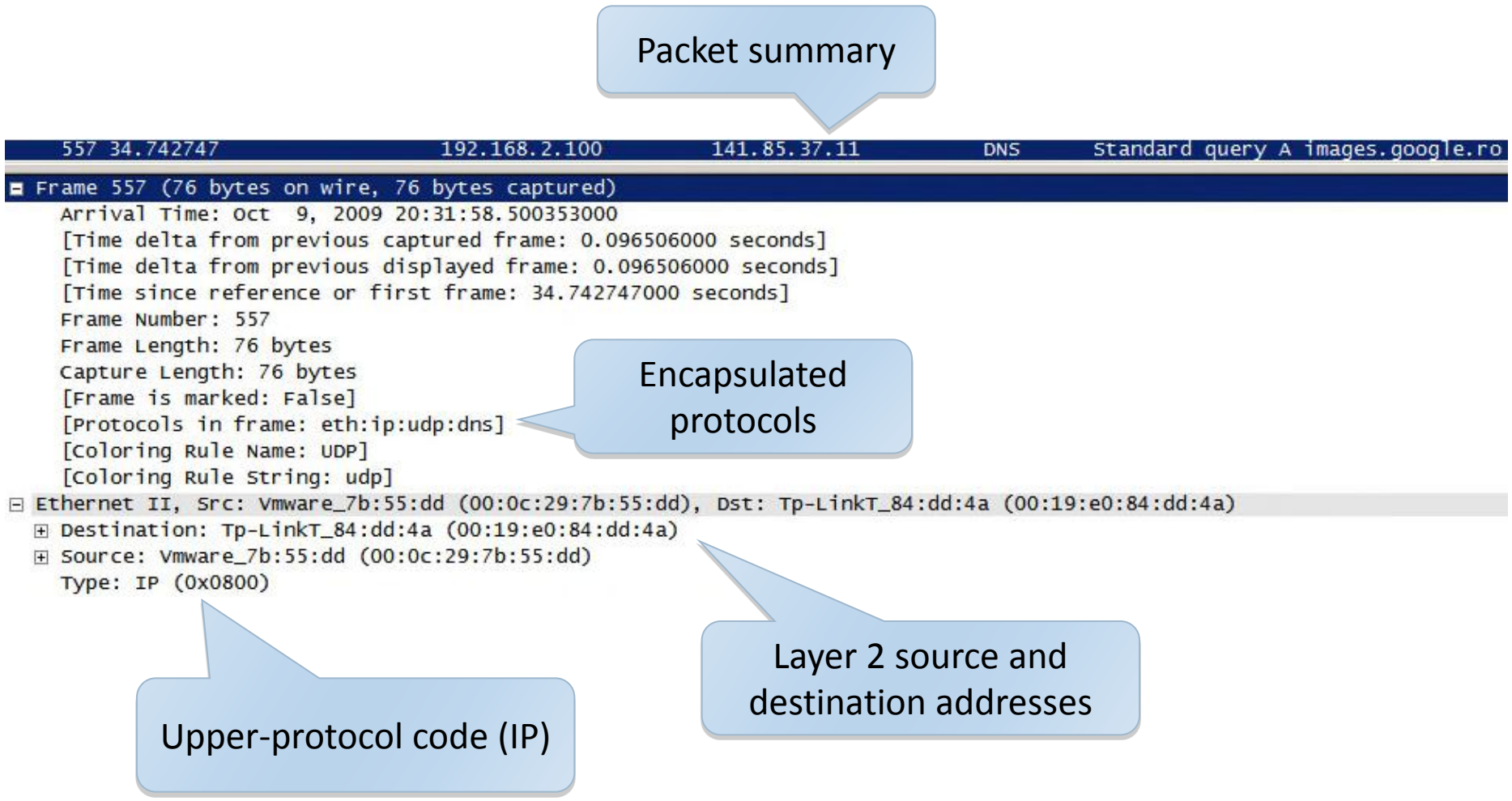



Summary of captured packets

Detailed tree-view of encapsulated protocols

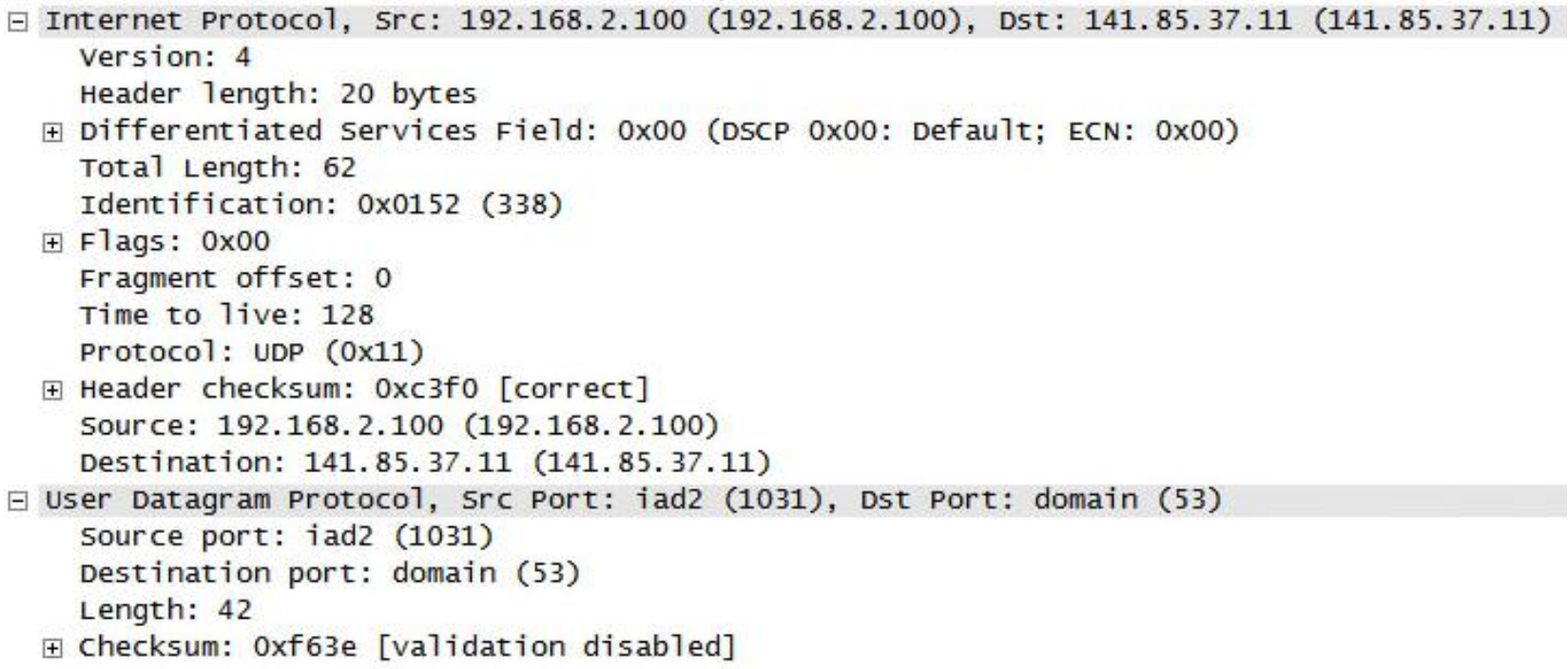
Hex/ASCII view of packets

# Wireshark – DNS query example (Layer 2)



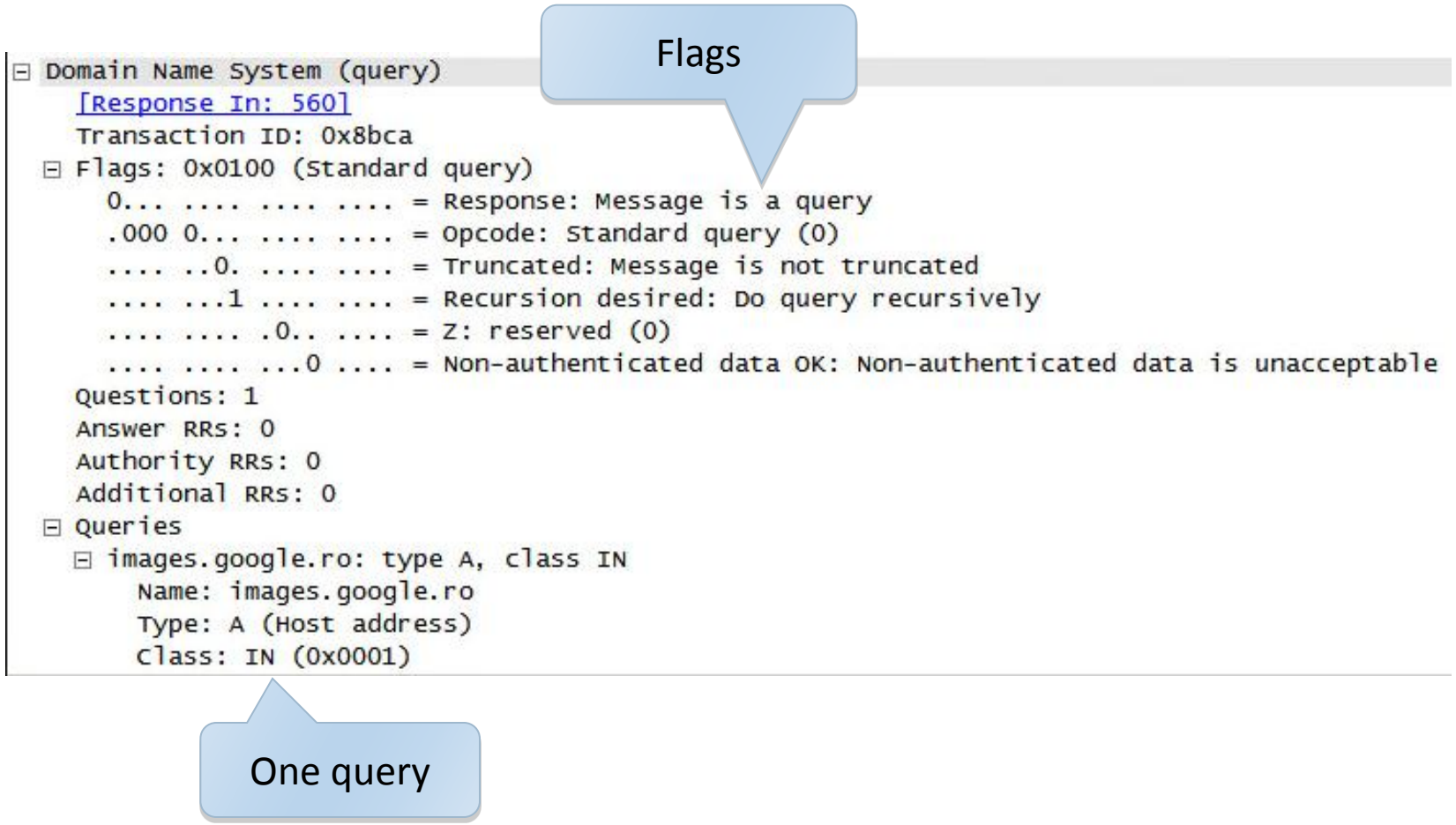
# Wireshark – DNS query example (Layers 3 and 4)

IP header; source and destination addresses




UDP header; source and destination ports

# Wireshark – DNS query example (Application)



# Tcpdump short quiz

- Enter the command for capturing 10 packets:

```
linux$ sudo tcpdump -i en1 -c 10
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on en1, link-type EN10MB (Ethernet), capture size 96 bytes
20:58:04.947521 IP 192.168.2.102.65193 > 64.236.76.160.http: FP 3351223874:3351224692(818) ack
    3791731684 win 65535
20:58:05.048363 IP 192.168.2.102.64948 > cs111.msg.sp1.yahoo.com.mmcc: P 3808254532:3808254567(35)
