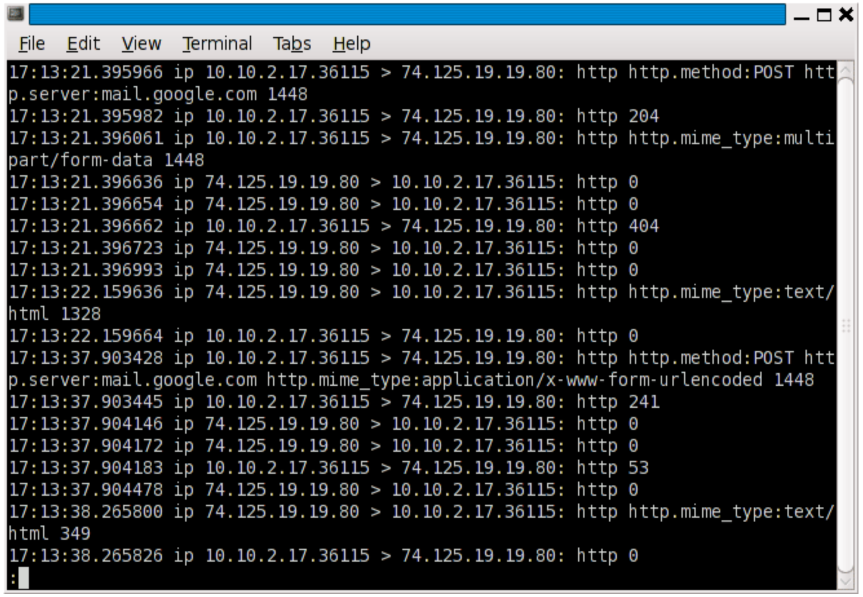
LINUX NETWORK TOOLS

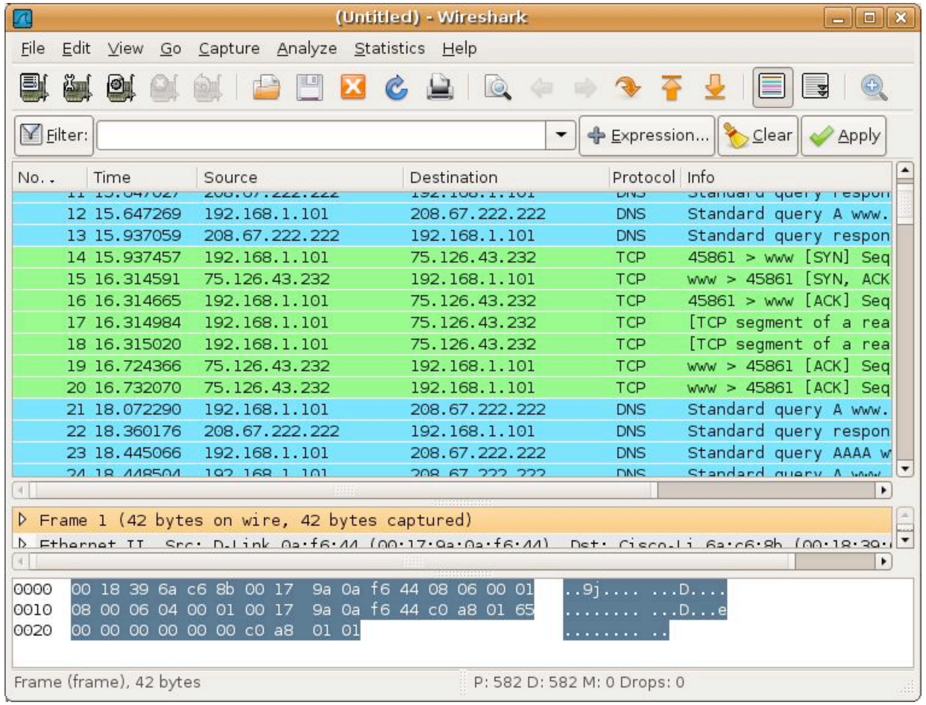
Let’s see some real traffic…



```
17:13:21.395966 ip 10.10.2.17.36115 > 74.125.19.19.80: http http.method:POST htt
p.server:mail.google.com 1448
17:13:21.395982 ip 10.10.2.17.36115 > 74.125.19.19.80: http 204
17:13:21.396061 ip 10.10.2.17.36115 > 74.125.19.19.80: http http.mime_type:multi
part/form-data 1448
17:13:21.396636 ip 74.125.19.19.80 > 10.10.2.17.36115: http 0
17:13:21.396654 ip 74.125.19.19.80 > 10.10.2.17.36115: http 0
17:13:21.396662 ip 10.10.2.17.36115 > 74.125.19.19.80: http 404
17:13:21.396723 ip 74.125.19.19.80 > 10.10.2.17.36115: http 0
17:13:21.396993 ip 74.125.19.19.80 > 10.10.2.17.36115: http 0
17:13:22.159636 ip 74.125.19.19.80 > 10.10.2.17.36115: http http.mime_type:text/
html 1328
17:13:22.159664 ip 10.10.2.17.36115 > 74.125.19.19.80: http 0
17:13:37.903428 ip 10.10.2.17.36115 > 74.125.19.19.80: http http.method:POST htt
p.server:mail.google.com http.mime_type:application/x-www-form-urlencoded 1448
17:13:37.903445 ip 10.10.2.17.36115 > 74.125.19.19.80: http 241
17:13:37.904146 ip 74.125.19.19.80 > 10.10.2.17.36115: http 0
17:13:37.904172 ip 74.125.19.19.80 > 10.10.2.17.36115: http 0
17:13:37.904183 ip 10.10.2.17.36115 > 74.125.19.19.80: http 53
17:13:37.904478 ip 74.125.19.19.80 > 10.10.2.17.36115: http 0
17:13:38.265800 ip 74.125.19.19.80 > 10.10.2.17.36115: http http.mime_type:text/
html 349
17:13:38.265826 ip 10.10.2.17.36115 > 74.125.19.19.80: http 0
:
```

tcpdump

wireshark



```
No. .  Time        Source          Destination     Protocol  Info
 11 15.647027  208.67.222.222  192.168.1.101   DNS   Standard query respon
 12 15.647269  192.168.1.101   208.67.222.222  DNS   Standard query A www.
 13 15.937059  208.67.222.222  192.168.1.101   DNS   Standard query respon
 14 15.937457  192.168.1.101   75.126.43.232   TCP   45861 > www [SYN] Seq
 15 16.314591  75.126.43.232   192.168.1.101   TCP   www > 45861 [SYN, ACK
 16 16.314665  192.168.1.101   75.126.43.232   TCP   45861 > www [ACK] Seq
 17 16.314984  192.168.1.101   75.126.43.232   TCP   [TCP segment of a rea
 18 16.315020  192.168.1.101   75.126.43.232   TCP   [TCP segment of a rea
 19 16.724366  75.126.43.232   192.168.1.101   TCP   www > 45861 [ACK] Seq
 20 16.732070  75.126.43.232   192.168.1.101   TCP   www > 45861 [ACK] Seq
 21 18.072290  192.168.1.101   208.67.222.222  DNS   Standard query A www.
 22 18.360176  208.67.222.222  192.168.1.101   DNS   Standard query respon
 23 18.445066  192.168.1.101   208.67.222.222  DNS   Standard query AAAA w
 24 18.448504  192.168.1.101   208.67.222.222  DNS   Standard query A www.

▷ Frame 1 (42 bytes on wire, 42 bytes captured)
▷ Ethernet II, Src: D-Link_0a:f6:44 (00:17:9a:0a:f6:44), Dst: Cisco-Li_6a:c6:8b (00:18:39:

0000  00 18 39 6a c6 8b 00 17  9a 0a f6 44 08 06 00 01   ..9j.... ...D....
0010  08 00 06 04 00 01 00 17  9a 0a f6 44 c0 a8 01 65   ........ ...D...e
0020  00 00 00 00 00 00 c0 a8  01 01                     ........ ..

Frame (frame), 42 bytes                P: 582 D: 582 M: 0 Drops: 0
```

`tcpdump`
the command line network analizer

For documentation:

- `man tcpdump` (program usage)
- http://danielmiessler.com/study/tcpdump/ (nice tutorial)

Essentials:

- Capture all packets on all interfaces and dump the entire packet:

```
tcpdump -i any -X
```

- Capture all packets on all interfaces and don't convert addresses to names:

```
tcpdump -i any -n
```

- Capture all packets on eth0 and save the trace on file (the whole packets…):

```
tcpdump -i eth0 -w file -s0
```

- Capture 10 packets on eth0 to/from `$ADDR`:

```
tcpdump -i eth0 -c 10 host $ADDR
```

- Capture all TCP packets to/from port 80 on eth0:

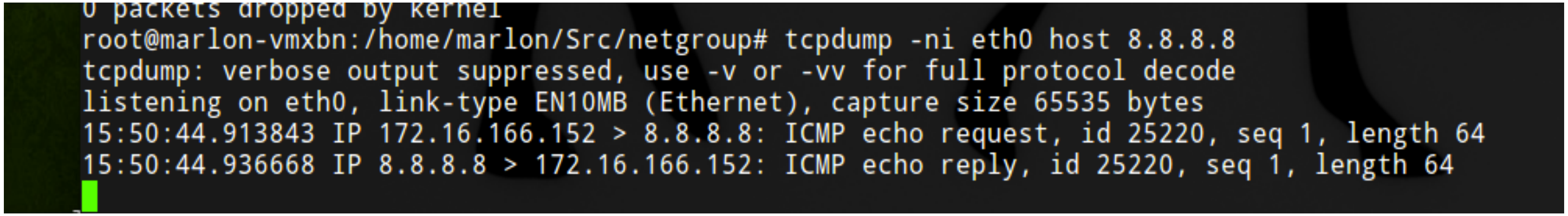
```
tcpdump -i eth0 tcp port 80
```

- Capture all packets with destination or source address != $ADDR and port in the range [10000:20000]:

```
tcpdump -i eth0 host not $ADDR portrange 10000-20000
```

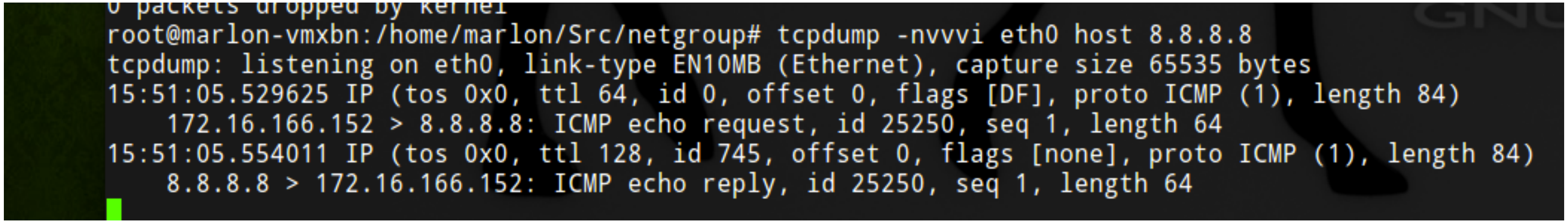
tcpdump
output format

Normal output



```
0 packets dropped by kernel
root@marlon-vmxbn:/home/marlon/Src/netgroup# tcpdump -ni eth0 host 8.8.8.8
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 65535 bytes
15:50:44.913843 IP 172.16.166.152 > 8.8.8.8: ICMP echo request, id 25220, seq 1, length 64
15:50:44.936668 IP 8.8.8.8 > 172.16.166.152: ICMP echo reply, id 25220, seq 1, length 64
```

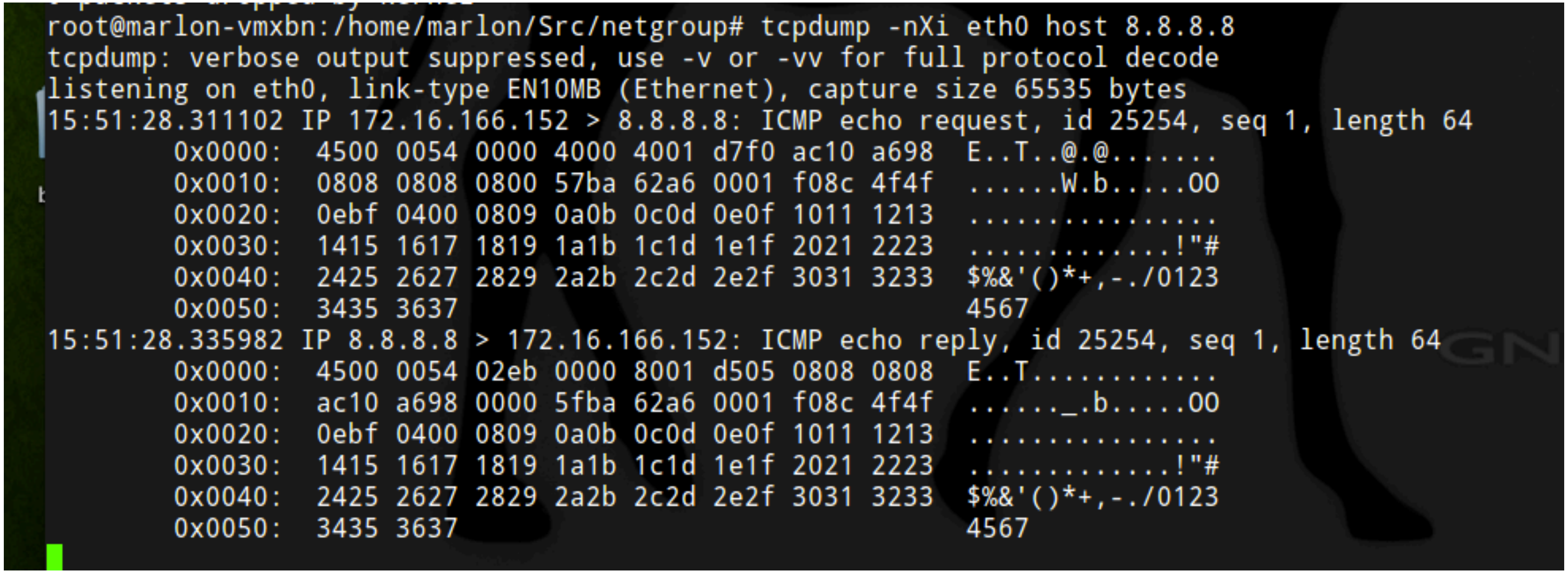
Verbose output



```
0 packets dropped by kernel
root@marlon-vmxbn:/home/marlon/Src/netgroup# tcpdump -nvvvi eth0 host 8.8.8.8
tcpdump: listening on eth0, link-type EN10MB (Ethernet), capture size 65535 bytes
15:51:05.529625 IP (tos 0x0, ttl 64, id 0, offset 0, flags [DF], proto ICMP (1), length 84)
    172.16.166.152 > 8.8.8.8: ICMP echo request, id 25250, seq 1, length 64
15:51:05.554011 IP (tos 0x0, ttl 128, id 745, offset 0, flags [none], proto ICMP (1), length 84)
    8.8.8.8 > 172.16.166.152: ICMP echo reply, id 25250, seq 1, length 64
```

