IP network tools & troubleshooting

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Network configuration

- Reminder, configure your network in /etc/ rc.conf (x = your IP, from .10 to ...)

```
ifconfig_bge0=”41.215.76.x/24”
defaultrouter=”41.215.76.254”
ipv6_enable="YES"
ipv6_ifconfig_em0="2001:470:933d::x/64"
ipv6_defaultrouter=”2001:470:933d::254"
```

Network configuration

- You can do this from the command line:

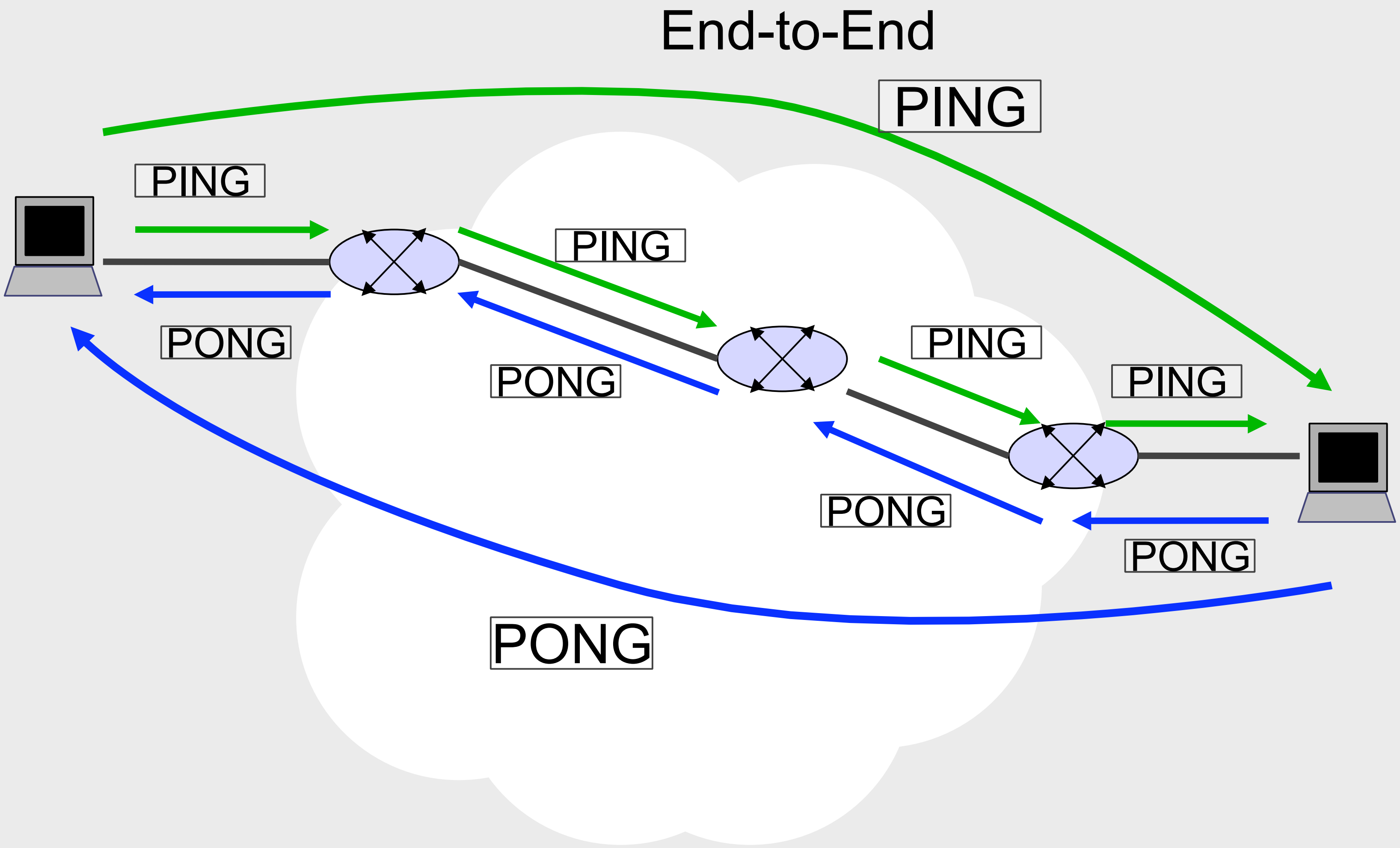
```
ifconfig em0 41.215.76.x/24
route add default 41.215.76.254
```

```
ifconfig em0 inet6 2001:470:933d::x
route add -inet6 default 2001:470:933d::254
```