    ack 1468375673 win 65535 <nop,nop,timestamp 1041121821 2502504253>
20:58:05.154875 IP 192.168.2.102.64397 > dnscache.cs.pub.ro.domain: 23404+ PTR? 160.76.236.64.in-
    addr.arpa. (44)
20:58:05.928980 IP dnscache.cs.pub.ro.domain > 192.168.2.102.64397: 23404 NXDomain 0/1/0 (110)
20:58:05.931073 IP 192.168.2.102.60327 > dnscache.cs.pub.ro.domain: 4591+ PTR? 16.217.180.68.in-
    addr.arpa. (44)
20:58:06.236795 IP dnscache.cs.pub.ro.domain > 192.168.2.102.60327: 4591 1/5/5 (251)
20:58:06.648490 arp who-has 192.168.2.112 tell 192.168.2.103
20:58:06.649205 arp who-has 192.168.2.113 tell 192.168.2.103
20:58:07.239861 IP 192.168.2.102.55585 > dnscache.cs.pub.ro.domain: 9323+ PTR? 112.2.168.192.in-
    addr.arpa. (44)
20:58:09.053072 IP 192.168.2.102.64948 > cs111.msg.sp1.yahoo.com.mmcc: P 0:35(35) ack 1 win 65535
    <nop,nop,timestamp 1041121861 2502504253>
10 packets captured
20 packets received by filter
0 packets dropped by kernel
```