tcpdump
output format

Packet content in HEX and ASCII



```
root@marlon-vmxbn:/home/marlon/Src/netgroup# tcpdump -nXi eth0 host 8.8.8.8
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 65535 bytes
15:51:28.311102 IP 172.16.166.152 > 8.8.8.8: ICMP echo request, id 25254, seq 1, length 64
        0x0000:  4500 0054 0000 4000 4001 d7f0 ac10 a698  E..T..@.@.......
        0x0010:  0808 0808 0800 57ba 62a6 0001 f08c 4f4f  ......W.b.....OO
        0x0020:  0ebf 0400 0809 0a0b 0c0d 0e0f 1011 1213  ................
        0x0030:  1415 1617 1819 1a1b 1c1d 1e1f 2021 2223  .............!"#
        0x0040:  2425 2627 2829 2a2b 2c2d 2e2f 3031 3233  $%&'()*+,-./0123
        0x0050:  3435 3637                                4567
15:51:28.335982 IP 8.8.8.8 > 172.16.166.152: ICMP echo reply, id 25254, seq 1, length 64
        0x0000:  4500 0054 02eb 0000 8001 d505 0808 0808  E..T............
        0x0010:  ac10 a698 0000 5fba 62a6 0001 f08c 4f4f  ......_.b.....OO
        0x0020:  0ebf 0400 0809 0a0b 0c0d 0e0f 1011 1213  ................
        0x0030:  1415 1617 1819 1a1b 1c1d 1e1f 2021 2223  .............!"#
        0x0040:  2425 2627 2829 2a2b 2c2d 2e2f 3031 3233  $%&'()*+,-./0123
        0x0050:  3435 3637                                4567
```

tcpdump advanced filtering

- man pcap-filter (filter syntax details)
- pcap filter primitives include
  - host, dst host, src host
  - port, dst port, src port
  - ether host, ether dst, ether src
  - net, dst net, src net
  - portrange, dst portrange, src portrange
  - less, greater
  - ip proto, ip6 proto, ether proto
  - ip broadcast, ip multicast
  - ip, ip6, arp, tcp, udp, icmp
  - ifname
  - proto [expr : size]
    - ip[16:4] = 0xffffffff → DEST BROADCAST IP PACKET
- Example:
  - tcpdump -ni any "ip[12:4] = 0xac10a69c”

NERD QUIZ

What do they mean?

```
(1) ether[0] & 1 != 0
(2) ip[0] & 0xf != 5
(3) ip[6:2] & 0x1fff = 0
```

Are you sure?
Shall we light them?

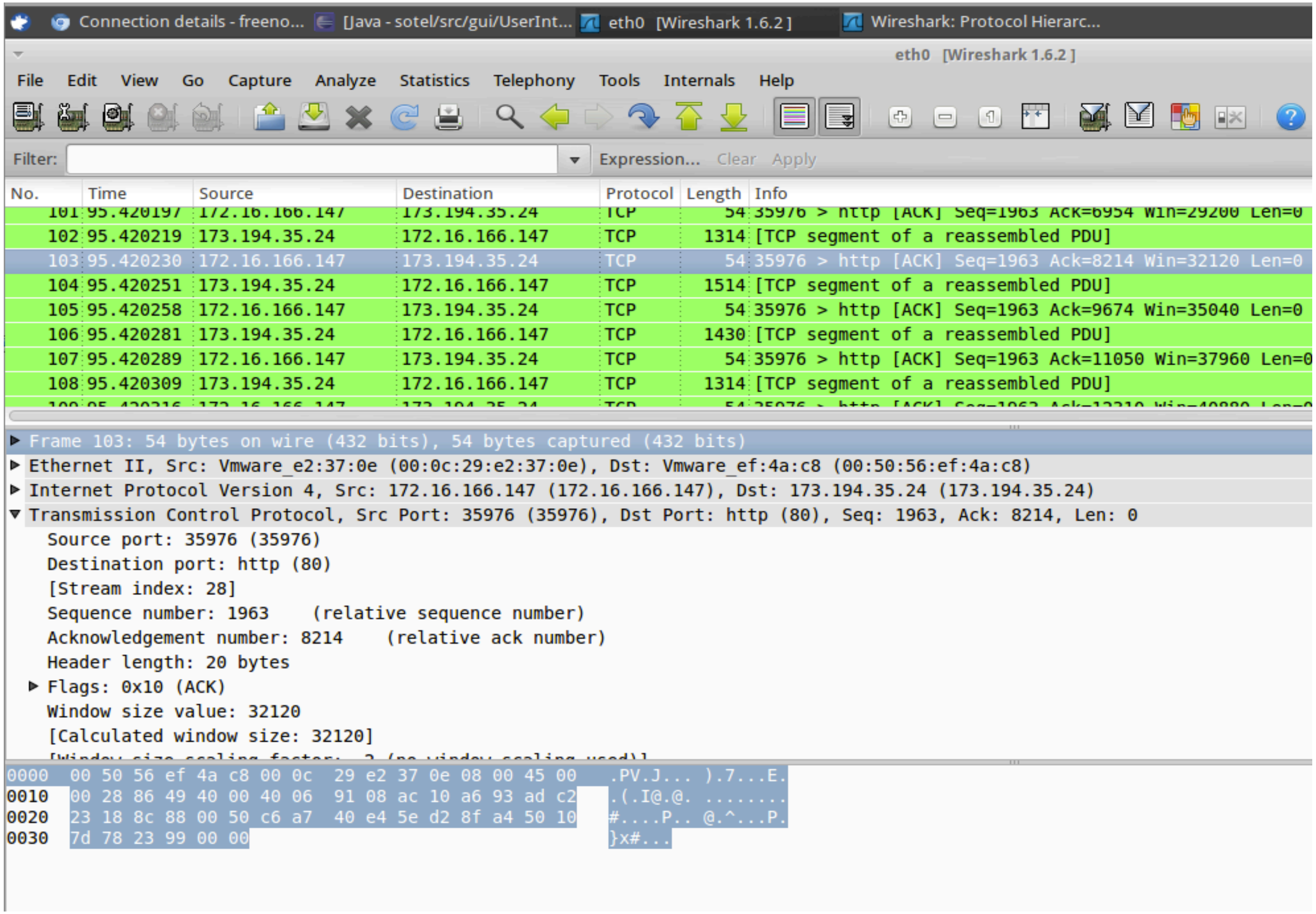
Solutions

```
ether[0] & 1 != 0      (ethernet multicast/broadcast packet)
ip[0] & 0xf != 5       (ip packets with option)
ip[6:2]  & 0x1fff = 0  (ip un-fragmented packets or frag0)
```

Wireshark

- Wireshark is a graphical packet analyzer
- Like `tcpdump` can analyze live streams or files
- It's compatible with `tcpdump` (pcap format) traces
- It provides additional features:
  - Better protocol parsing
  - Statistics tool
  - Exporting
  - Better Filtering (different syntax)
  - Can be extended to understand proprietary protocol

Wireshark

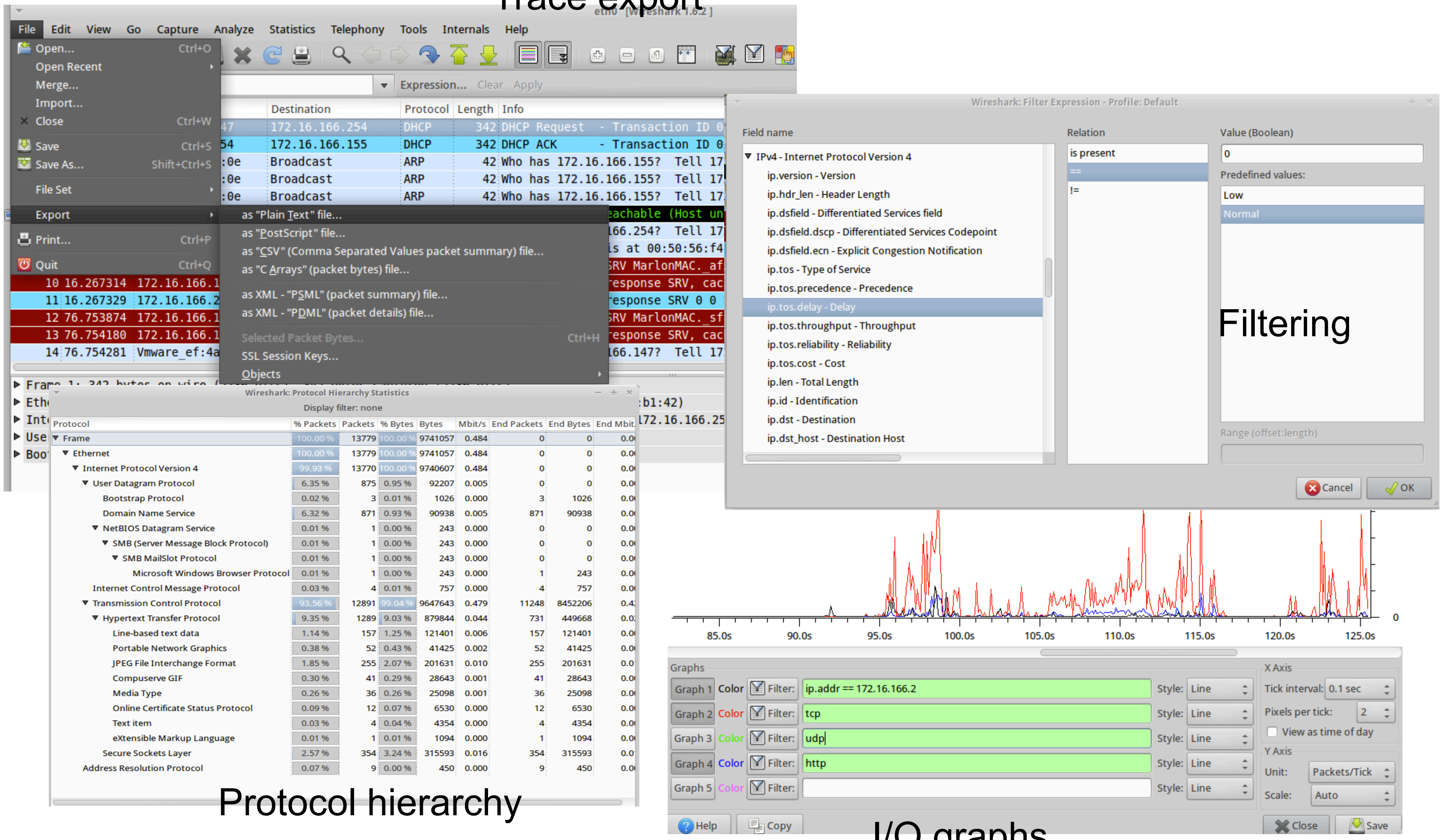


```
No.  Time       Source          Destination     Protocol Length Info
 101 95.420197  172.16.166.147  173.194.35.24   TCP        54 35976 > http [ACK] Seq=1963 Ack=6954 Win=29200 Len=0
 102 95.420219  173.194.35.24   172.16.166.147  TCP      1314 [TCP segment of a reassembled PDU]
 103 95.420230  172.16.166.147  173.194.35.24   TCP        54 35976 > http [ACK] Seq=1963 Ack=8214 Win=32120 Len=0
 104 95.420251  173.194.35.24   172.16.166.147  TCP      1514 [TCP segment of a reassembled PDU]
 105 95.420258  172.16.166.147  173.194.35.24   TCP        54 35976 > http [ACK] Seq=1963 Ack=9674 Win=35040 Len=0
 106 95.420281  173.194.35.24   172.16.166.147  TCP      1430 [TCP segment of a reassembled PDU]
 107 95.420289  172.16.166.147  173.194.35.24   TCP        54 35976 > http [ACK] Seq=1963 Ack=11050 Win=37960 Len=0
 108 95.420309  173.194.35.24   172.16.166.147  TCP      1314 [TCP segment of a reassembled PDU]
 109 95.420316  172.16.166.147  173.194.35.24   TCP        54 35976 > http [ACK] Seq=1963 Ack=12310 Win=40880 Len=0
```

```
▶ Frame 103: 54 bytes on wire (432 bits), 54 bytes captured (432 bits)
▶ Ethernet II, Src: Vmware_e2:37:0e (00:0c:29:e2:37:0e), Dst: Vmware_ef:4a:c8 (00:50:56:ef:4a:c8)
▶ Internet Protocol Version 4, Src: 172.16.166.147 (172.16.166.147), Dst: 173.194.35.24 (173.194.35.24)
▼ Transmission Control Protocol, Src Port: 35976 (35976), Dst Port: http (80), Seq: 1963, Ack: 8214, Len: 0
    Source port: 35976 (35976)
    Destination port: http (80)
    [Stream index: 28]
    Sequence number: 1963    (relative sequence number)
    Acknowledgement number: 8214    (relative ack number)
    Header length: 20 bytes
  ▶ Flags: 0x10 (ACK)
    Window size value: 32120
    [Calculated window size: 32120]
    [Window size scaling factor: -2 (no window scaling used)]
```

```
0000  00 50 56 ef 4a c8 00 0c  29 e2 37 0e 08 00 45 00   .PV.J... ).7...E.
0010  00 28 86 49 40 00 40 06  91 08 ac 10 a6 93 ad c2   .(.I@.@. ........
0020  23 18 8c 88 00 50 c6 a7  40 e4 5e d2 8f a4 50 10   #....P.. @.^...P.
0030  7d 78 23 99 00 00                                  }x#...
```