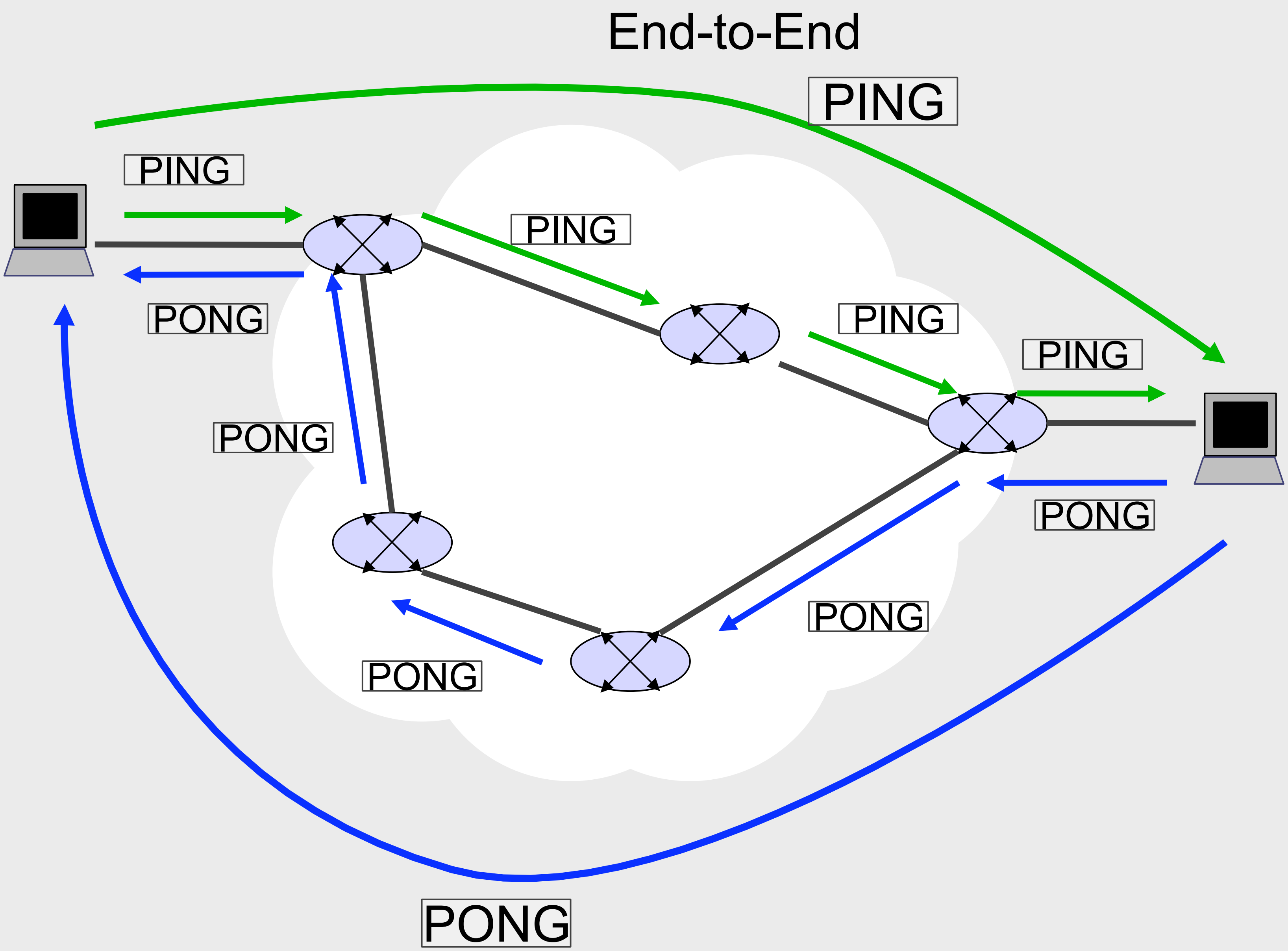
The IP end-to-end principle

- IP is an end-to-end protocol
- The network doesn't keep track of connections
- The host takes a decision on where to send *each packet*
- The network equipment takes a decision on where to forward packets *every time*
- **The path is not necessarily symmetric**
- Cost constraints, reconfiguration of the network, network failures can make the IP packets