# Tcpdump short quiz

- Enter the command for capturing 10 http requests:

**linux$ sudo tcpdump -i en1 -c 10 dst port 80**

```
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode

listening on en1, link-type EN10MB (Ethernet), capture size 96 bytes

21:04:27.331834 IP 192.168.2.102.65285 > f36.ymdb.vip.sp2.yahoo.com.http: S 3835386219:3835386219(0)
    win 65535 <mss 1460,nop,wscale 3,nop,nop,timestamp 1041125640 0,sackOK,eol>

21:04:27.541264 IP 192.168.2.102.65285 > f36.ymdb.vip.sp2.yahoo.com.http: . ack 346088808 win 65535
    <nop,nop,timestamp 1041125642 3613110350>

21:04:27.541458 IP 192.168.2.102.65285 > f36.ymdb.vip.sp2.yahoo.com.http: P 0:184(184) ack 1 win
    65535 <nop,nop,timestamp 1041125642 3613110350>

21:04:27.796773 IP 192.168.2.102.65250 > 65.55.12.249.http: P 4197506267:4197507391(1124) ack
    211762492 win 65535

21:04:27.860367 IP 192.168.2.102.65285 > f36.ymdb.vip.sp2.yahoo.com.http: . ack 2897 win 65535
    <nop,nop,timestamp 1041125645 3613110562>

21:04:28.076775 IP 192.168.2.102.65285 > f36.ymdb.vip.sp2.yahoo.com.http: . ack 5793 win 65522
    <nop,nop,timestamp 1041125648 3613110879>

21:04:28.232615 IP 192.168.2.102.65250 > 65.55.12.249.http: . ack 4381 win 65535

21:04:28.236517 IP 192.168.2.102.65250 > 65.55.12.249.http: . ack 7301 win 65535

21:04:28.244273 IP 192.168.2.102.65250 > 65.55.12.249.http: . ack 10221 win 65535

21:04:28.260835 IP 192.168.2.102.65285 > f36.ymdb.vip.sp2.yahoo.com.http: . ack 7241 win 65535
    <nop,nop,timestamp 1041125649 3613110879>
```

# Tcpdump short quiz – Boss ☺

- Enter the command for capturing and saving to a file all the packets that are not intended for web servers and with numerical address format:

```
$ tcpdump -ni eth0 -w file.cap not port 80
```

- Enter the command for displaying the capture file:

```
$ tcpdump -r file.cap
```

# Reconnaissance attacks – “whois” information

- Internet information queries: **`whois cisco.com`**

Domain Name..... cisco.com
Creation Date..... 1987-05-14
Registration Date.... 2011-04-06
Expiry Date..... 2013-05-16
Organisation Name.... Cisco Technology, Inc.
Organisation Address. 170 W. Tasman Drive
Organisation Address.
Organisation Address.
Organisation Address. San Jose
Organisation Address. 95134
Organisation Address. CA
Organisation Address. UNITED STATES
Admin Name..... Info Sec
Admin Address..... 170 West Tasman Drive
Admin Address.....
Admin Address.....
Admin Address. San Jose
Admin Address..... 95134
Admin Address..... CA
Admin Address..... UNITED STATES
Admin Email..... infosec@cisco.com
Admin Phone..... +1.4085273842
Admin Fax..... +1.4085264575
Tech Name..... Network Services
Tech Address..... 170 W. Tasman Drive
Tech Address.....
Tech Address.....
Tech Address..... San Jose
Tech Address..... 95134
Tech Address..... CA
Tech Address..... UNITED STATES
Tech Email..... dns-info@cisco.com
Tech Phone..... +1.4085279223
Tech Fax..... +1.4085267373
Name Server..... NS1.CISCO.COM
Name Server..... NS2.CISCO.COM

Whois.Net℠
DOMAIN-BASED RESEARCH SERVICES

# Reconnaissance attacks – DNS information

- Listing mail servers

```
linux$ host -t MX cisco.com
cisco.com mail is handled by 25 syd-inbound-a.cisco.com.
cisco.com mail is handled by 10 sj-inbound-a.cisco.com.
cisco.com mail is handled by 10 sj-inbound-b.cisco.com.
cisco.com mail is handled by 10 sj-inbound-c.cisco.com.
cisco.com mail is handled by 10 sj-inbound-d.cisco.com.
cisco.com mail is handled by 10 sj-inbound-e.cisco.com.
cisco.com mail is handled by 10 sj-inbound-f.cisco.com.
cisco.com mail is handled by 15 rtp-mx-01.cisco.com.
cisco.com mail is handled by 20 ams-inbound-a.cisco.com.
```

- Listing name servers

```
linux$ host -t NS cs.pub.ro
cs.pub.ro name server ns.cs.pub.ro.
cs.pub.ro name server pub.pub.ro.
```

# Access attacks

- Exploit known vulnerabilities
- Target services that (normally) do not offer access to everyone
- This is where password breaking comes into play
- Purpose: to gain access to servers, accounts and confidential data
  - basically: to steal or destroy stuff

- What do you think is the motivation behind:
  - Information theft
  - Destruction of information

# Types of access attacks

- Password attack – dictionary or brute-force
- Trust exploitation – unauthorized use of privileges
- Port redirection – compromised system used to attacks other targets
  - Must have an intrusion tool installed on the system
- Man-in-the-middle attack
  - The attacker intercepts all communications between peers
  - Purpose: to read traffic and/or to alter it
- Buffer overflow
  - Sending data to a program beyond its allocated buffer
  - Valid data gets overwritten – enables other functions

# Detecting access attacks

- Logs – look for failed and repeated logins attempts
  - Do not allow unlimited failed login attempts => brute-force
- Unusually high network traffic: Possible MiTM attack
  - MiTM attacks replicate data
- High CPU load, program crashes
  - Possible buffer overflow

# Mitigating access attacks

- The basics: sTr0ng! P4$$w0rdz!
- Strong authentication and encryption make sniffing very little effective
  - Example: one-time-password (banking)
  - Vital business traffic should be encrypted
  - Network management traffic should be encrypted


- Switched networks isolate traffic
- Port scanning can be detected and stopped by IPS
- Deactivating ICMP prevents ping sweeps
  - But makes network troubleshooting more difficult

# Denial-of-service attacks

- Send many requests in a short timespan
- Purpose: to overwhelm the target application or computer and to prevent it from processing normal requests.
- DoS attacks can crash and slow down processes