Wireshark



Trace export

eth0 [Wireshark 1.6.2]
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Open... Ctrl+O
Open Recent
Merge...
Import...
Close Ctrl+W
Save Ctrl+S
Save As... Shift+Ctrl+S
File Set
Export
Print... Ctrl+P
Quit Ctrl+Q
as "Plain Text" file...
as "PostScript" file...
as "CSV" (Comma Separated Values packet summary) file...
as "C Arrays" (packet bytes) file...
as XML - "PSML" (packet summary) file...
as XML - "PDML" (packet details) file...
Selected Packet Bytes... Ctrl+H
SSL Session Keys...
Objects
Expression... Clear Apply

```
     Destination      Protocol Length Info
47   172.16.166.254   DHCP     342 DHCP Request  - Transaction ID 0
54   172.16.166.155   DHCP     342 DHCP ACK      - Transaction ID 0
:0e  Broadcast        ARP       42 Who has 172.16.166.155?  Tell 17
:0e  Broadcast        ARP       42 Who has 172.16.166.155?  Tell 17
:0e  Broadcast        ARP       42 Who has 172.16.166.155?  Tell 17
                                   eachable (Host un
                                   166.254?  Tell 17
                                   is at 00:50:56:f4
                                   SRV MarlonMAC. af
10 16.267314 172.16.166.1          esponse SRV, cac
11 16.267329 172.16.166.2          esponse SRV 0 0
12 76.753874 172.16.166.1          SRV MarlonMAC. sf
13 76.754180 172.16.166.1          esponse SRV, cac
14 76.754281 Vmware_ef:4a          166.147?  Tell 17
Frame 1: 342 bytes on wire
Eth                                :b1:42)
Int                                172.16.166.25
Use
Boo
```

Filtering

Field name:
- IPv4 - Internet Protocol Version 4
  - ip.version - Version
  - ip.hdr_len - Header Length
  - ip.dsfield - Differentiated Services field
  - ip.dsfield.dscp - Differentiated Services Codepoint
  - ip.dsfield.ecn - Explicit Congestion Notification
  - ip.tos - Type of Service
  - ip.tos.precedence - Precedence
  - ip.tos.delay - Delay
  - ip.tos.throughput - Throughput
  - ip.tos.reliability - Reliability
  - ip.tos.cost - Cost
  - ip.len - Total Length
  - ip.id - Identification
  - ip.dst - Destination
  - ip.dst_host - Destination Host

Relation: is present, ==, !=

Value (Boolean): 0

Predefined values: Low, Normal

Protocol hierarchy

Wireshark: Protocol Hierarchy Statistics

Display filter: none

Protocol	% Packets	Packets	% Bytes	Bytes	Mbit/s	End Packets	End Bytes	End Mbit
▼ Frame	100.00 %	13779	100.00 %	9741057	0.484	0	0	0.0
▼ Ethernet	100.00 %	13779	100.00 %	9741057	0.484	0	0	0.0
▼ Internet Protocol Version 4	99.93 %	13770	100.00 %	9740607	0.484	0	0	0.0
▼ User Datagram Protocol	6.35 %	875	0.95 %	92207	0.005	0	0	0.0
Bootstrap Protocol	0.02 %	3	0.01 %	1026	0.000	3	1026	0.0
Domain Name Service	6.32 %	871	0.93 %	90938	0.005	871	90938	0.0
▼ NetBIOS Datagram Service	0.01 %	1	0.00 %	243	0.000	0	0	0.0
▼ SMB (Server Message Block Protocol)	0.01 %	1	0.00 %	243	0.000	0	0	0.0
▼ SMB MailSlot Protocol	0.01 %	1	0.00 %	243	0.000	0	0	0.0
Microsoft Windows Browser Protocol	0.01 %	1	0.00 %	243	0.000	1	243	0.0
Internet Control Message Protocol	0.03 %	4	0.01 %	757	0.000	4	757	0.0
▼ Transmission Control Protocol	93.56 %	12891	99.04 %	9647643	0.479	11248	8452206	0.4
▼ Hypertext Transfer Protocol	9.35 %	1289	9.03 %	879844	0.044	731	449668	0.0
Line-based text data	1.14 %	157	1.25 %	121401	0.006	157	121401	0.0
Portable Network Graphics	0.38 %	52	0.43 %	41425	0.002	52	41425	0.0
JPEG File Interchange Format	1.85 %	255	2.07 %	201631	0.010	255	201631	0.0
Compuserve GIF	0.30 %	41	0.29 %	28643	0.001	41	28643	0.0
Media Type	0.26 %	36	0.26 %	25098	0.001	36	25098	0.0
Online Certificate Status Protocol	0.09 %	12	0.07 %	6530	0.000	12	6530	0.0
Text item	0.03 %	4	0.04 %	4354	0.000	4	4354	0.0
eXtensible Markup Language	0.01 %	1	0.01 %	1094	0.000	1	1094	0.0
Secure Sockets Layer	2.57 %	354	3.24 %	315593	0.016	354	315593	0.0
Address Resolution Protocol	0.07 %	9	0.00 %	450	0.000	9	450	0.0

Graph	Color	Filter	Style
Graph 1	Color	ip.addr == 172.16.166.2	Line
Graph 2	Color	tcp	Line
Graph 3	Color	udp	Line
Graph 4	Color	http	Line
Graph 5	Color		Line

X Axis: Tick interval: 0.1 sec; Pixels per tick: 2; □ View as time of day

Y Axis: Unit: Packets/Tick; Scale: Auto

I/O graphs

Wireshark and NETKIT

- Can I use wireshark to capture traffic on a NETKIT VM?
  - No! But I can use wireshark to open a trace captured with `tcpdump`
  - It's only a matter of copying the file from the VM to the HOST machine (let's use the hosthome directory)
  - Second option: copy the file with `nc, scp or rsync` (later on…)

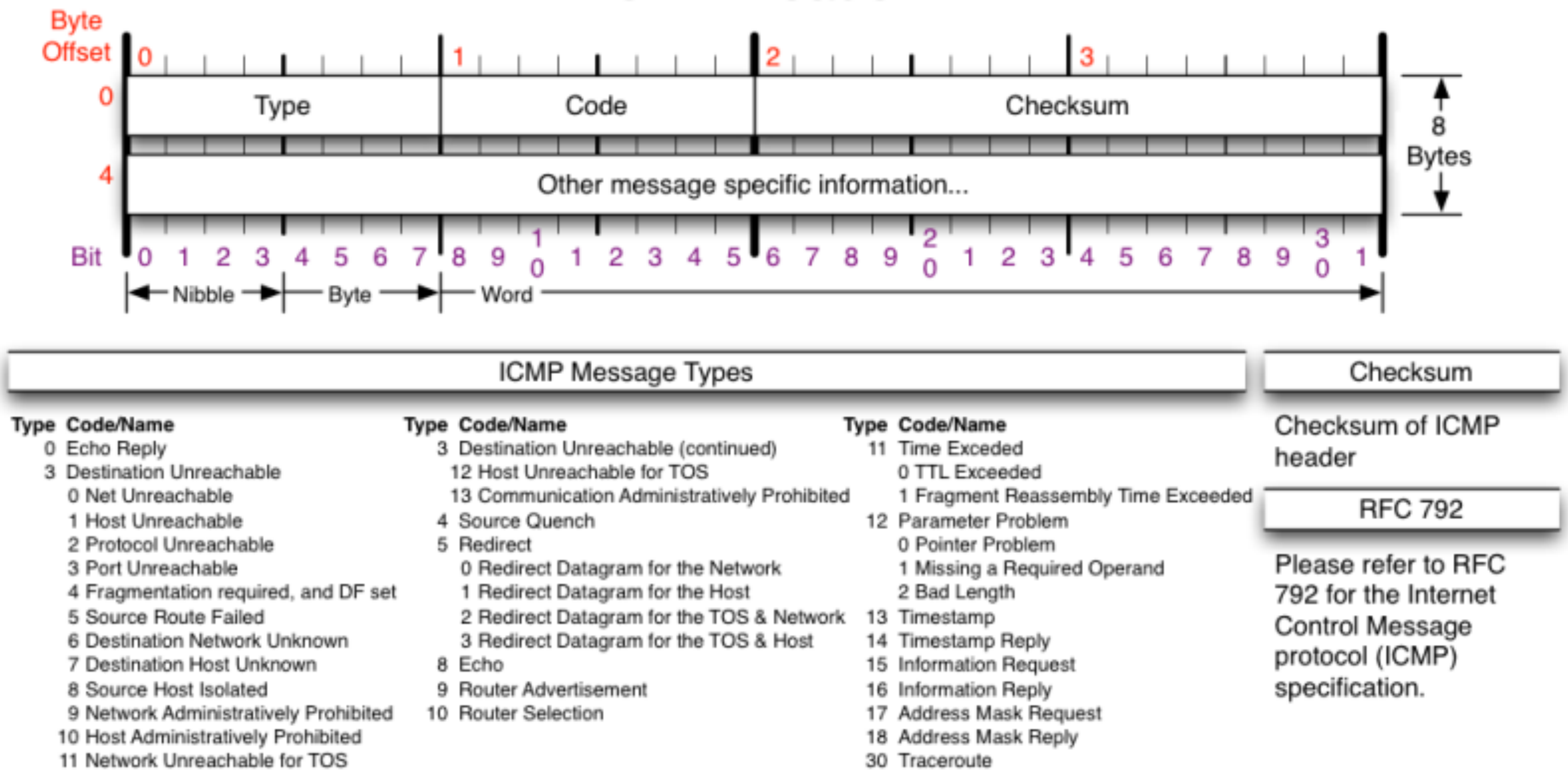
`ping`

- `ping` is one of the oldest IP utilities around
- `ping` asks another host if it is alive, and records the round-trip time between the request and the reply
- `ping` relies on ICMP echo-request and echo-reply packets (next slide..)
- **warning**: in some cases ICMP traffic is dropped by firewalls. We can not assume that all machines are down if they don’t reply to a ping…

ICMP basics

- The **Internet Control Message Protocol** is one of the core protocols of the IP Suite
- ICMP packets are mainly used for diagnostic (ping, traceroute, timestamp request) and error notification (routing anomalies, unreachability, TTL expired, etc…)
- It goes directly on top of IP (but it can't be seen as a transport protocol)
  - IP.proto = 1
- We will focus on ICMP Echo Request/Reply. We'll see (and force the transmission) of other ICMP messages later on…

ICMP header



ICMP Message Types

Type **Code/Name**

0 Echo Reply
3 Destination Unreachable
  0 Net Unreachable
  1 Host Unreachable
  2 Protocol Unreachable
  3 Port Unreachable
  4 Fragmentation required, and DF set
  5 Source Route Failed
  6 Destination Network Unknown
  7 Destination Host Unknown
  8 Source Host Isolated
  9 Network Administratively Prohibited
  10 Host Administratively Prohibited
  11 Network Unreachable for TOS

Type **Code/Name**

3 Destination Unreachable (continued)
  12 Host Unreachable for TOS
  13 Communication Administratively Prohibited
4 Source Quench
5 Redirect
  0 Redirect Datagram for the Network
  1 Redirect Datagram for the Host
  2 Redirect Datagram for the TOS & Network
  3 Redirect Datagram for the TOS & Host
8 Echo
9 Router Advertisement
10 Router Selection

Type **Code/Name**

11 Time Exceded
  0 TTL Exceeded
  1 Fragment Reassembly Time Exceeded
12 Parameter Problem
  0 Pointer Problem
  1 Missing a Required Operand
  2 Bad Length
13 Timestamp
14 Timestamp Reply
15 Information Request
16 Information Reply
17 Address Mask Request
18 Address Mask Reply
30 Traceroute

Checksum

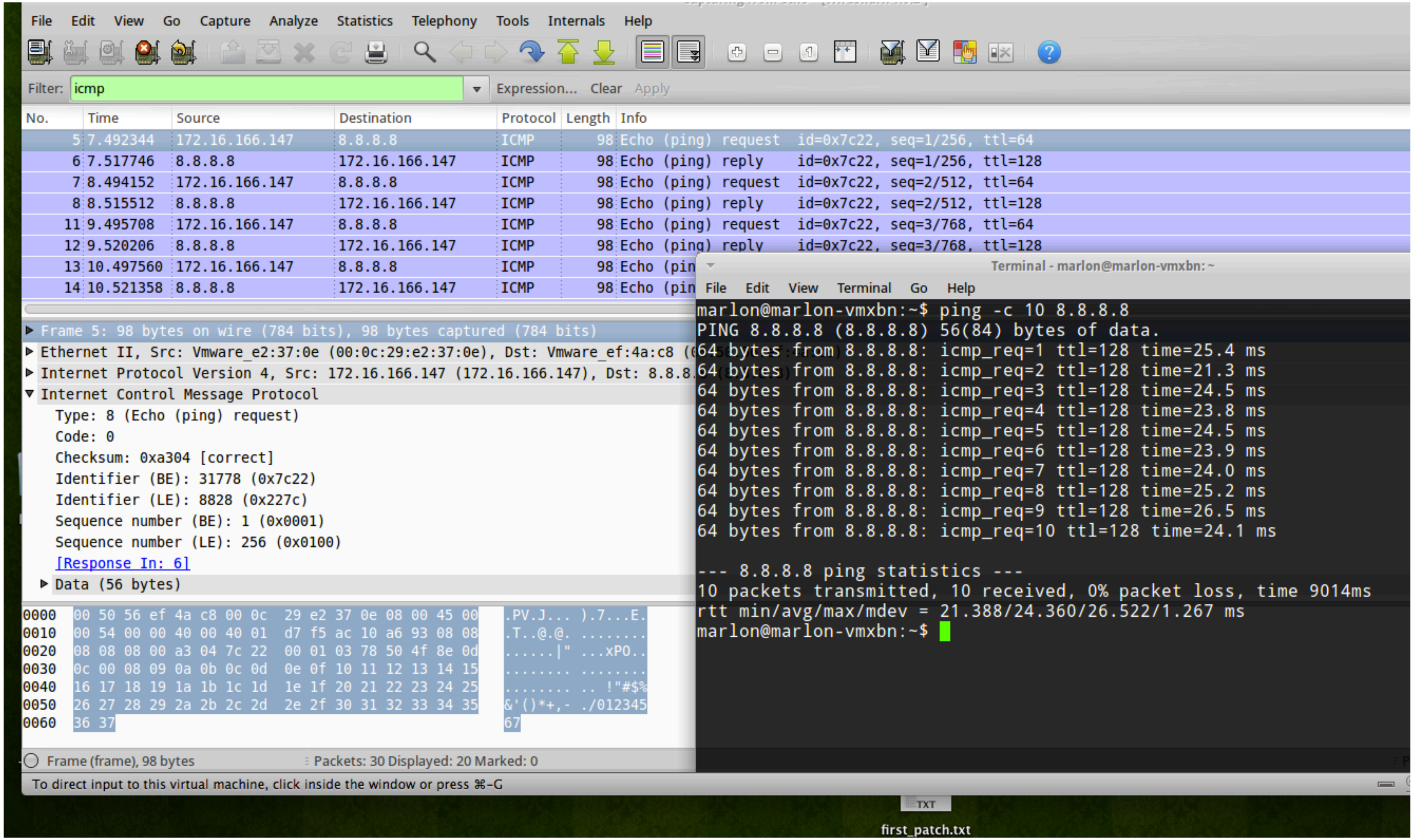
Checksum of ICMP header

RFC 792

Please refer to RFC 792 for the Internet Control Message protocol (ICMP) specification.