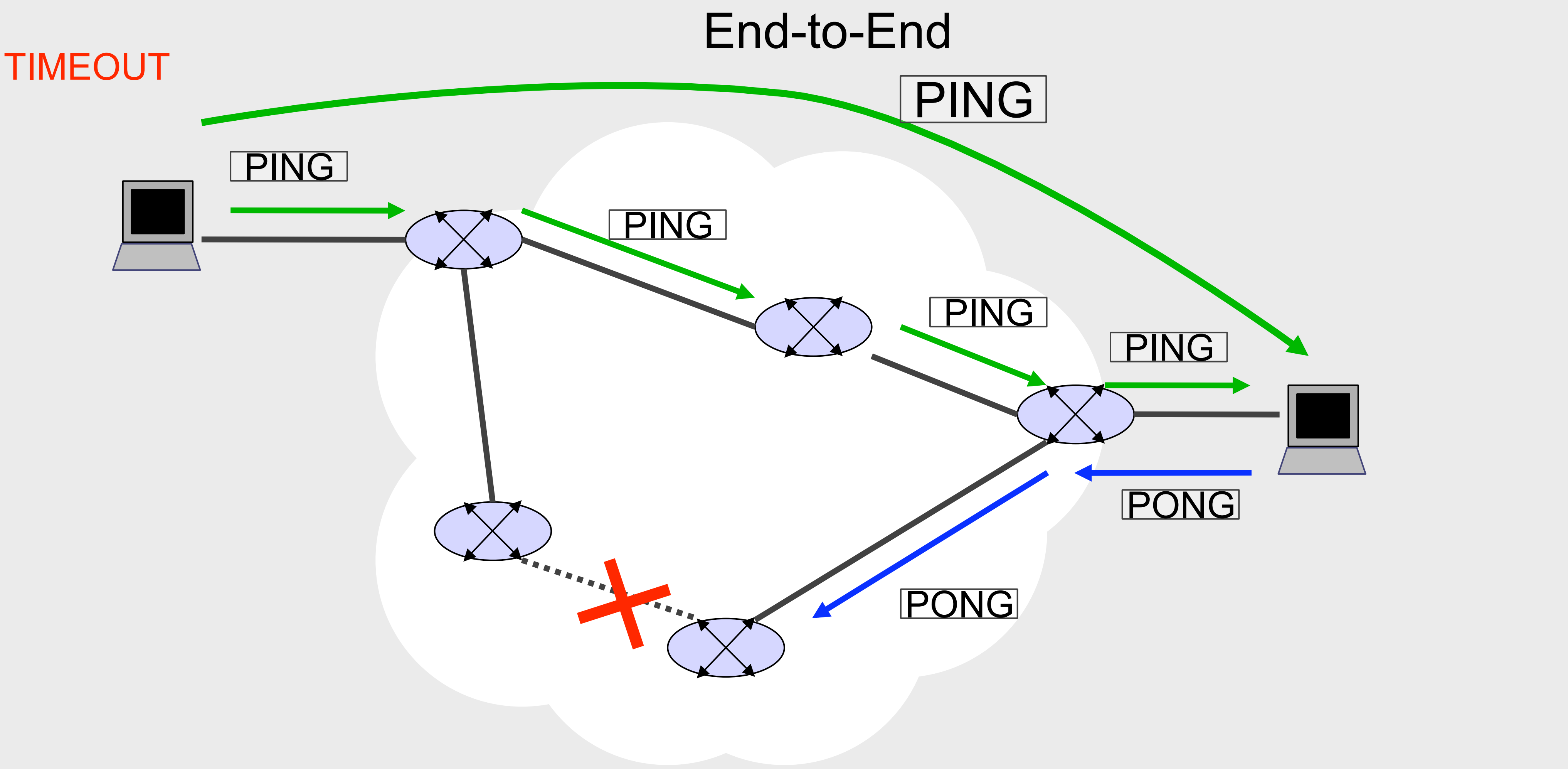
IP path



IP path


End-to-End
PING
PING
PING
PING
PING
PONG
PONG
PONG
PONG
PONG
PONG

IP path



Network tools

- What network tools can we use to troubleshoot ?

- **ping** – requests echo reply from a computer
- **traceroute** – show path taken by IP packets through a network
- **tcpdump** – show network traffic
- **netstat** – show routing entries and listening/active sockets
- **arp** – show/modify the IP <-> MAC address table
- **ndp** – show debug/ndp (Neighb. Disc. Protocol)
- **route** – show/modify the routing table
- **mtr** – combines ping & traceroute

ping

- usage:

  ```
  ping hostname_or_IP_address
  ping6 hostname_or_IPv6_address
  ```

- ping sends an ICMP/ICMP6 echo request (type 8), and the responding host sends an ICMP/ICMP6 echo reply (type)
- ICMP and ICMP6 sit on top of IP, side by side with TCP and UDP

ping – sample output

```
# ping 196.200.218.254
PING 196.200.218.254 (196.200.218.254): 56 data bytes
64 bytes from 196.200.218.254: icmp_seq=0 ttl=255 time=0.424 ms
64 bytes from 196.200.218.254: icmp_seq=1 ttl=255 time=0.429 ms
64 bytes from 196.200.218.254: icmp_seq=2 ttl=255 time=0.468 ms
...
```

```
# ping6 2001:4348:0:223:196:200:223:254
PING6(56=40+8+8 bytes) 2001:4348:0:218:196:200:218:1 -->
2001:4348:0:223:196:200:223:254
16 bytes from 2001:4348:0:223:196:200:223:254, icmp_seq=0 hlim=64 time=0.426 ms