- DDoS = Distributed Denial of Service
  - Sends many requests from several sources at a time

# DoS attacks

- DoS attacks rely on the fact that servers must maintain state information
  - That is, servers use memory for each request, until it is completed
- Servers might not be able to differentiate between legitimate requests and flooded requests.
  - Hard to avoid
- Many tools available
  - Very simple to conduct

# Identifying DoS (and other attacks)

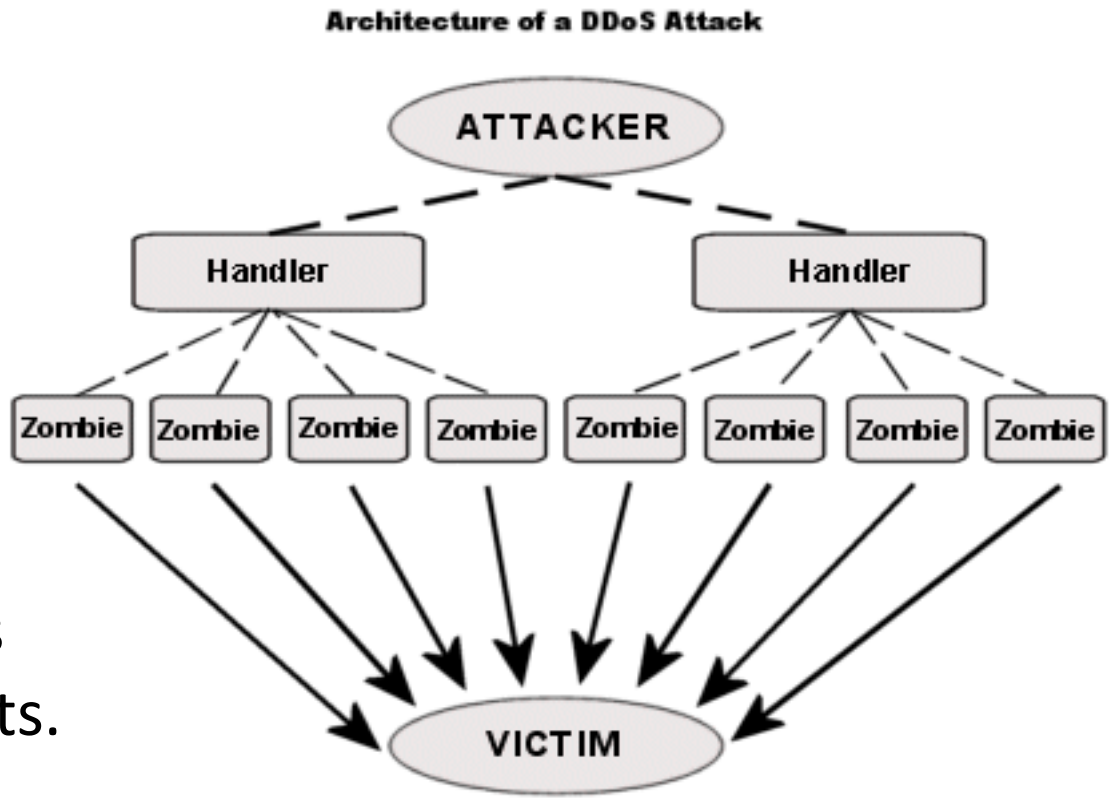
- Each network MUST have a benchmark of:
  - Total bandwidth utilization
  - Bandwidth usage per protocol
  - Protocols active in the network
  - Hardware load
    - For hosts
    - For network devices
    - Servers

- All the above measured for different times of the day

- These statistics can be used to detect anomalies
  - Anomalies can represent attacks

# DDoS

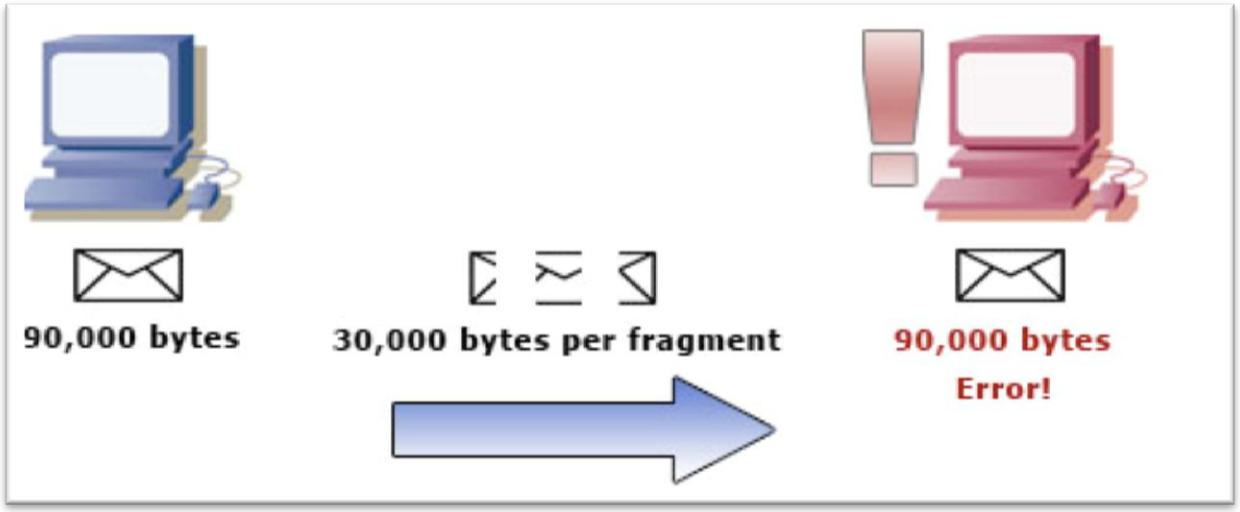
Handlers = “masters”
Zombies = “slaves”




- Handlers and zombies are compromised hosts.
- Once started, much harder to stop than a DoS.
  - Why is it harder?