source: http://nmap.org/book/tcpip-ref.html

ping output and ICMP packets


File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Filter: icmp
Expression... Clear Apply
Terminal - marlon@marlon-vmxbn: ~
File Edit View Terminal Go Help
TXT
first_patch.txt

No.	Time	Source	Destination	Protocol	Length	Info
5	7.492344	172.16.166.147	8.8.8.8	ICMP	98	Echo (ping) request id=0x7c22, seq=1/256, ttl=64
6	7.517746	8.8.8.8	172.16.166.147	ICMP	98	Echo (ping) reply id=0x7c22, seq=1/256, ttl=128
7	8.494152	172.16.166.147	8.8.8.8	ICMP	98	Echo (ping) request id=0x7c22, seq=2/512, ttl=64
8	8.515512	8.8.8.8	172.16.166.147	ICMP	98	Echo (ping) reply id=0x7c22, seq=2/512, ttl=128
11	9.495708	172.16.166.147	8.8.8.8	ICMP	98	Echo (ping) request id=0x7c22, seq=3/768, ttl=64
12	9.520206	8.8.8.8	172.16.166.147	ICMP	98	Echo (ping) reply id=0x7c22, seq=3/768, ttl=128
13	10.497560	172.16.166.147	8.8.8.8	ICMP	98	Echo (pin
14	10.521358	8.8.8.8	172.16.166.147	ICMP	98	Echo (pin

```
▶ Frame 5: 98 bytes on wire (784 bits), 98 bytes captured (784 bits)
▶ Ethernet II, Src: Vmware_e2:37:0e (00:0c:29:e2:37:0e), Dst: Vmware_ef:4a:c8 (0
▶ Internet Protocol Version 4, Src: 172.16.166.147 (172.16.166.147), Dst: 8.8.8.
▼ Internet Control Message Protocol
    Type: 8 (Echo (ping) request)
    Code: 0
    Checksum: 0xa304 [correct]
    Identifier (BE): 31778 (0x7c22)
    Identifier (LE): 8828 (0x227c)
    Sequence number (BE): 1 (0x0001)
    Sequence number (LE): 256 (0x0100)
    [Response In: 6]
  ▶ Data (56 bytes)
```

```
0000  00 50 56 ef 4a c8 00 0c  29 e2 37 0e 08 00 45 00   .PV.J... ).7...E.
0010  00 54 00 00 40 00 40 01  d7 f5 ac 10 a6 93 08 08   .T..@.@. ........
0020  08 08 08 00 a3 04 7c 22  00 01 03 78 50 4f 8e 0d   ......|" ...xPO..
0030  0c 00 08 09 0a 0b 0c 0d  0e 0f 10 11 12 13 14 15   ........ ........
0040  16 17 18 19 1a 1b 1c 1d  1e 1f 20 21 22 23 24 25   ........ .. !"#$%
0050  26 27 28 29 2a 2b 2c 2d  2e 2f 30 31 32 33 34 35   &'()*+,- ./012345
0060  36 37                                              67
```

○ Frame (frame), 98 bytes   Packets: 30 Displayed: 20 Marked: 0

To direct input to this virtual machine, click inside the window or press ⌘-G

```
marlon@marlon-vmxbn:~$ ping -c 10 8.8.8.8
PING 8.8.8.8 (8.8.8.8) 56(84) bytes of data.
64 bytes from 8.8.8.8: icmp_req=1 ttl=128 time=25.4 ms
64 bytes from 8.8.8.8: icmp_req=2 ttl=128 time=21.3 ms
64 bytes from 8.8.8.8: icmp_req=3 ttl=128 time=24.5 ms
64 bytes from 8.8.8.8: icmp_req=4 ttl=128 time=23.8 ms
64 bytes from 8.8.8.8: icmp_req=5 ttl=128 time=24.5 ms
64 bytes from 8.8.8.8: icmp_req=6 ttl=128 time=23.9 ms
64 bytes from 8.8.8.8: icmp_req=7 ttl=128 time=24.0 ms
64 bytes from 8.8.8.8: icmp_req=8 ttl=128 time=25.2 ms
64 bytes from 8.8.8.8: icmp_req=9 ttl=128 time=26.5 ms
64 bytes from 8.8.8.8: icmp_req=10 ttl=128 time=24.1 ms

--- 8.8.8.8 ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9014ms
rtt min/avg/max/mdev = 21.388/24.360/26.522/1.267 ms
marlon@marlon-vmxbn:~$
```

`ping` usage

- For a complete doc: `man ping`
- Essentials
  - Don’t convert IP addresses to names (`-n`)

    ```
    ping -n 160.80.103.147
    ```
  - Specify the number of packets (`-c`) and display only the summary line (`-q`)

    ```
    ping -q -c 10 160.80.103.147
    ```
  - Specify the source address of the packets (`-I`)

    ```
    ping —I 10.0.0.12 160.80.103.147
    ```
  - Stress the network (flood `-f`) and specify the size of the packet (`-s`)

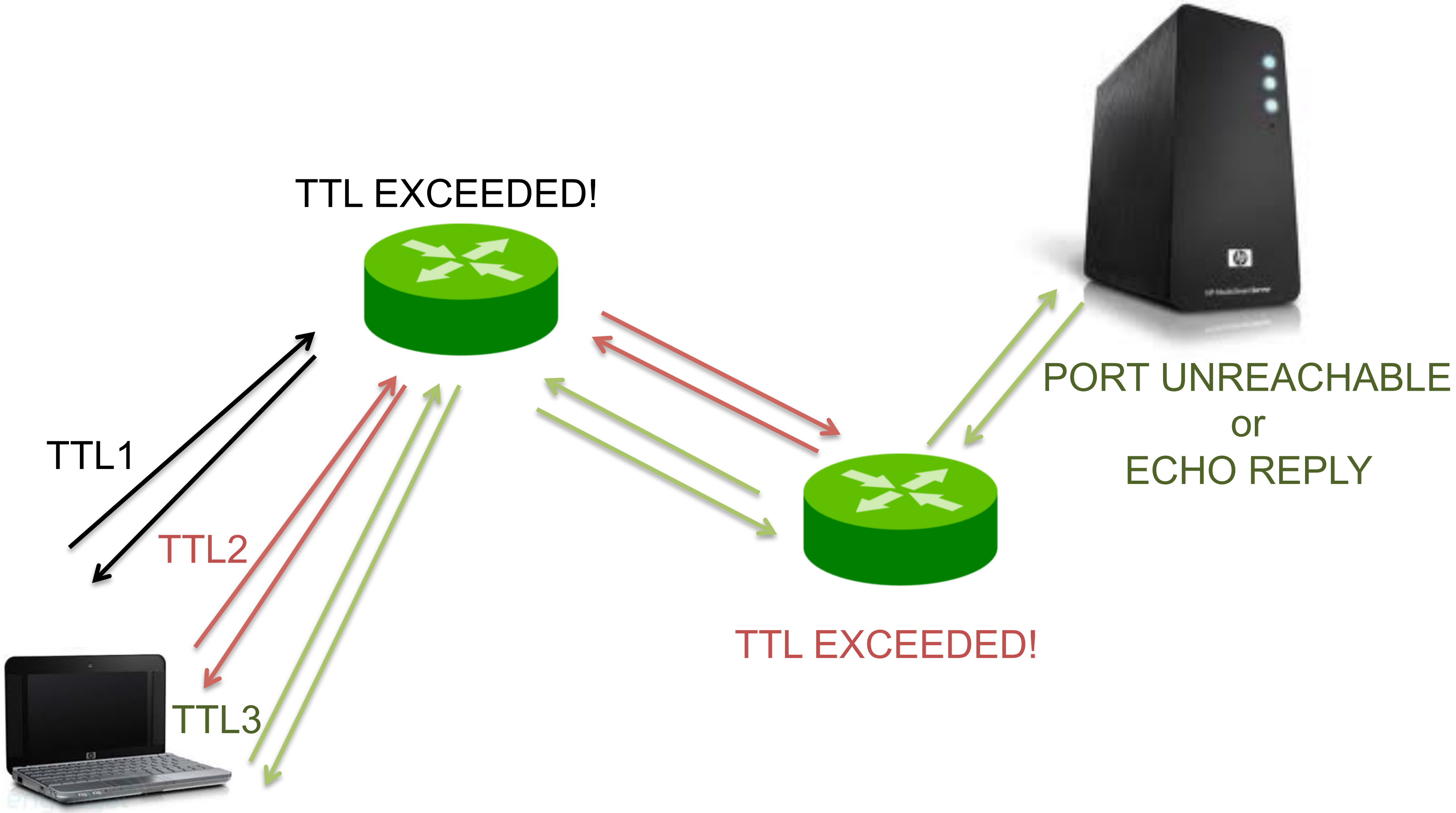
    ```
    ping -c 5000 -s 512 -f 160.80.103.14
    ```
  - Record the network route (many hosts ignore the ROUTE RECORD option. Let’s use `traceroute` for that)

    ```
    ping -R 160.80.103.14
    ```

`traceroute`

- A computer network diagnostic tool for displaying the route and measuring transit delays of packets across an IP network
- `traceroute` sends a sequence of packets to the destination
- `traceroute` works by increasing the TTL value of each successive (set of) packet(s)
- `traceroute` reconstructs the path to the destination by receiving the ICMP TTL Exceeded message by each router traversed by the packet
- Implementations on Unix-like OSs use UDP with ports from 33434 to 33534. Others use ICMP Echo Request
- For UDP version, `traceroute` ends when a port unreachable is received from the destination
- For ICMP version, `traceroute` ends when a ICMP Echo Reply is received for the destination

How does `traceroute` work?



TTL EXCEEDED!

TTL1

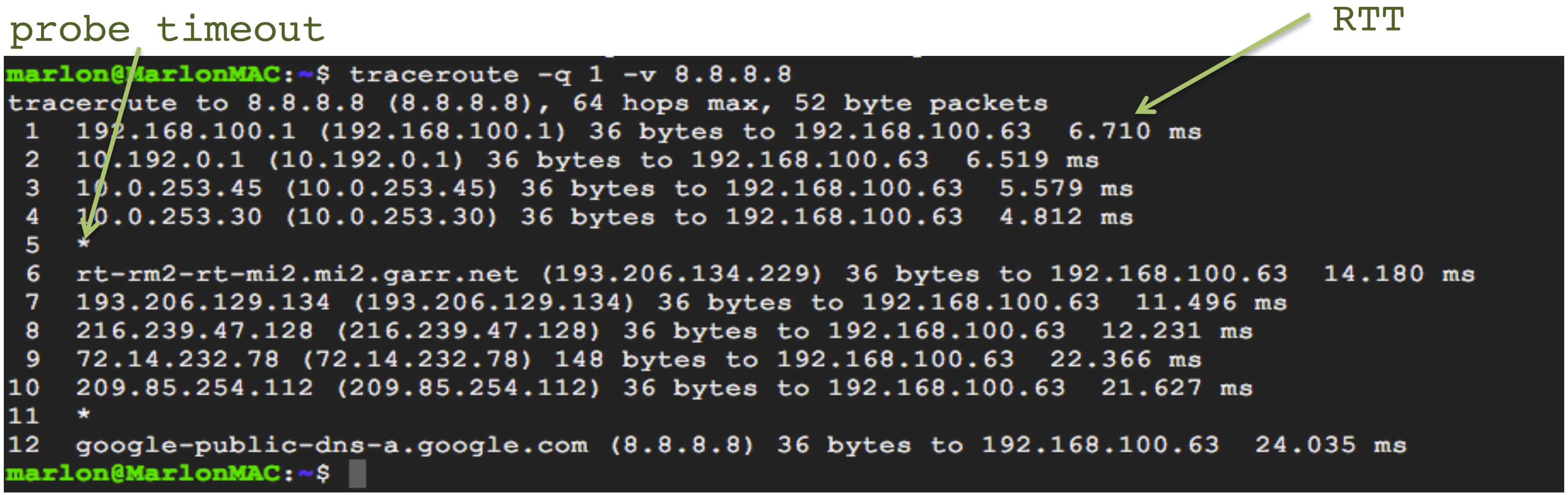
TTL2

TTL3

TTL EXCEEDED!