16 bytes from 2001:4348:0:223:196:200:223:254, icmp_seq=1 hlim=64 time=0.451 ms
16 bytes from 2001:4348:0:223:196:200:223:254, icmp_seq=2 hlim=64 time=0.446 ms
```

Traceroute

- discover path taken by packets on the way to another host
- usage:

```
$ traceroute [-n] hostname_or_IP
( -n == no DNS lookup )
```

```
# traceroute afnog.org
traceroute to afnog.org (196.216.2.34), 64 hops max, 40 byte packets
 1  196.200.218.254 (196.200.218.254)  0.435 ms  0.323 ms  0.311 ms
 2  l181-2-205-33-192-81.l181-2.iam.net.ma (81.192.33.205)  1.628 ms  1.330 ms
1.367 ms
 3  172.20.2.31 (172.20.2.31)  1.485 ms  1.517 ms  1.423 ms
 4  ppp-20-3-217-212.dialup.iam.net.ma (212.217.3.20)  1.360 ms  1.376 ms  1.443
ms
 5  pal2-almaghrib-2.pal.seabone.net (195.22.197.41)  58.213 ms  58.178 ms
58.205 ms
 6  POS4-3.BR1.LND9.ALTER.NET.25 (146.188.70.25)  70.771 ms  68.942 ms  70.539 ms
```

Traceroute - IPv6

- usage:

```
$ traceroute6 [-n] hostname_or_IPv6
( -n == no DNS lookup )
```

```
# traceroute6 -n x1.x0.dk
traceroute6 to x1.x0.dk (2001:41d0:1:2cc8::1) from
      2001:4348:0:218:196:200:218:1, 64 hops max, 12 byte packets

 1  2001:4348:0:218:196:200:218:254  0.449 ms  0.363 ms  0.338 ms
 2  2001:418:1:101::1  232.759 ms *  232.122 ms
 3  * 2001:418:0:5000::25  252.862 ms  232.198 ms
 4  2001:450:2008:1020::2  235.555 ms  232.634 ms  232.478 ms
```

Traceroute – how does it work ?