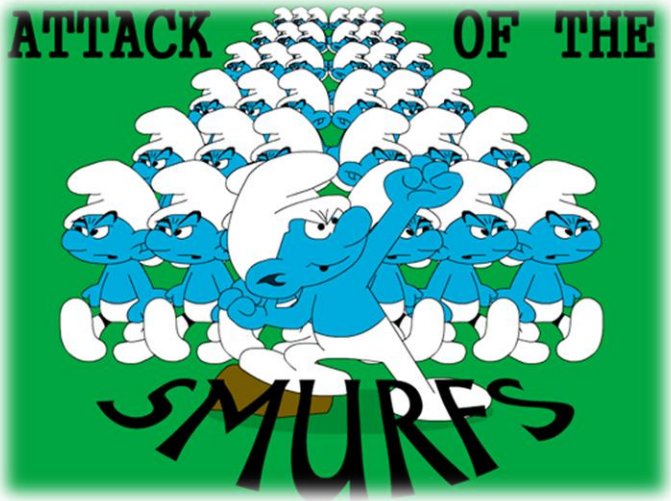
# Types of DoS attacks

- Ping of death (POD)
  - 10 years ago
  - IP packet with an echo request larger than 65535 bytes
  - It used to crash basically everything: Unix, Linux, Windows, Mac, routers and printers!
  - They've all been patched up until today.

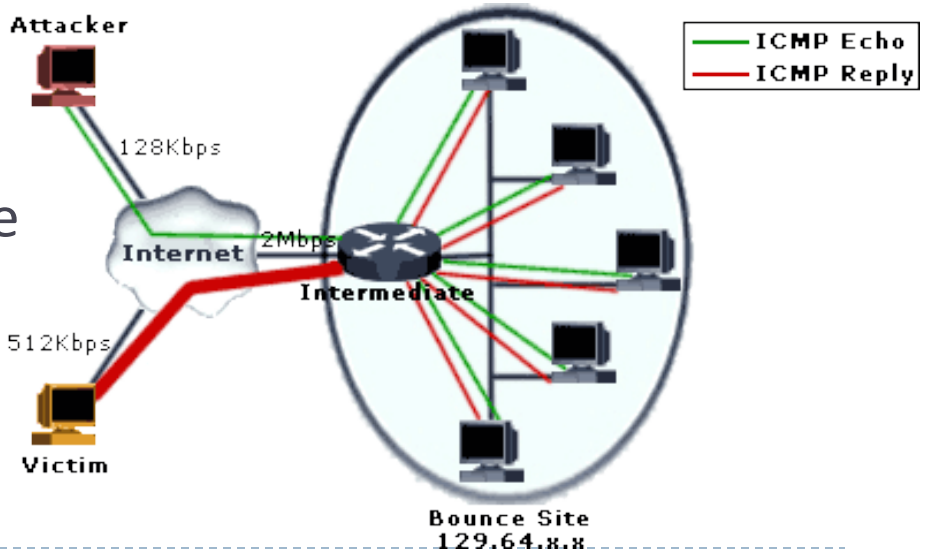


# Types of DoS attacks

- Smurf attack
  - Large number of ICMP requests (“smurfs” ☺ ) to a network’s broadcast address.
  - The source of the ICMP packets is spoofed




- Result:
  - All hosts reply with ICMP echo-reply packets.
  - The victim – the host having the address that was spoofed
  - Large networks could cause hundreds of hosts to generate traffic.



# Types of DoS attacks

- How to avoid smurf attacks?
  - Install a trap for the smurfs !!!

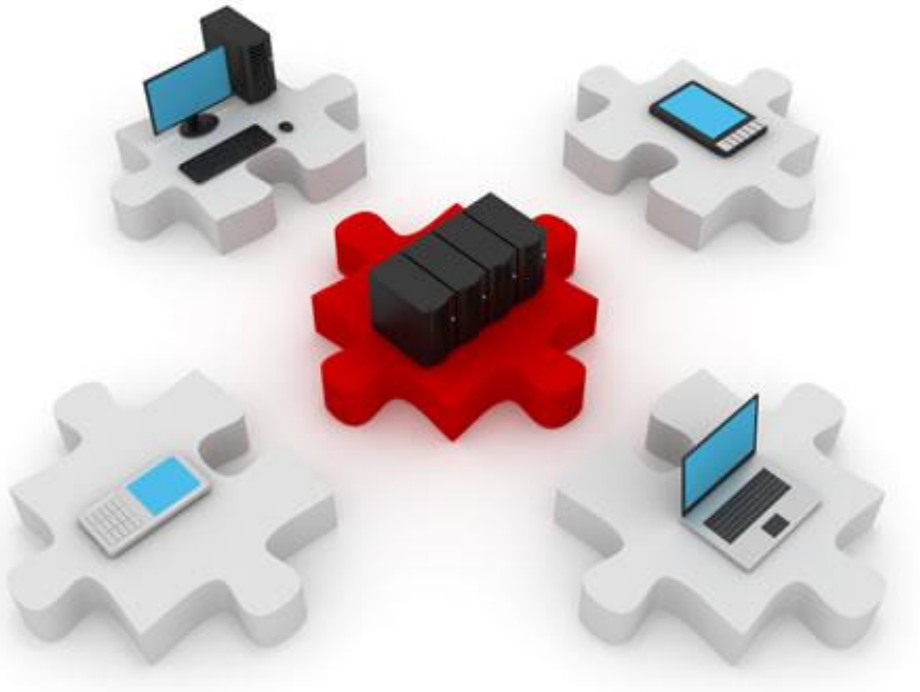
  - No, in fact it is much simpler than that
  - Routers must not allow directed broadcasts
  - Just to get a hint:

```
Router(config-if)# no ip directed-broadcast
```

    - And you're done
  - How simple is that? ☺

# TCP SYN Flood

- Sending a large number of TCP SYN packets
- Each packet is handled like a connection request
- The server sends back TCP SYN-ACK packets but does not receive responses to complete the three-way handshake
  - Result: Many half-open TCP connections
  - The server's connections become saturated
  - The server cannot respond to legitimate requests
- Solution: limit the number of half-open connections



# Malicious Software

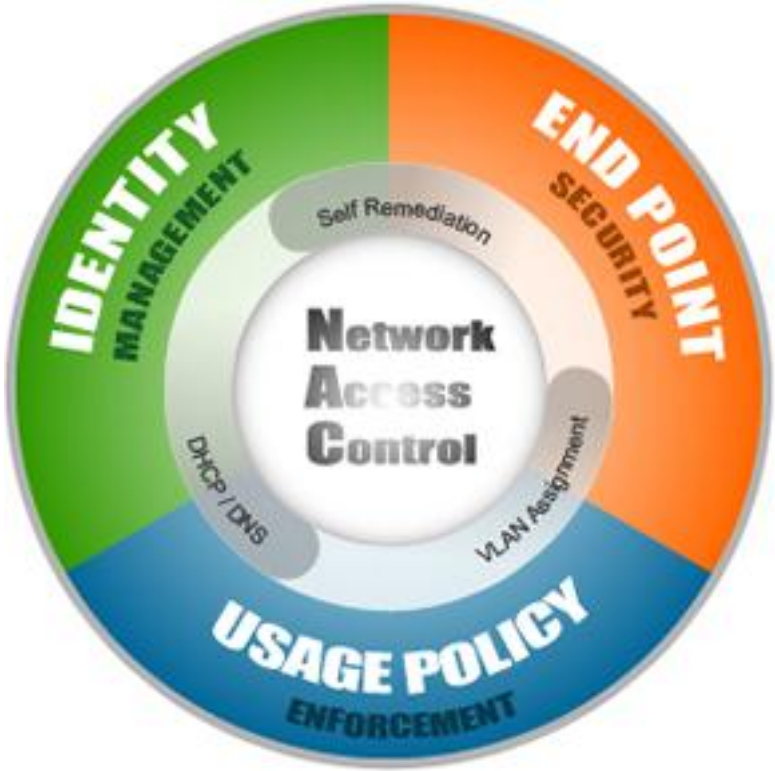
Viruses, worms, trojans and other species.