PORT UNREACHABLE
or
ECHO REPLY

traceroute



probe timeout

RTT

```
marlon@MarlonMAC:~$ traceroute -q 1 -v 8.8.8.8
traceroute to 8.8.8.8 (8.8.8.8), 64 hops max, 52 byte packets
 1  192.168.100.1 (192.168.100.1) 36 bytes to 192.168.100.63  6.710 ms
 2  10.192.0.1 (10.192.0.1) 36 bytes to 192.168.100.63  6.519 ms
 3  10.0.253.45 (10.0.253.45) 36 bytes to 192.168.100.63  5.579 ms
 4  10.0.253.30 (10.0.253.30) 36 bytes to 192.168.100.63  4.812 ms
 5  *
 6  rt-rm2-rt-mi2.mi2.garr.net (193.206.134.229) 36 bytes to 192.168.100.63  14.180 ms
 7  193.206.129.134 (193.206.129.134) 36 bytes to 192.168.100.63  11.496 ms
 8  216.239.47.128 (216.239.47.128) 36 bytes to 192.168.100.63  12.231 ms
 9  72.14.232.78 (72.14.232.78) 148 bytes to 192.168.100.63  22.366 ms
10  209.85.254.112 (209.85.254.112) 36 bytes to 192.168.100.63  21.627 ms
11  *
12  google-public-dns-a.google.com (8.8.8.8) 36 bytes to 192.168.100.63  24.035 ms
marlon@MarlonMAC:~$ 
```

Basis usage:

```
    traceroute [options] $DEST_HOST
```

Useful options:

```
    -q <num_queries>: number of queries
    -i <iface_name>: source interface
    -s <addr>: source address
    -M <ttl>: initial TTL
    -m <ttl>: maximum TTL
    -w <time>: wait time for a probe response
```

netcat

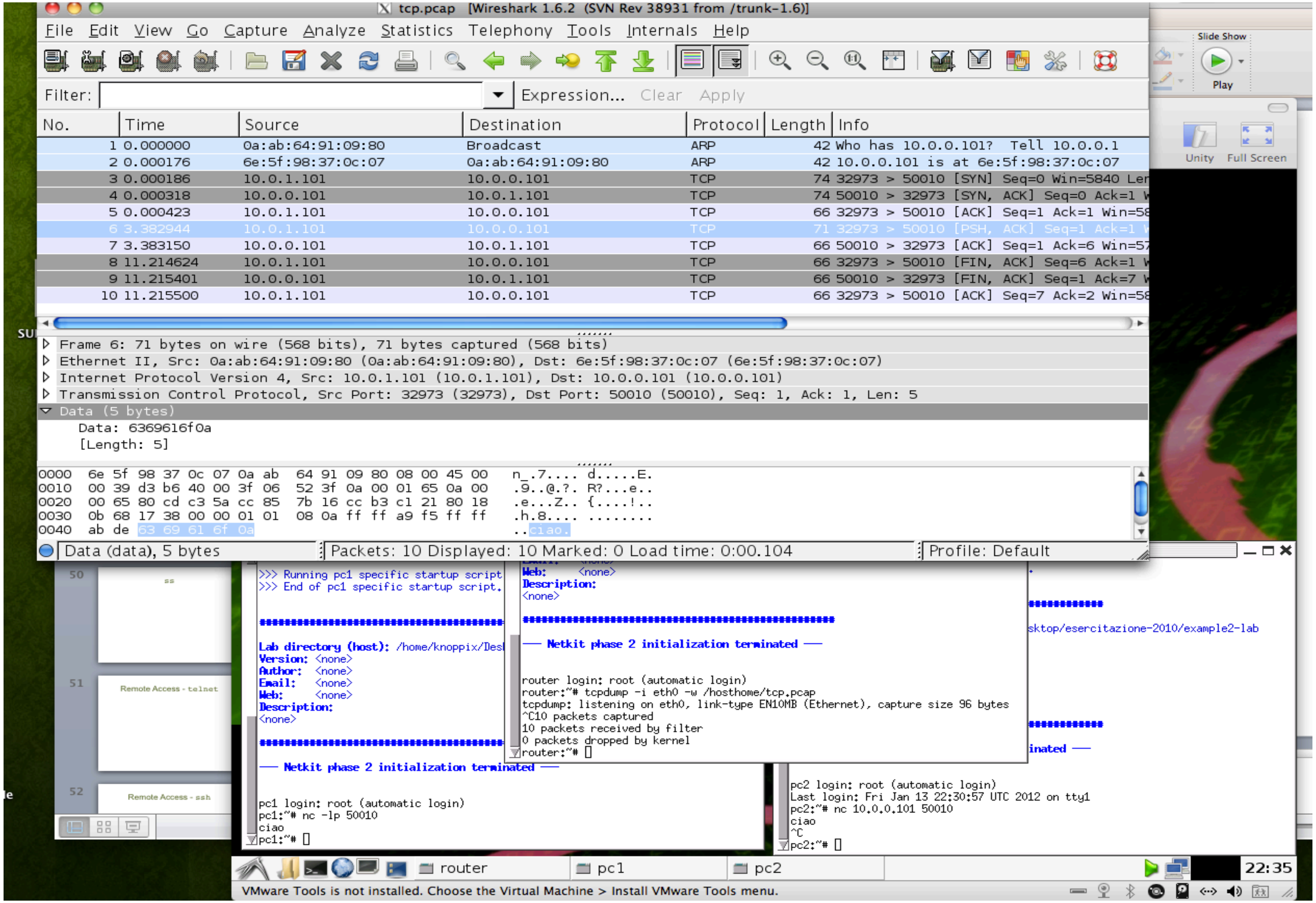
- Utility that reads and writes data through IP transport session, either TCP or UDP
- It can create TCP or UDP socket in listening
  - `nc -l 9000` (open a TCP socket listening on port 9000)
  - `nc -lu 9000` (open a UDP socket listening on port 9000)
- It can connect a TCP socket
  - `nc 160.80.103.147 9000`
- It can create a UDP socket for sending packets
  - `nc –u 160.80.103.147 9000`

- **NOTE:** there are 2 versions of nc. One is the GNU version. The other one is the BSD porting. These 2 versions have a slightly different syntax and options. For example (that’s the case of `nc` on the NETKIT VM), you might have to use the following syntax for listening sockets:
  - `# nc -l -p 9000`

Exercise: TCP connection

- Let’s get back to Lab0
- On PC1 create a listening TCP socket on port 9999
- On PC2 connect a TCP socket to PC1:9999
- Write something and press CTRL+C to close
- Sniff the entire TCP flow on router (connection, data, close – use `tcpdump` and write to a file)
- Display the trace with wireshark

Exercise: TCP connection



tcp.pcap [Wireshark 1.6.2 (SVN Rev 38931 from /trunk-1.6)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Filter:
Expression... Clear Apply
Slide Show
Play
Unity
Full Screen

```
No.  Time       Source              Destination         Protocol Length Info
  1 0.000000   0a:ab:64:91:09:80   Broadcast           ARP      42 Who has 10.0.0.101?  Tell 10.0.0.1
  2 0.000176   6e:5f:98:37:0c:07   0a:ab:64:91:09:80   ARP      42 10.0.0.101 is at 6e:5f:98:37:0c:07
  3 0.000186   10.0.1.101          10.0.0.101          TCP      74 32973 > 50010 [SYN] Seq=0 Win=5840 Len
  4 0.000318   10.0.0.101          10.0.1.101          TCP      74 50010 > 32973 [SYN, ACK] Seq=0 Ack=1 W
  5 0.000423   10.0.1.101          10.0.0.101          TCP      66 32973 > 50010 [ACK] Seq=1 Ack=1 Win=58
  6 3.382944   10.0.1.101          10.0.0.101          TCP      71 32973 > 50010 [PSH, ACK] Seq=1 Ack=1 W
  7 3.383150   10.0.0.101          10.0.1.101          TCP      66 50010 > 32973 [ACK] Seq=1 Ack=6 Win=57
  8 11.214624  10.0.1.101          10.0.0.101          TCP      66 32973 > 50010 [FIN, ACK] Seq=6 Ack=1 W
  9 11.215401  10.0.0.101          10.0.1.101          TCP      66 50010 > 32973 [FIN, ACK] Seq=1 Ack=7 W
 10 11.215500  10.0.1.101          10.0.0.101          TCP      66 32973 > 50010 [ACK] Seq=7 Ack=2 Win=58
```

```
▷ Frame 6: 71 bytes on wire (568 bits), 71 bytes captured (568 bits)
▷ Ethernet II, Src: 0a:ab:64:91:09:80 (0a:ab:64:91:09:80), Dst: 6e:5f:98:37:0c:07 (6e:5f:98:37:0c:07)
▷ Internet Protocol Version 4, Src: 10.0.1.101 (10.0.1.101), Dst: 10.0.0.101 (10.0.0.101)
▷ Transmission Control Protocol, Src Port: 32973 (32973), Dst Port: 50010 (50010), Seq: 1, Ack: 1, Len: 5
▽ Data (5 bytes)
    Data: 6369616f0a
    [Length: 5]
```

```
0000  6e 5f 98 37 0c 07 0a ab  64 91 09 80 08 00 45 00   n_.7.... d.....E.
0010  00 39 d3 b6 40 00 3f 06  52 3f 0a 00 01 65 0a 00   .9..@.?. R?...e..
0020  00 65 80 cd c3 5a cc 85  7b 16 cc b3 c1 21 80 18   .e...Z.. {....!..
0030  0b 68 17 38 00 00 01 01  08 0a ff ff a9 f5 ff ff   .h.8.... ........
0040  ab de 63 69 61 6f 0a                               ..ciao.
```

Data (data), 5 bytes | Packets: 10 Displayed: 10 Marked: 0 Load time: 0:00.104 | Profile: Default

```
>>> Running pc1 specific startup script
>>> End of pc1 specific startup script.

########################################

Lab directory (host): /home/knoppix/Desl
Version: <none>
Author:  <none>
Email:   <none>
Web:     <none>
Description:
<none>

########################################

--- Netkit phase 2 initialization terminated ---

pc1 login: root (automatic login)
pc1:~# nc -lp 50010
ciao
pc1:~# 
```

```
Web:     <none>
Description:
<none>

################################################

--- Netkit phase 2 initialization terminated ---

router login: root (automatic login)
router:~# tcpdump -i eth0 -w /hosthome/tcp.pcap
tcpdump: listening on eth0, link-type EN10MB (Ethernet), capture size 96 bytes
^C10 packets captured
10 packets received by filter
0 packets dropped by kernel
router:~# 
```

```
############

sktop/esercitazione-2010/example2-lab

############

inated ---

pc2 login: root (automatic login)
Last login: Fri Jan 13 22:30:57 UTC 2012 on tty1
pc2:~# nc 10.0.0.101 50010
ciao
^C
pc2:~# 
```

VMware Tools is not installed. Choose the Virtual Machine > Install VMware Tools menu.

Advanced use of `netcat`

- We already saw `nc` as a chat ☺

- We can also transfer files:
  - `server:# nc -l 9000 > received_file`
  - `client:# cat file_to_send | nc $server 9000`

- Get a web page (like `wget`)
  - `client:# printf "GET / HTTP/1.0\\r\\n\\r\\n\n" | nc 160.80.103.147 80`

- Remote shell (dangerous – removed from bsd porting)
  - `server:# nc -l 9000 -e /bin/bash`
  - `client:# nc $server 9000`

- Perform a port scan (`-z` option)
  - `client# nc -v -z $target 7-1023`

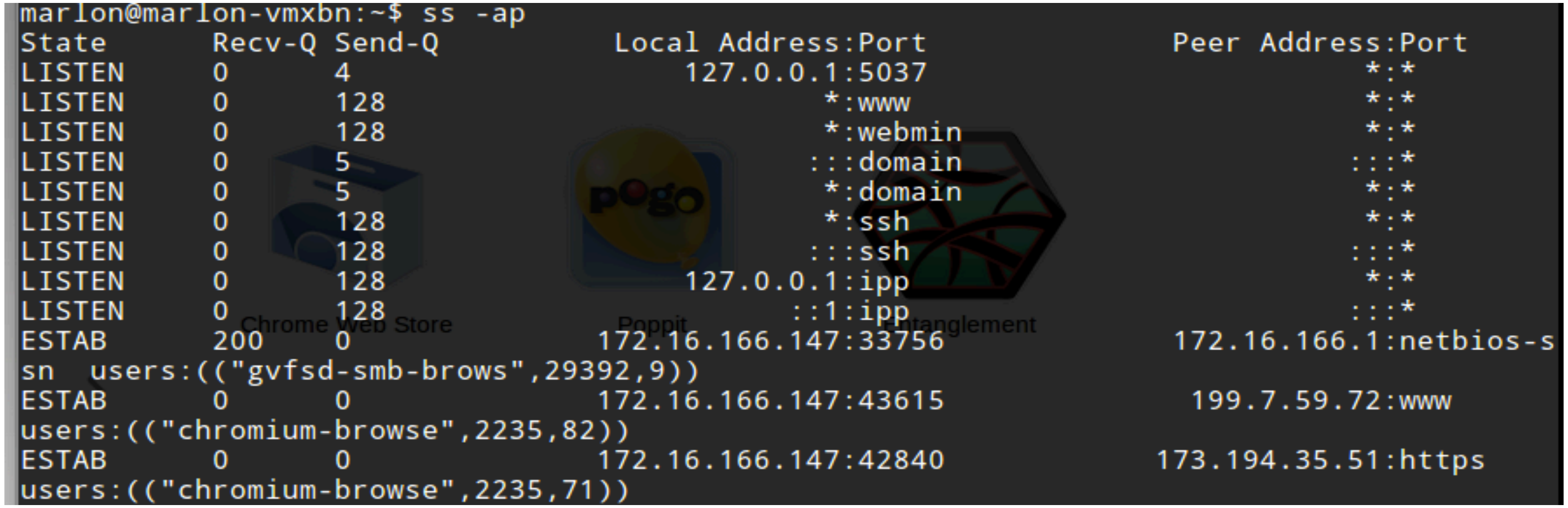
ss

- Utility to investigate sockets
- All TCP sockets, all UDP sockets, all established ssh / ftp / http / https connections, all local processes connected to X server, etc…
- Basic usage: # `ss [options] [filter]`

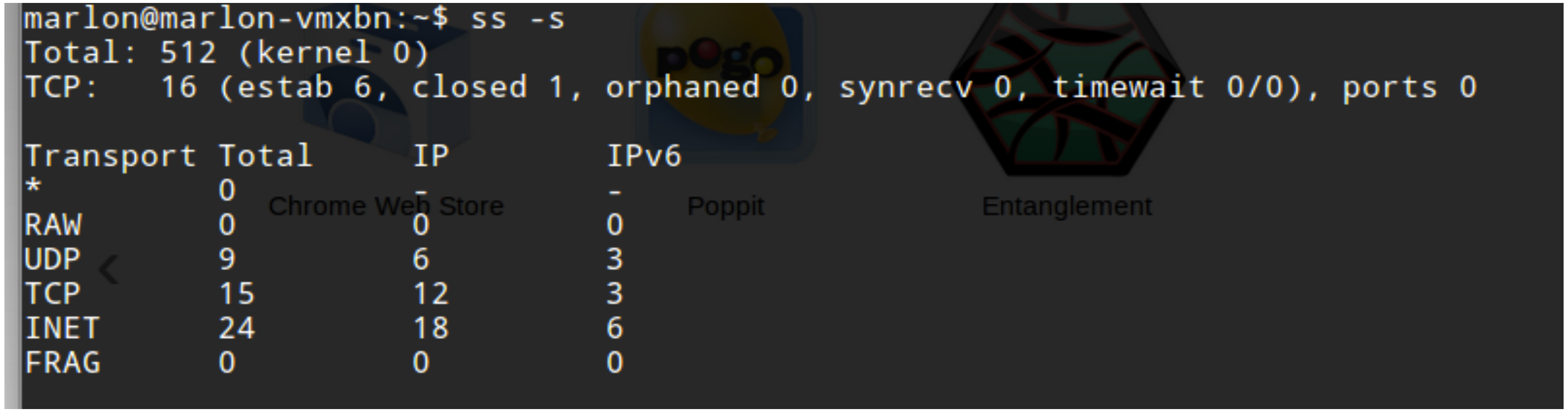
```
-s: display summary
-a: display both listening and non-listening
-l: display listening socket
-t: display TCP sockets
-u: display UDP sockets
-p: display processes using sockets

And many more…
```