- uses the TTL property of IP packets

  send the first packet with a TTL of 1, to the destination host.

  the gateway sees the TTL of 1, decrements it to 0, and returns a “TTL expired” message to the sending host

  send the second packet, still for the destination host, but this time with a TTL of 2

  the first gateway lets the packet go through, decrements the TTL from 2 to 1, and passes it on to the next hop

  the second gateway decrements the TTL from 1 to 0, and returns a TTL expired message to the sending host

  etc...

netstat

- Allows you to view the status of your network
- The routing table - usage:

```
$  netstat [-n] -r                          # v4,v6
$ netstat [-n] -r -f inet                 # ipv4
$ netstat [-n] -r -f inet6       # ipv6
```

```
$  netstat -n -r -f inet
Routing tables

Internet:
Destination        Gateway            Flags    Refs      Use  Netif
Expire
default            196.200.218.254    UGS         1     4610   bge0
127.0.0.1          link#3             UH          0      108    lo0
196.200.218.0/24   link#1             U           0      881   bge0
196.200.218.148    link#1             UHS         0        0    lo0
```

netstat

- The open connections and listening sockets:

```
$ netstat [-n] -a
```

```
$ netstat -a -n
Active Internet connections (including servers)↰
Proto Recv-Q Send-Q  Local Address          Foreign Address        (state)↰
tcp4       0      0  196.200.218.1.22       196.200.216.49.63843 ESTABLISHED
tcp4       0      0  *.22                   *.*                    LISTEN
tcp6       0      0  *.22                   *.*                    LISTEN
udp4       0      0  *.514                  *.*
udp6       0      0  *.514                  *.*
Active UNIX domain sockets
Address  Type   Recv-Q Send-Q    Inode      Conn      Refs  Nextref Addr
c55155e8 stream
0

     0 c556c770        0        0        0 /tmp/ssh-1To0610lI7/agent.983
...
```

ARP

- Used to show IPv4 <-> MAC address lookup tables
- Usually ethernet
- Usage:

```
$ arp -a
```

```
$ arp -a
? (196.200.218.148) at 00:1e:c9:52:86:be on bge0 permanent
[ethernet]
? (196.200.218.254) at 00:25:45:6a:5b:39 on bge0 [ethernet]
```

ARP on v6 ?

- No ARP on v6...
- Use 'ndp'

```
test# ndp -a
Neighbor                       Linklayer Address  Netif Expire    S Flags
2001:4348:0:218:196:200:218:1    0:1e:b:b2:f7:e0  em0 20h35m18s S
2001:4348:0:218:196:200:218:200  0:1e:b:b5:a3:c9  em0 permanent R
2001:4348:0:218:196:200:218:254  0:1c:58:22:1c:e0 em0 17h15m2s  S R
fe80::21c:58ff:fe22:1ce0%em0     0:1c:58:22:1c:e0 em0 17h14m43s S R
fe80::21e:bff:feb5:a3c9%em0      0:1e:b:b5:a3:c9  em0 permanent R
fe80::1%lo0                      (incomplete)     lo0 permanent R
```

The route command

- The route command it used to modify or query the routing table. Examples for IPv4:

```
route [-n] get default
route add 196.216.2.34 196.200.218.254
route add default 196.200.218.253
route change default 196.200.218.254
```

```
# route get default
   route to: default
destination: default
       mask: default
    gateway: 196.200.218.254
  interface: bge0
      flags: <UP,GATEWAY,DONE,STATIC>
...
```

The route command

- Examples for IPv6

```
route [-n] get -inet6 default
route add 2001:4348:0:223:196:200:223:1
  2001:4348:0:218:196:200:218:254
route add -inet6 default
  2001:4348:0:218:196:200:218:254
route change -inet6 default
  2001:4348:0:218:196:200:218:254
```

```
 route -n get -inet6 default
   route to: ::
destination: ::
       mask: default
    gateway: 2001:4348:0:218:196:200:218:254
  interface: bge0
      flags: <UP,GATEWAY,DONE,STATIC>
...
```

tcpdump

- tcpdump used to view network traffic on the wire
- basic usage:

```
# tcpdump [-e] [-n] -i if0 [expr.]
```