# Viruses

- Most harmful type of malware
- Code attached to legitimate programs
- Require user interaction with the infected file
- When activated, can spread to other files
- Infecting the operating system allows the virus to execute any code, with full administrative privileges
- Viruses spread by:
  - USB sticks
  - Network share
  - E-mail attachments
  - Downloaded files

# Virus mitigation techniques

- Updated antivirus software
- NAC implementation
  - NAC = Network Access Control
  - NAC: consider endpoint security prior to offering access
  - When a computer connects, it is completely isolated until it complies with a set of standards:
    - Valid identity
    - Anti-virus system
    - Firewall
    - System update
    - Other policies



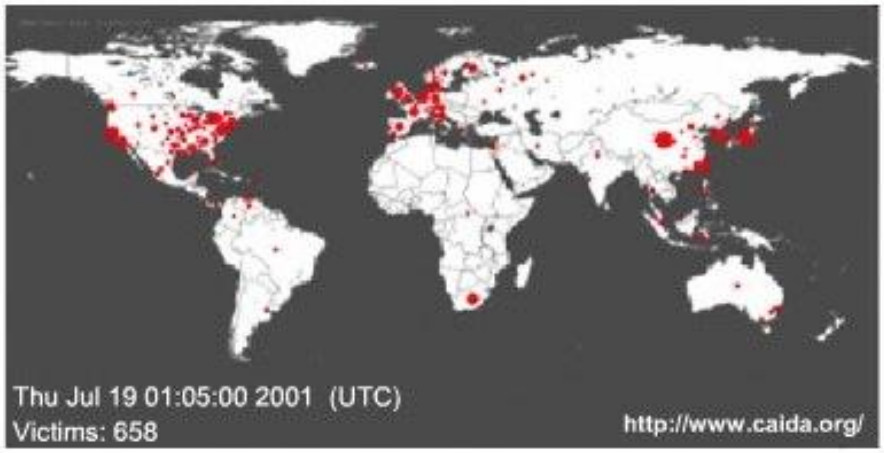
# Worms

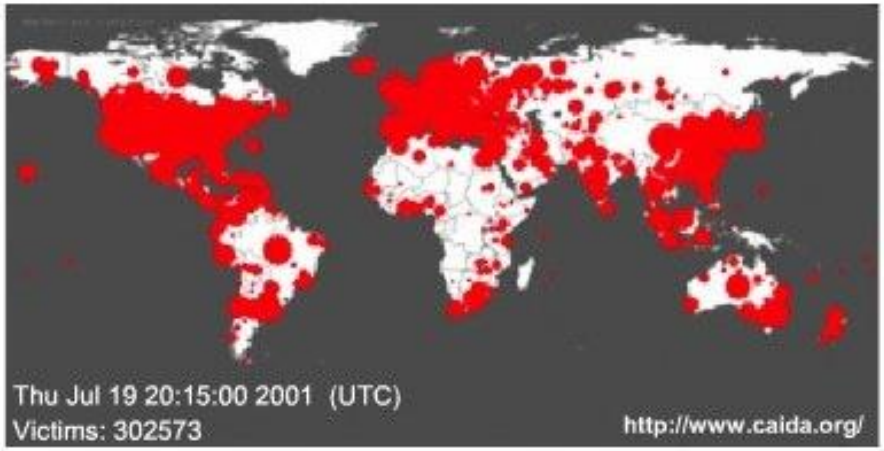
- User interaction not required, unlike viruses
- Not need to attach to other programs
- Worms have the ability to run and replicate by themselves on other hosts.
- Programmed to search for known vulnerabilities.
  - When found, they are exploited to allow the worm to propagate.

# Worm mitigation procedure

- Containment
  - Isolate infected parts of the network
  - Contain the worm's spread
- Inoculation
  - Patch all uninfected systems
  - Run a deep scan on uninfected systems
- Quarantine
  - Isolate each infected host from the network
- Treatment
  - Patch infected systems, if possible
  - Reinstall completely otherwise

# Example: SQL Slammer Worm (2001-2003)



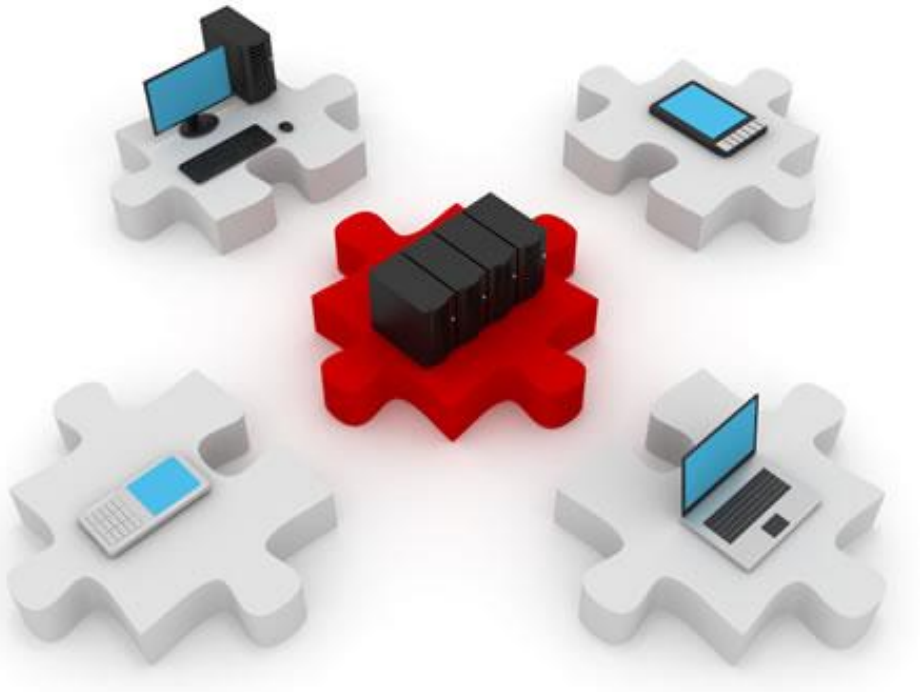

# Trojans

- Malicious code hidden behind a legitimate function or application.
- The program executes normally
- The trojan code runs in the background