- Documentation: `/usr/share/doc/iproute-doc/ss.html`

ss output



```
marlon@marlon-vmxbn:~$ ss -ap
State      Recv-Q Send-Q        Local Address:Port           Peer Address:Port
LISTEN     0      4                 127.0.0.1:5037                     *:*
LISTEN     0      128                       *:www                      *:*
LISTEN     0      128                       *:webmin                   *:*
LISTEN     0      5                       :::domain                   :::*
LISTEN     0      5                         *:domain                   *:*
LISTEN     0      128                       *:ssh                      *:*
LISTEN     0      128                      :::ssh                     :::*
LISTEN     0      128               127.0.0.1:ipp                      *:*
LISTEN     0      128                     ::1:ipp                     :::*
ESTAB      200    0            172.16.166.147:33756        172.16.166.1:netbios-s
sn  users:(("gvfsd-smb-brows",29392,9))
ESTAB      0      0            172.16.166.147:43615          199.7.59.72:www
users:(("chromium-browse",2235,82))
ESTAB      0      0            172.16.166.147:42840        173.194.35.51:https
users:(("chromium-browse",2235,71))
```



```
marlon@marlon-vmxbn:~$ ss -s
Total: 512 (kernel 0)
TCP:   16 (estab 6, closed 1, orphaned 0, synrecv 0, timewait 0/0), ports 0

Transport Total     IP        IPv6
*         0         -         -
RAW       0         0         0
UDP       9         6         3
TCP       15        12        3
INET      24        18        6
FRAG      0         0         0
```

Remote access - `telnet`

- Telnet protocol provides a fairly general, bi-directional, eight-bit byte oriented communications facility
- A telnet connection is a Transmission Control Protocol (TCP – listening port 23) connection used to transmit data with interspersed telnet control information
  - Data: 1st bit 0 (ASCII character)
  - Commands: 1st bit 1
- Nice article describing the protocol:
  - http://support.microsoft.com/kb/231866
- Typical use: remote shell
- Example PCAP trace:
  - http://stud.netgroup.uniroma2.it/cgrl/traces/telnet.pcap
- Client/server implementation for virtually all OSs!
  - On linux: `telnet/telnetd`
  - daemon usually not installed `(apt-get install telnetd)`
- Due to several security aspects it has been “abandoned” in favor of SSH

Remote Access - SSH

- Secure Shell (SSH) is a protocol for secure remote login and other secure network services over an insecure network

- RFCs define 3 major components:
  - The Transport Layer Protocol (RFC4252)
  - The User Authentication Protocol (RFC4253)
  - The Connection Protocol (RFC4254)

- OpenSSH (client/server implementation):
  - Encryption, Authentication, Data integrity
  - Secure file transfer (`scp`)
  - X session forwarding
  - Port forwarding
  - SOCKS4|5 proxy
  - Public Key authentication

- We won't take a look at the protocol, but we'll focus on some practical uses

OpenSSH installation and configuration (DEBIAN)

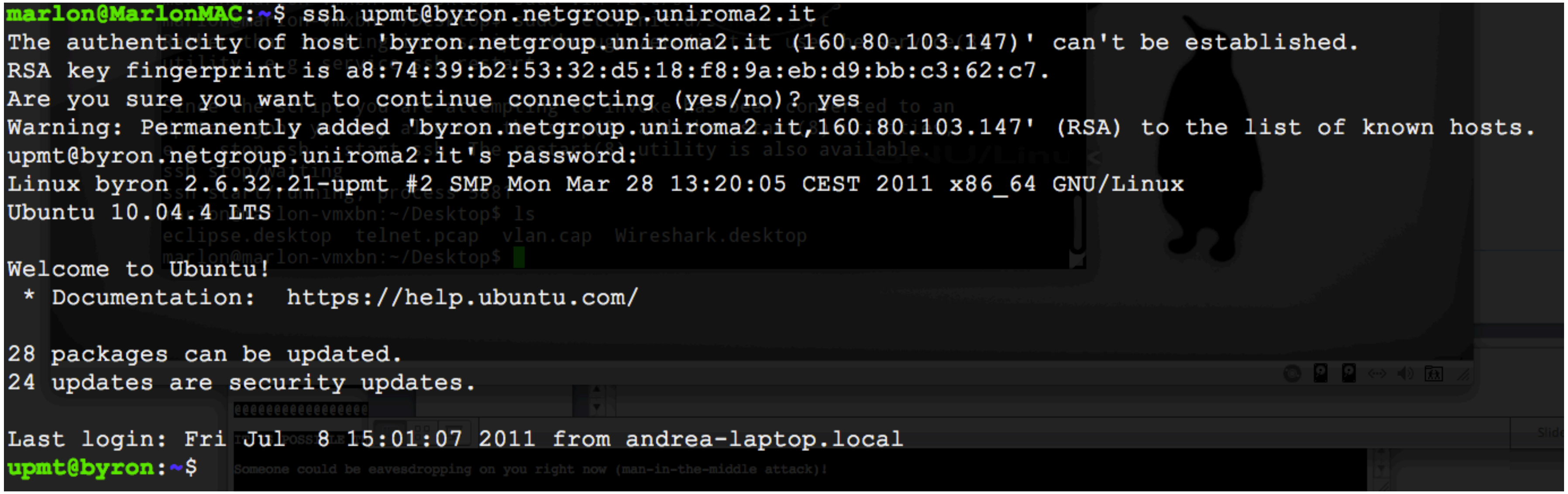
- `openssh-client` present in almost all Linux distribution (DEBIAN included)
- `openssh-server` usually not included
  - `apt-get install openssh-server`
- Configuration file in:
  - `Server: /etc/ssh/sshd_config`
  - `Client: /etc/ssh/ssh_config`
- Documentation:
  - `man (ssh_config|sshd_config)`
- Useful configuration parameters (server, except ServerAliveInterval):
  - `Protocol (1|2)`
  - `PermitRootLogin (yrs|no)`
  - `PasswordAuthentication (yes|no)`
  - `X11Forwarding` (yes|no)
  - `ServerAliveInterval` <seconds>
  - `DenyUsers <user list>` and `DenyGroups <group list>`
  - `UseDNS no`

- Remember to restart ssh to apply any changes in the configuration file
  - `/etc/init.d/ssh restart`

OpenSSH basic usage

To connect to a ssh server just type

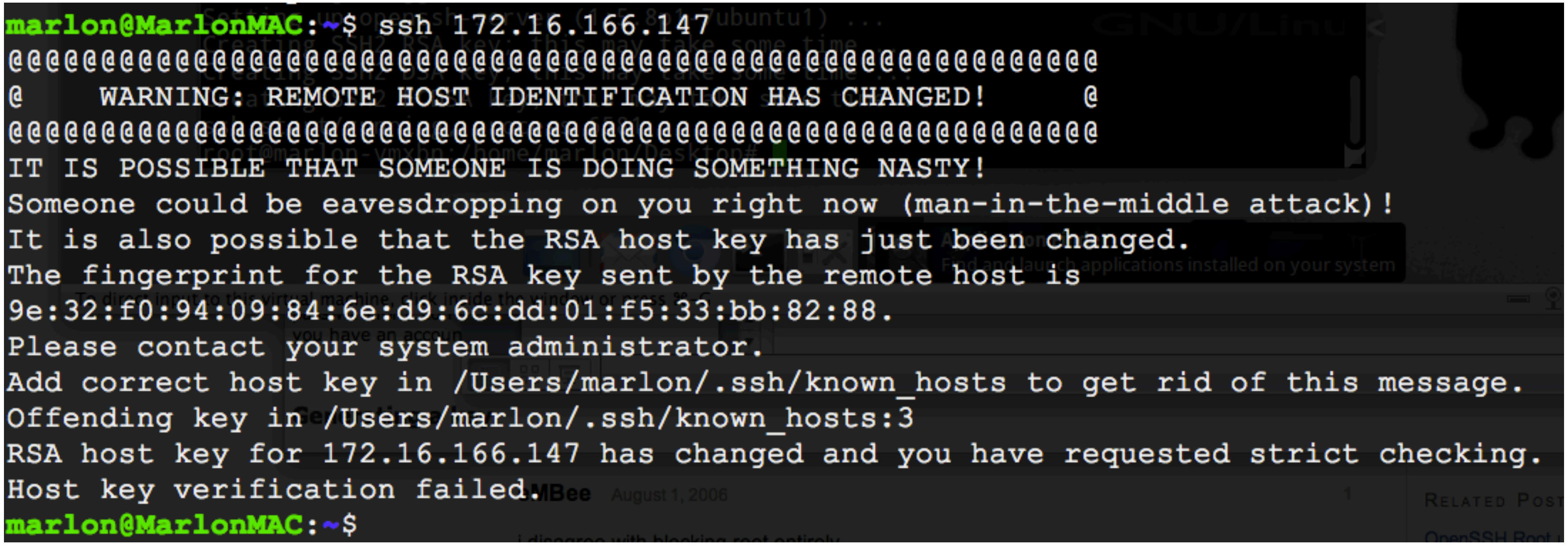
```
ssh user@server
```



```
marlon@MarlonMAC:~$ ssh upmt@byron.netgroup.uniroma2.it
The authenticity of host 'byron.netgroup.uniroma2.it (160.80.103.147)' can't be established.
RSA key fingerprint is a8:74:39:b2:53:32:d5:18:f8:9a:eb:d9:bb:c3:62:c7.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added 'byron.netgroup.uniroma2.it,160.80.103.147' (RSA) to the list of known hosts.
upmt@byron.netgroup.uniroma2.it's password:
Linux byron 2.6.32.21-upmt #2 SMP Mon Mar 28 13:20:05 CEST 2011 x86_64 GNU/Linux
Ubuntu 10.04.4 LTS

Welcome to Ubuntu!
 * Documentation:  https://help.ubuntu.com/

28 packages can be updated.
24 updates are security updates.

Last login: Fri Jul  8 15:01:07 2011 from andrea-laptop.local
upmt@byron:~$
```

- The server send it’s public key fingerprint
- The program asks you to verify the authenticity of the key
- Once the host is recognized, the server address is put in the file `~/.ssh/known_host`
- What if the key fingerprint doesn’t match the one stored in `~/.ssh/known_host`? See the next slide…

SSH key authentication failure



```
marlon@MarlonMAC:~$ ssh 172.16.166.147
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
@    WARNING: REMOTE HOST IDENTIFICATION HAS CHANGED!     @
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
IT IS POSSIBLE THAT SOMEONE IS DOING SOMETHING NASTY!
Someone could be eavesdropping on you right now (man-in-the-middle attack)!
It is also possible that the RSA host key has just been changed.
The fingerprint for the RSA key sent by the remote host is
9e:32:f0:94:09:84:6e:d9:6c:dd:01:f5:33:bb:82:88.
Please contact your system administrator.
Add correct host key in /Users/marlon/.ssh/known_hosts to get rid of this message.
Offending key in /Users/marlon/.ssh/known_hosts:3
RSA host key for 172.16.166.147 has changed and you have requested strict checking.
Host key verification failed.
marlon@MarlonMAC:~$
```

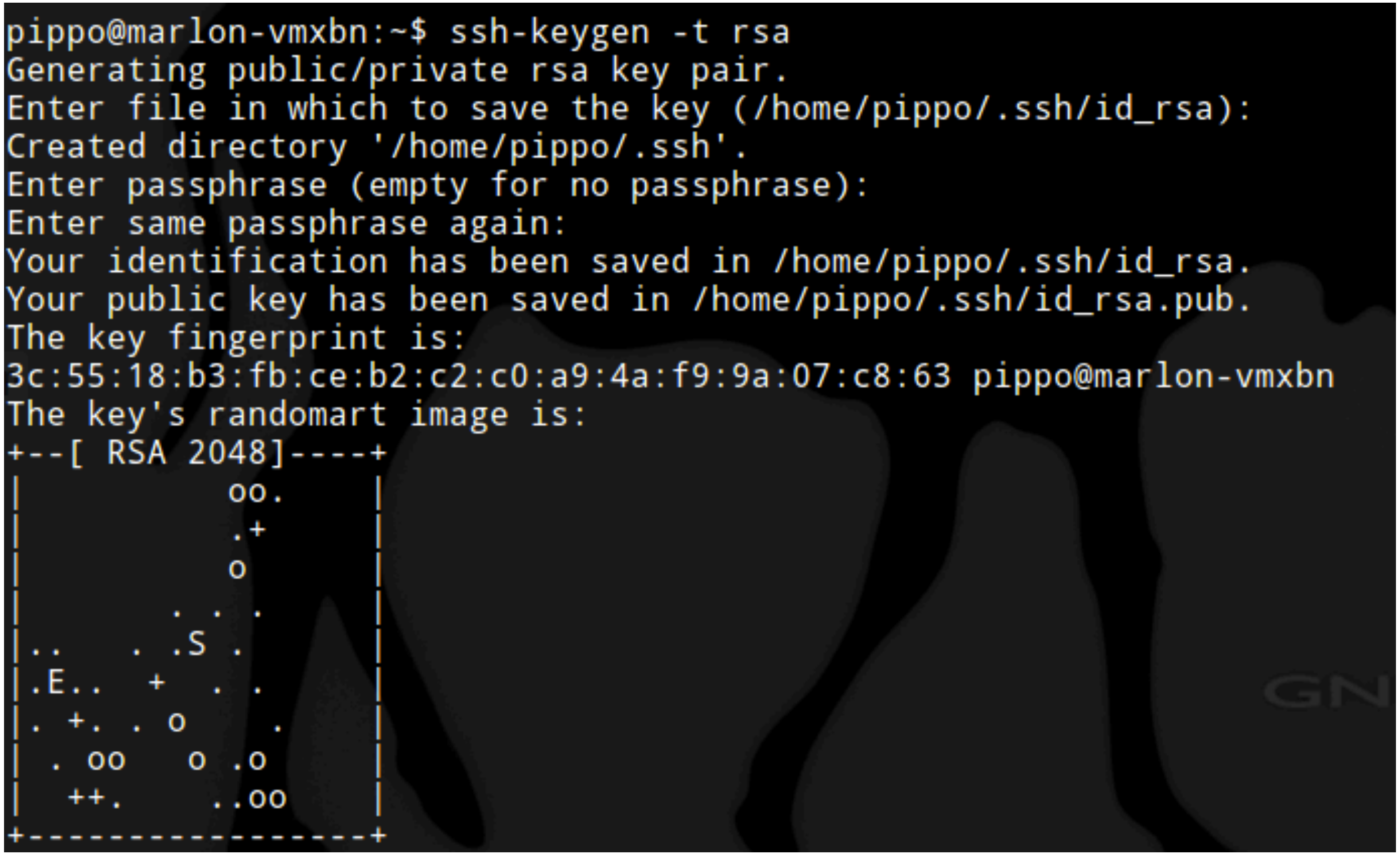
Not necessarily something nasty is happening!