... where *if0* is your interface (e.g.: bge0)

- To set how much data you want to see, use the '-s' option, for example: -s1500
- Expr limits the traffic to certain types (default IPv4)

```
# tcpdump -n -i bge0 icmp
# tcpdump -n -i bge0 -s1500 tcp and not port 22
# tcpdump -n -i bge0 icmp6
```

tcpdump

- Example:

```
# tcpdump -n -i bge0
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on bge0, link-type EN10MB (Ethernet), capture size 96 bytes
20:47:08.700828 IP 196.200.218.148.22 > 196.200.216.43.38378: Flags [P.],
ack 2892018734, win 8326, options [nop,nop,TS val 1949407208 ecr 35128236],
length 192
20:47:08.701938 IP 196.200.216.43.38378 > 196.200.218.148.22: Flags [.], ac
192, win 999, options [nop,nop,TS val 35128237 ecr 1949407208], length 0
20:47:09.108777 ARP, Request who-has 172.16.0.55 tell 172.16.4.164, length
46
20:47:09.657099 STP 802.1d, Config, Flags [none], bridge-id 80da.
00:09:43:a0:79:80.8005, length 43
20:47:09.722271 IP 196.200.218.148.22 > 196.200.216.43.38378: Flags [P.],
ack 1, win 8326, options [nop,nop,TS val 1949408209 ecr 35128237], length
352
```

Tcpdump - IPv6

- Example (with -e to see ethernet addresses)

```
# tcpdump -e -ni bge0 ip6

19:44:43.434075 00:1e:0b:b2:f7:e0 > 33:33:ff:18:02:00, ethertype IPv6
(0x86dd), length 86: 2001:4348:0:218:196:200:218:1 > ff02::1:ff18:200:
ICMP6, neighbor solicitation, who has 2001:4348:0:218:196:200:218:200,
length 32

19:44:43.434104 00:1e:0b:b5:a3:c9 > 00:1e:0b:b2:f7:e0, ethertype IPv6
(0x86dd), length 86: 2001:4348:0:218:196:200:218:200 >
2001:4348:0:218:196:200:218:1: ICMP6, neighbor advertisement, tgt is
2001:4348:0:218:196:200:218:200, length 32

19:44:43.434496 00:1e:0b:b2:f7:e0 > 00:1e:0b:b5:a3:c9, ethertype IPv6
(0x86dd), length 70: 2001:4348:0:218:196:200:218:1 >
2001:4348:0:218:196:200:218:200: ICMP6, echo request, seq 0, length 16

19:44:43.434505 00:1e:0b:b5:a3:c9 > 00:1e:0b:b2:f7:e0, ethertype IPv6
(0x86dd), length 70: 2001:4348:0:218:196:200:218:200 >
2001:4348:0:218:196:200:218:1: ICMP6, echo reply, seq 0, length 16
```

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mtr

- Can be obtained with pkg_add -r mtr
- Combines traceroute & ping – works with v4 & v6

```
# mtr [hostname or IP]

Keys:  Help   Display mode   Restart statistics   Order of fields   quit
                                                Packets               Pings
 Host                           Loss%   Snt   Last   Avg  Best  Wrst StDev
 1. 2001:4348::216:196:200:217 0.0%     6    2.5   2.7   2.5   2.9   0.2
 2. 2001:418:1:101::1          0.0%     6  235.0 235.6 234.0 238.7   1.8
 3. fa-4-6.r00.sttlwa01.us.bb 16.7%     6  239.5 239.1 234.8 249.7   6.2
 4. 2001:450:2008:1020::2      0.0%     6  235.1 234.9 234.1 235.9   0.6
 5. ???
 6. ???
 7. ???
 8. ???
 9. ???
10. 2001:41d0:1:2cc8::1        0.0%     5  406.8 405.9 402.0 409.0   2.6
```

Questions ?

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