- Most do not have immediate effect, but open backdoors.
- Can be designed for specific targets
  - extremely hard to detect

# Types of trojans

- Remote access trojan
  - Opens certain ports that provide remote access
- Data-sending trojan
  - Gathers information from the computer and sends them to a specific address
- Proxy trojan
  - Runs a proxy server in the background
- Security trojan
  - Stops antivirus and firewall software
- Destructive trojan (rare)
  - Deletes or corrupts files and programs



# Hackers

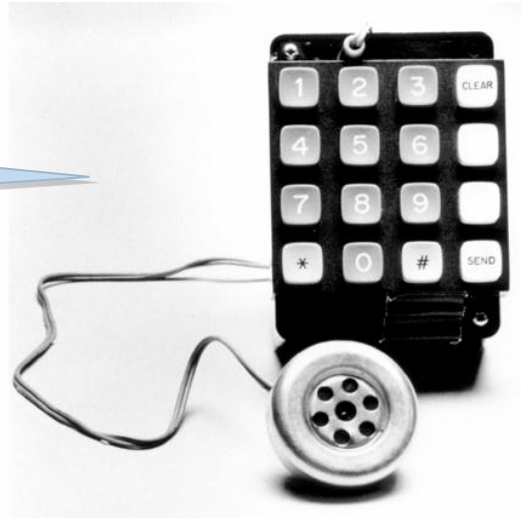
# Beginnings

- “Phreakers”
  - Started in 1960
  - Exploited switches from telephone companies using tone generators (“blue boxes”), to make long-distance calls
  - Later on, they managed to make their own phone numbers free to call
- “Wardialers”
  - Started in 1980, when dial-up modems were introduced
  - Dialed random numbers in search of modems then attempted to break the computer’s password
  - The “ancestor” of today’s ping sweep

# History fact:

- 1972: John Draper, soon to be known as "Captain Crunch," discovers that the plastic whistle in a box of breakfast cereal reproduces a 2600-hertz tone. With a blue box, the whistle unlocks AT&T's phone network, allowing free calls and manipulation of the network.

A “blue box” tone generator



# History fact:

- The first worm was created by… Xerox, in 1979
- Engineers created a short program that scanned the network for idle processors intending to provide more efficient computer use
- The scanning and replication mechanism is now used by modern destructive worms

# The meaning of “hacker”

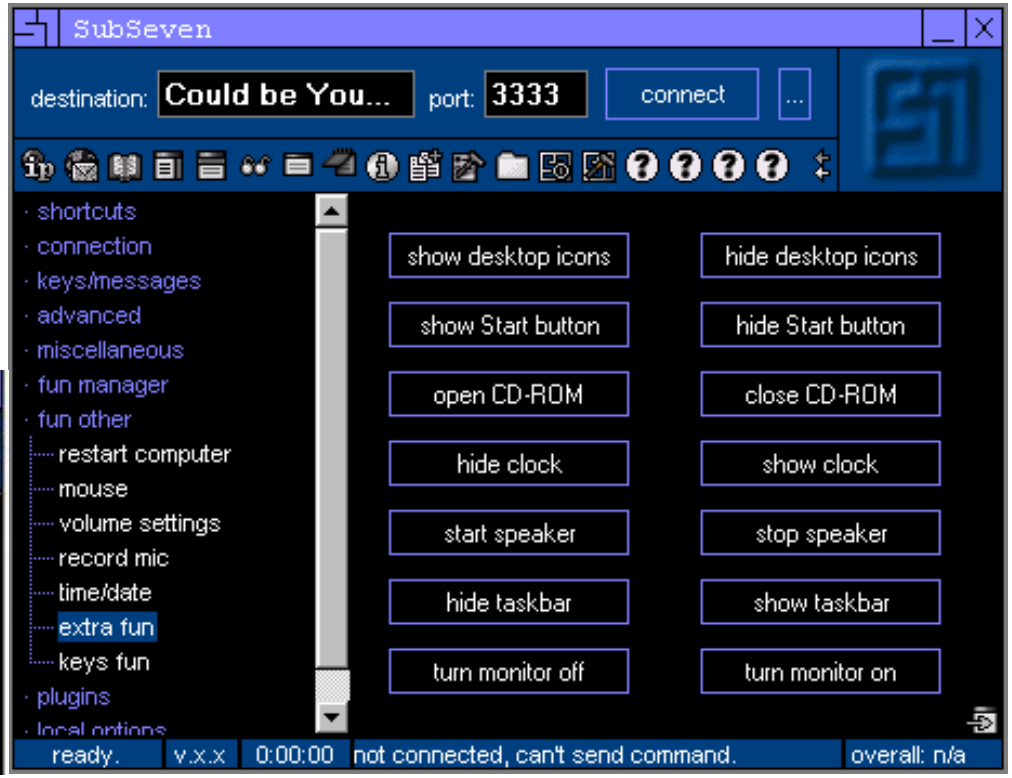
| Positive | Negative |
| --- | --- |
| • Network professional<br>• User of sophisticated tools<br>• Internet programming skills<br>• Security tester | • Gains unauthorized access<br>• Targets sensitive data<br>• Attempts to destroy data<br>• Restricts network access<br>• Slows or shuts down services |

# Hacker “flavors”

- White hat
  - Also known as “ethical hacker”
  - Breaks for non-malicious reasons, but for testing
  - Term for “security consultant”
- Black hat
  - Or “cracker”, illegally breaks computer security
  - Steals or compromises data
- Grey hat
  - Middle-ground between the above two
- Script kiddie
  - Has little understanding of security
  - Simply uses tools developed by other hackers
- Hacktivist
  - Hacks only to promote a message: ideological, political, etc.