E.g.: ssh has been reinstalled or a big update has request the generation of a new key (pair)

SSH public key authentication

- It might happen that a sysadmin doesn’t trust the strength of a user password
- Users’ account violation can lead to apocalyptic scenarios (sudoers users…)
- Public key authentication is a stronger auth method
- Users are requested to generate a public/private key
- The public key is manually (and over a secure channel) installed on the server
- The user is not authenticated via user/password verification, but via a “safer” cryptographically challenge/response mechanism (later on…)

Public key authentication with OpenSSH



```
pippo@marlon-vmxbn:~$ ssh-keygen -t rsa
Generating public/private rsa key pair.
Enter file in which to save the key (/home/pippo/.ssh/id_rsa):
Created directory '/home/pippo/.ssh'.
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/pippo/.ssh/id_rsa.
Your public key has been saved in /home/pippo/.ssh/id_rsa.pub.
The key fingerprint is:
3c:55:18:b3:fb:ce:b2:c2:c0:a9:4a:f9:9a:07:c8:63 pippo@marlon-vmxbn
The key's randomart image is:
+--[ RSA 2048]----+
|          oo.    |
|          .+     |
|          o      |
|       . . .     |
|..   . .S .      |
|.E..  +  . .     |
|. +. . o    .    |
| . oo   o .o     |
|  ++.    ..oo    |
+-----------------+
```

Public key authentication with OpenSSH

- The client generates the key pair

```
ssh-keygen -t (rsa|dsa)
```

- By default, the public key is stored in:

```
~/.ssh/id_rsa.pub
         or
~/.ssh/id_dsa.pub
```

- The public key has to be appended to the file `~/.ssh/authorized_keys` in the home of the authorized user
- 1st way, assuming that `id_rsa.pub` has been securely copied on the remote machine

```
cat id_rsa.pub >> ~/.ssh/authorized_keys
```

- 2nd way, with a tool provided by OpenSSH (from the client)

```
ssh-copy-id user@server
```

Exercise

- Back to Lab0-interfaces
- Install SSH server on router (if needed)
- Force public key authentication
- Configure public key authentication for user@router

Secure file transfer over SSH

- Basic usage
  - `scp [-r] [[user@]host1:]file1 ... [[user@]host2:]file2`
- `Examples`

```
1) scp file1 marlon@example.org:
2) scp marlon@example.org:file2 /home/marlon/dir/
3) scp –r dir/ marlon@example.org:/home/marlon/
dir_target
```

Where:

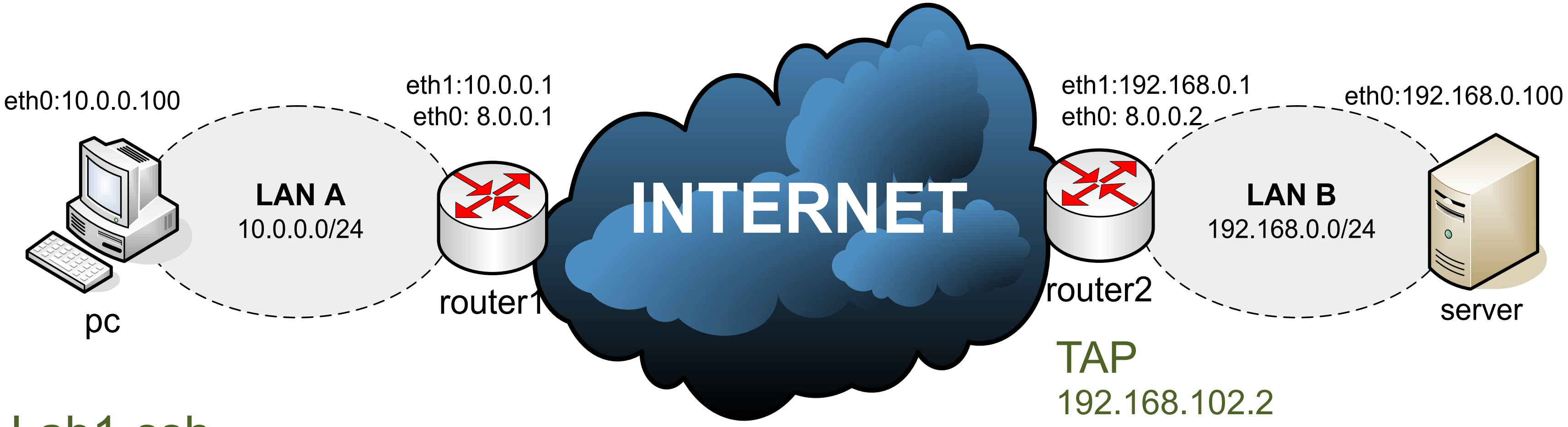
1) `file1` is copied in marlon’s home on the remote host
2) `file2` (in marlon’s remote home) is copied in the specified local path with the same name
3) The local directory `dir` is recursively copied into the specified remote path

OpenSSH advanced usage

- Running commands over ssh
  - `ssh username@server “command”`
- Forward X session
  - `ssh -X username@server`
- Local Port forward
  - `ssh -L lport:remote_addr:rport username@server`
- Remote port forward
  - `ssh -R rport:local_addr:lport username@server`
- Socks5 proxy
  - `ssh -ND 9999 username@server`
- Remote filesystem with sshfs
  - `sshfs  user@host: mountpoint`

- Nice tutorials:
  - http://www.subhashdasyam.com/2011/05/25-best-ssh-commands-tricks.html

Local Port Forwarding example



TAP
192.168.102.2

Lab1-ssh

Problem: router1 doesn't have the route to 192.168.0.0/24 (as in real world topologies…)

(Note: router1 and router2 on the same lan is not a real topology… let's pretend they reach each other through the internet…)

Goal: connect pc to server:2024 with nc trough a "SSH tunnel"

Preliminaries:

Install openssh-server on router2 (if not already installed)
Create a guest account (user) for ssh login on router2 (set the password for "user" account)

To reach server from pc:

1) Put server:2024 in listening on port 2024

```
server# nc -l -p 2024
```

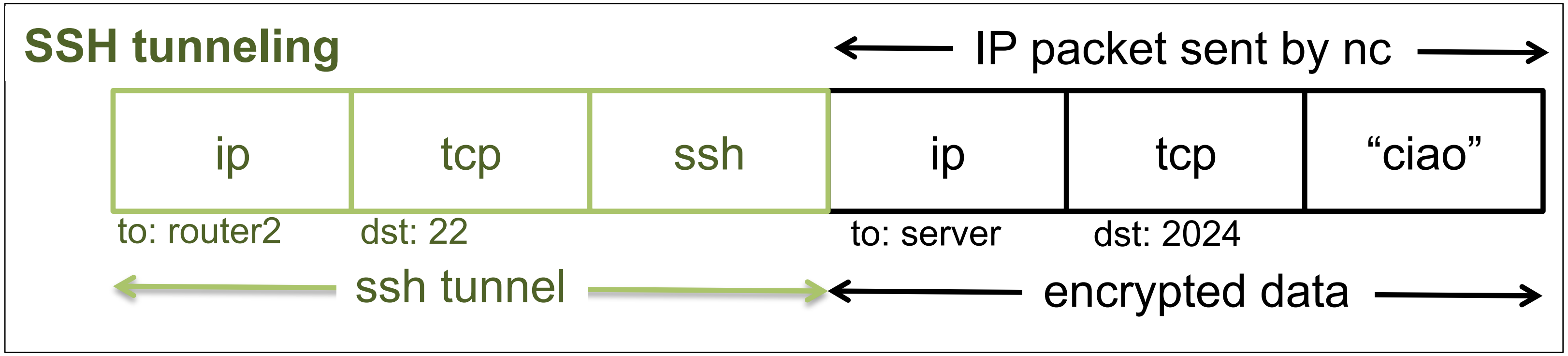
2) Run ssh port forwarding command on pc

```
pc# ssh -NL 3456:192.168.0.100:2024 user@8.0.0.2
```

3) Connect nc to server

```
pc# nc 127.0.0.1 3456
```

Local Port Forwarding: how it works



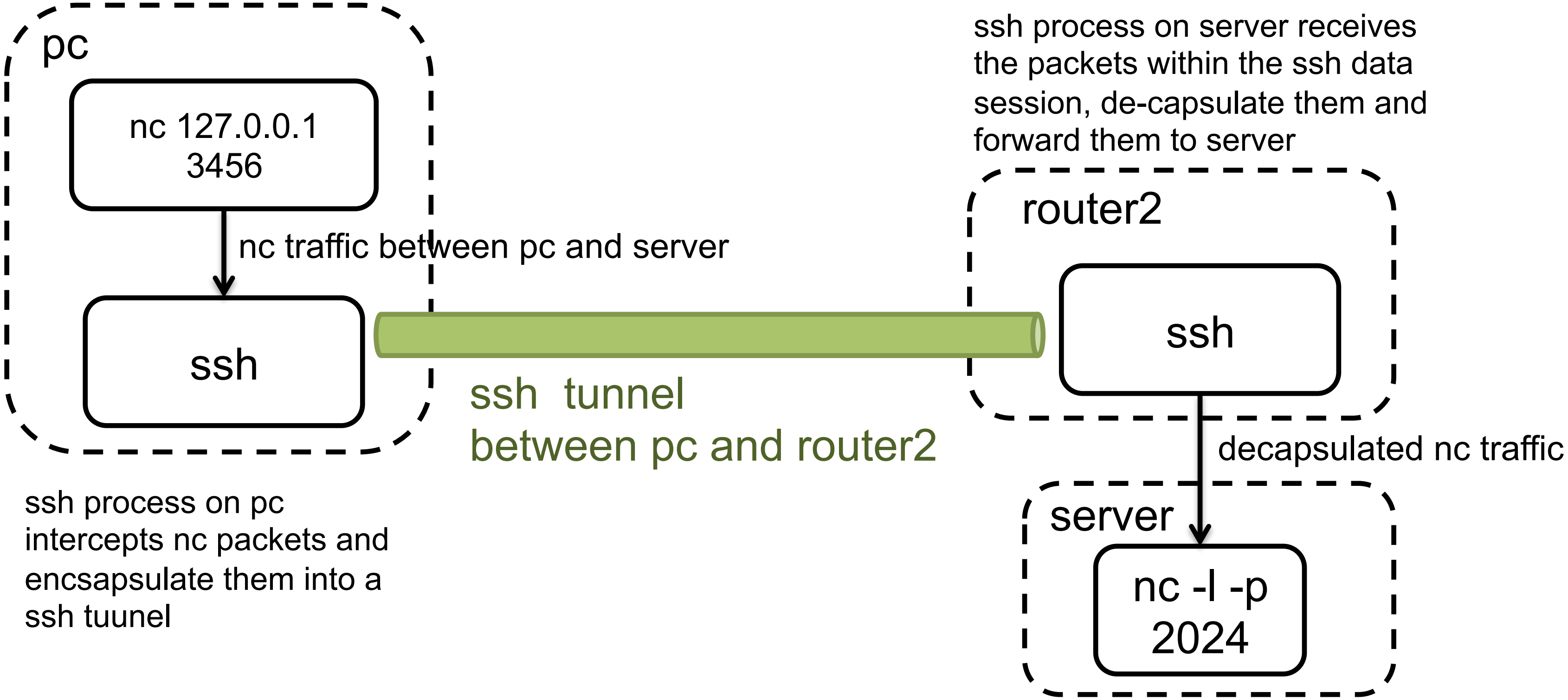
SSH tunneling

IP packet sent by nc

ip	tcp	ssh	ip	tcp	“ciao”
to: router2	dst: 22		to: server	dst: 2024	

ssh tunnel

encrypted data



pc

nc 127.0.0.1 3456

nc traffic between pc and server

ssh

ssh tunnel between pc and router2

router2

ssh

decapsulated nc traffic

server

nc -l -p 2024

ssh process on server receives the packets within the ssh data session, de-capsulate them and forward them to server

ssh process on pc intercepts nc packets and encsapsulate them into a ssh tuunel

SSH remote port forwarding

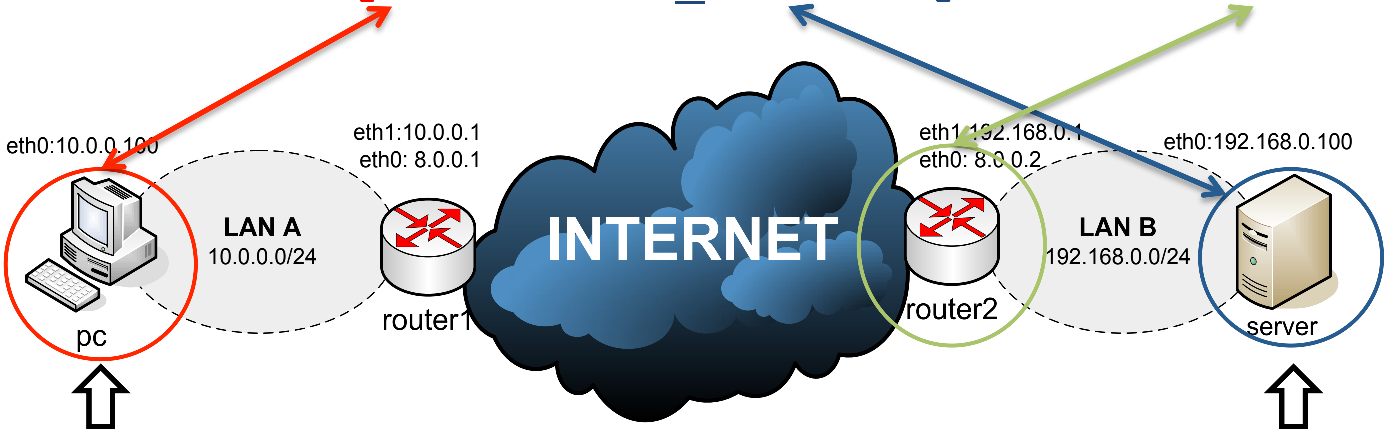
- Remote port fowarding
  - `ssh -NR r_port:local_addr:l_port user@server`
- In the previous example, we want to connect a tcp socket port 3000 from router2 to pc:2000
  - `pc# ssh  -NR 3000:10.0.0.100:2000 user@8.0.0.2`
- We put nc in linstening on pc
  - `pc# nc -l -p 2000`
- We connect nc from router2
  - `router2# nc 127.0.0.1 3000`