# Tools: Sub7

- The “classic” script-kiddie tool for many years
- Client-server application
- Installs on victim computer and provides access to:
  - File system
  - Hardware devices
  - Operating system
  - Keylogger
  - Screen capture

# Tools: Project Metasploit

- Project for exploiting security vulnerabilities
- Sub-project: Metasploit Framework
  - Contains a database of several hundreds of known exploits for all operating systems
  - Tool for developing and executing exploit code on target machines


- Useful for:
  - Penetration testing
  - IDS signature development
  - Exploit research

# Tools: Metasploit

```
msf > show exploits
```

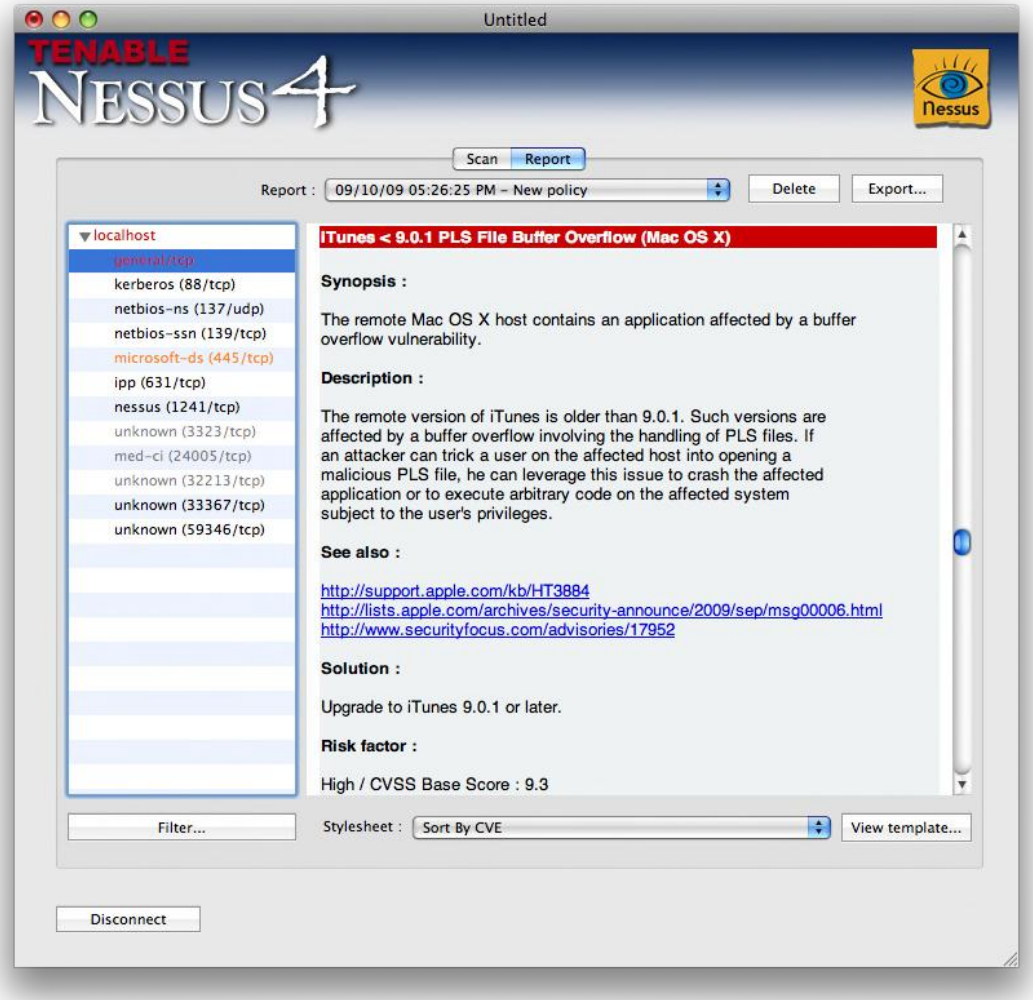
| | |
|---|---|
| windows/misc/hp_ovtrace | HP OpenView Operations OVTrace Buffer Overflow |
| windows/misc/ib_isc_attach_database | Borland InterBase isc_attach_database() Buffer Overflow |
| windows/misc/ib_isc_create_database | Borland InterBase isc_create_database() Buffer Overflow |
| windows/misc/ib_svc_attach | Borland InterBase SVC_attach() Buffer Overflow |
| windows/misc/landesk_aolnsrvr | LANDesk Management Suite 8.7 Alert Service Buffer Overflow |
| windows/misc/mercury_phonebook | Mercury/32 <= v4.01b PH Server Module Buffer Overflow |
| windows/misc/ms07_064_sami | Microsoft DirectX DirectShow SAMI Buffer Overflow |
| windows/misc/netcat110_nt | Netcat v1.10 NT Stack Overflow |
| windows/misc/shixxnote_font | ShixxNOTE 6.net Font Field Overflow |
| windows/misc/tiny_identd_overflow | TinyIdentD 2.2 Stack Overflow |
| windows/misc/windows_rsh | Windows RSH daemon Buffer Overflow |
| windows/mssql/ms02_039_slammer | Microsoft SQL Server Resolution Overflow |
| windows/mssql/ms02_056_hello | Microsoft SQL Server Hello Overflow |
| windows/mysql/mysql_yassl | MySQL yaSSL SSL Hello Message Buffer Overflow |
| windows/nntp/ms05_030_nntp | Microsoft Outlook Express NNTP Response Parsing Buffer Overflow |
| windows/novell/groupwisemessenger_client | Novell GroupWise Messenger Client Buffer Overflow |
| windows/novell/nmap_stor | Novell NetMail <= 3.52d NMAP STOR Buffer Overflow |
| windows/novell/zenworks_desktop_agent | Novell ZENworks 6.5 Desktop/Server Management Overflow |
| windows/pop3/seattlelab_pass | Seattle Lab Mail 5.5 POP3 Buffer Overflow |
| windows/proxy/bluecoat_winproxy_host | Blue Coat WinProxy Host Header Overflow |
| windows/proxy/ccproxy_telnet_ping | CCProxy <= v6.2 Telnet Proxy Ping Overflow |
| windows/proxy/proxypro_http_get | Proxy-Pro Professional GateKeeper 4.7 GET Request Overflow |
| windows/scada/realwin | DATAC RealWin SCADA Server Buffer Overflow |
| windows/sip/aim_triton_cseq | AIM Triton 1.0.4 CSeq Buffer Overflow |

Just a short list of available exploits for Windows systems.

# Tools: Nessus

- Vulnerability scanning tool
- Client-server application
- Ability to scan remote hosts
- Periodic plugin updates

# Buffer overflow vulnerability found (iTunes)



# Something to laugh about on your way home…

*"Nowadays, security guys break the Mac every single day. Every single day, they come out with a total exploit, your machine can be taken over totally. I dare anybody to do that once a month on the Windows machine."*

Bill Gates (2007)