SSH port forwarding “for everyone”

- We can also set up a gateway that forwards ports for all hosts in a LAN
- For example, we can run ssh local port forwaring on router1 for all hosts in LAN A
  - `router1# ssh -NL 3456:192.168.0.100:2024 user@router2 -g`
- For remote port forwarding there’s no “-g” option
  - We have to set the following config option in sshd_config
    - `GatewayPorts yes`

SSH local port forwarding explained

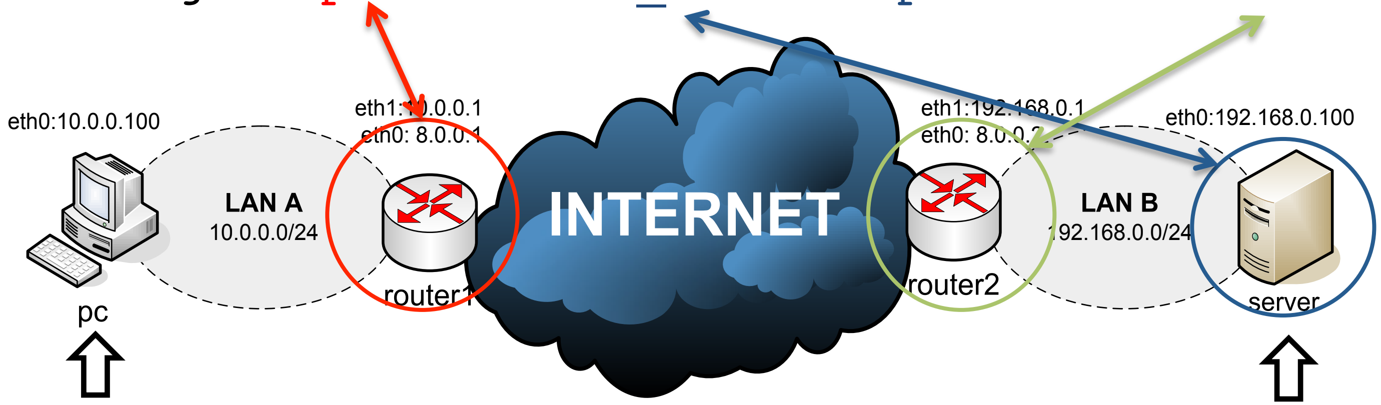
```
pc# ssh -NL lport:remote_addres:rport user@server
```



```
nc 127.0.0.1 port
```

```
nc -l -p rport
```

```
router1# ssh -gNL lport:remote_addres:rport user@server
```

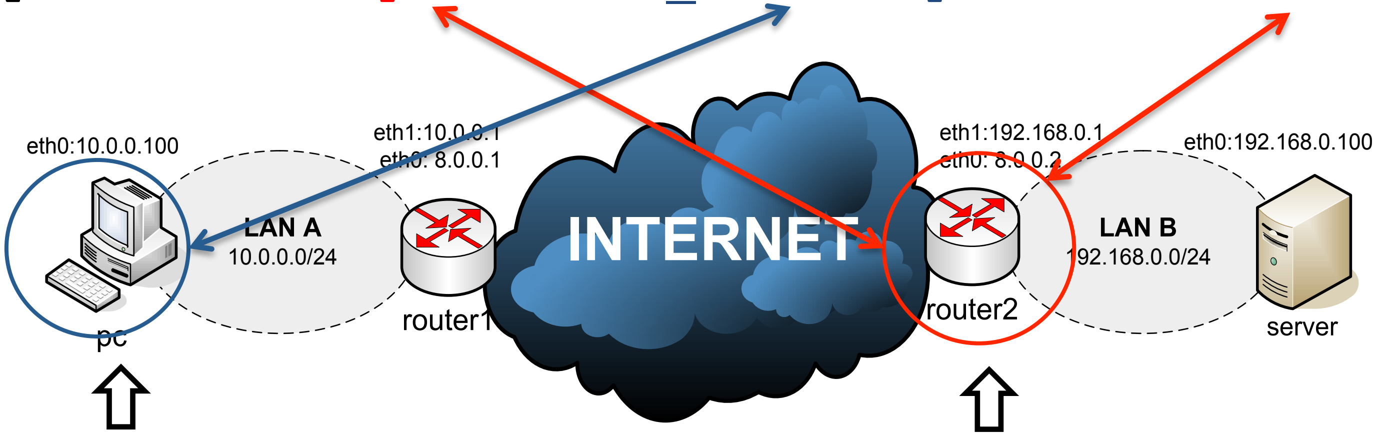


```
nc router1 lport
```

```
nc -l -p rport
```

SSH remote port forwarding explained

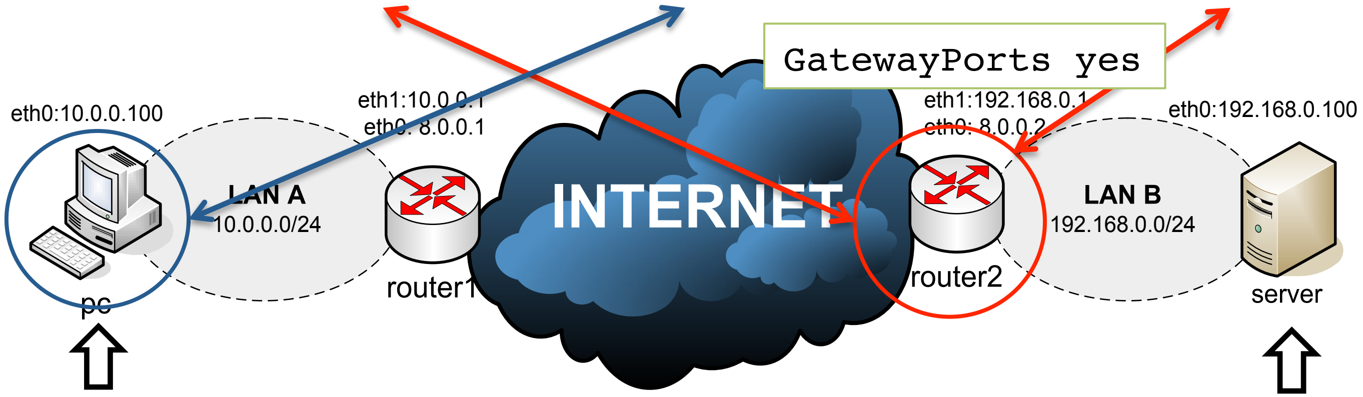
```
pc# ssh -NR rport:local_addres:lport user@server
```



```
nc -l –p lport
```

```
nc 127.0.0.1 rport
```

```
router1# ssh -NR rport:local_addres:lport user@server
```


```
GatewayPorts yes
```

```
nc -l -p lport
```

```
nc router2 rport
```

Shared screen and X forward with SSH

- Useful trick to share the same remote screen
  1. ssh to my machine marlonmac.local (or let's see what address I have now…) with the user "student" password "student"
  2. Attach to a already attached screen with "screen -r -x"
  3. Have fun!

- To run a graphic application on server
  - Set on server `sshd_config:`

    ```
    X11Forwarding yes
    ```

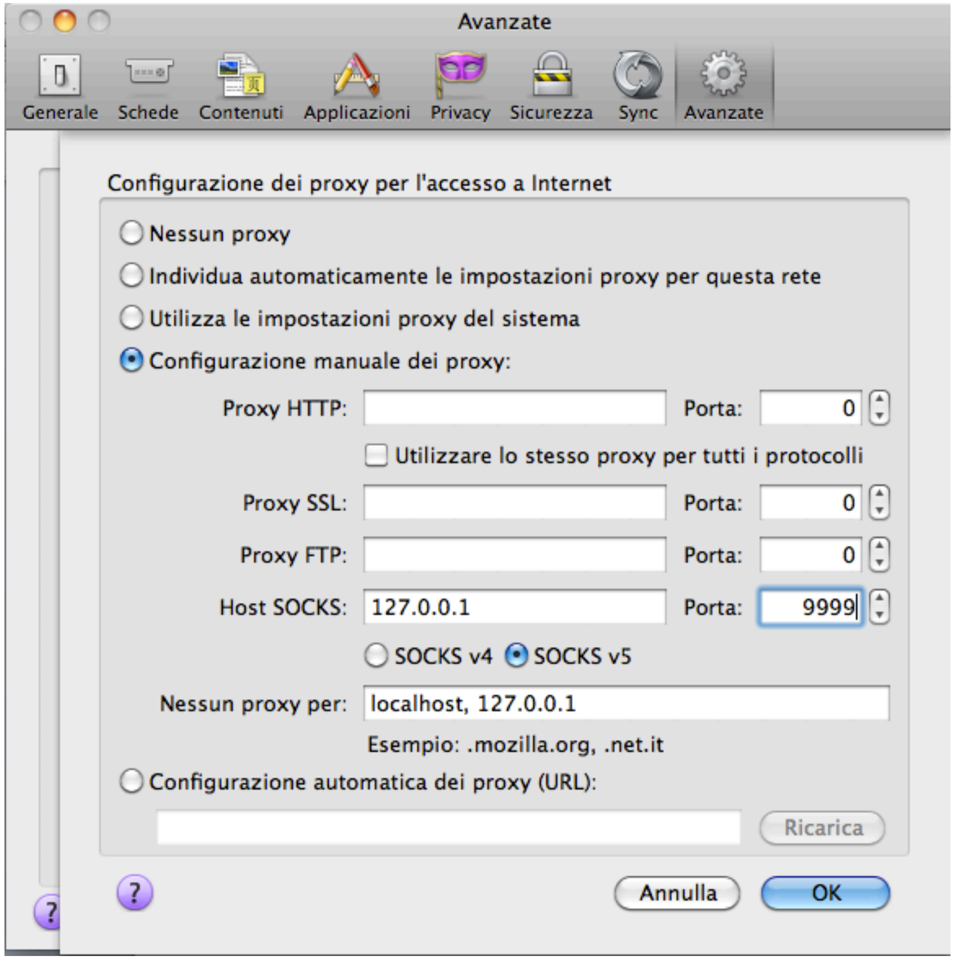
  - Run ssh on client

    ```
    client# ssh -X user@server
    ```

  - Run a graphic app on client

    ```
    client# xclock
    ```

SSH SOCKS5 proxy



Configurazione dei proxy per l'accesso a Internet

○ Nessun proxy

○ Individua automaticamente le impostazioni proxy per questa rete

○ Utilizza le impostazioni proxy del sistema

● Configurazione manuale dei proxy:

Proxy HTTP: Porta: 0

□ Utilizzare lo stesso proxy per tutti i protocolli

Proxy SSL: Porta: 0

Proxy FTP: Porta: 0

Host SOCKS: 127.0.0.1 Porta: 9999

○ SOCKS v4 ● SOCKS v5

Nessun proxy per: localhost, 127.0.0.1

Esempio: .mozilla.org, .net.it

○ Configurazione automatica dei proxy (URL):

```
Example:  ssh -ND 9999 username@server
```

SSH SOCKS5 test

- Copy Lab1-ssh/web_page_test/* into server:/var/www
- Configure firefox on the host machine to use a SOCKS5 local proxy
- Use router2 as relay to server

- Start apache in VM “server”
- Open the web page http://192.168.0.100, which is VM “server”

rsync

- Rsync is a fast and versatile file copying tool
- Rsync copies files either to or from a remote host, or locally on the current host
- Delta-transfer Algorithm
  - reduces the amount of data sent over the network by sending only the differences between the source files and the existing files in the destination
- Two modes:
  1. Through a secure shell (ssh, rsh)
  2. Contacting a remote rsync daemon directly via TCP
- Basic usages (man for the options..):

```
rsync -avz --progress foo:src/bar/ /data/tmp
rsync -av src/ dest/
rsync -av --delete host::src /dest
rsync -avd rsync:://host:src /dest
rsync -ravz --exclude=“*.o” foo:src/bar /data/tmp
```

- Nice tutorial
  - http://www.thegeekstuff.com/2010/09/rsync-command-examples/

Simple backup script with rsync in Lab1-ssh

```
#!/bin/sh
LOCAL=/root
REMOTE=/var/backup
HOST=8.0.0.1
LOG=/var/log/backup.log
SYNCLOG=/var/log/backup.synclog

#start log
echo $(date +"%d/%m/%Y") | cat >> $LOG
echo $(date +"%H:%M.%S") backup started... | cat >> $LOG

#Rsync
rsync --delete -azv -e ssh $LOCAL root@$HOST:$REMOTE | cat > $SYNCLOG

#end log
echo $(date +"%H:%M.%S") backup ended! | cat >> $LOG
```

1) Save the script in

```
/bin/rsyn_backup.sh
```

2) Make it executable

```
chmod +x /bin/rsyn_backup.sh
```

3) Add the cron job with the command

```
crontab -e
```

4) Put the following line

```
0 4 * * * /usr/local/bin/rsync_backup.sh
```

wget

- GNU Wget is a free utility for non-interactive download of files from the Web
- It supports HTTP, HTTPS, and FTP protocols, as well as retrieval through HTTP proxies
- Wget is non-interactive, meaning that it can work in the background, while the user is not logged on. This allows you to start a retrieval and disconnect from the system, letting wget finish the work
- Basic usage:
  - `wget` [*http://www.example.com/*](http://www.example.com/)
- Recursive download (1 folder):
  - `wget -l 1 -r byron.netgroup.uniroma2.it/~marlon/RAT`

  (Change 1 → “n” for more levels...)

wget - mirroring

```
wget  --recursive --no-clobber --page-requisites --adjust-
extension --convert-links --restrict-file-names=windows --
domains website.org --no-parent website.org
```

- --recursive: download the entire Web site
- --domains website.org: don't follow links outside website.org
- --no-parent: don't follow links outside the directory tutorials/html/
- --page-requisites: get all the elements that compose the page (images, CSS and so on)
- --adjust-extension: save files with the .html extension
- --convert-links: convert links so that they work locally, off-line
- --restrict-file-names=windows: modify filenames so that they will work in Windows as well
- --no-clobber: don't overwrite any existing files (used in case the download is interrupted and resumed)

source:
http://www.linuxjournal.com/content/downloading-entire-web-site-wget