packet filters using cisco access lists

Fri 19 June 97

Packet Filters

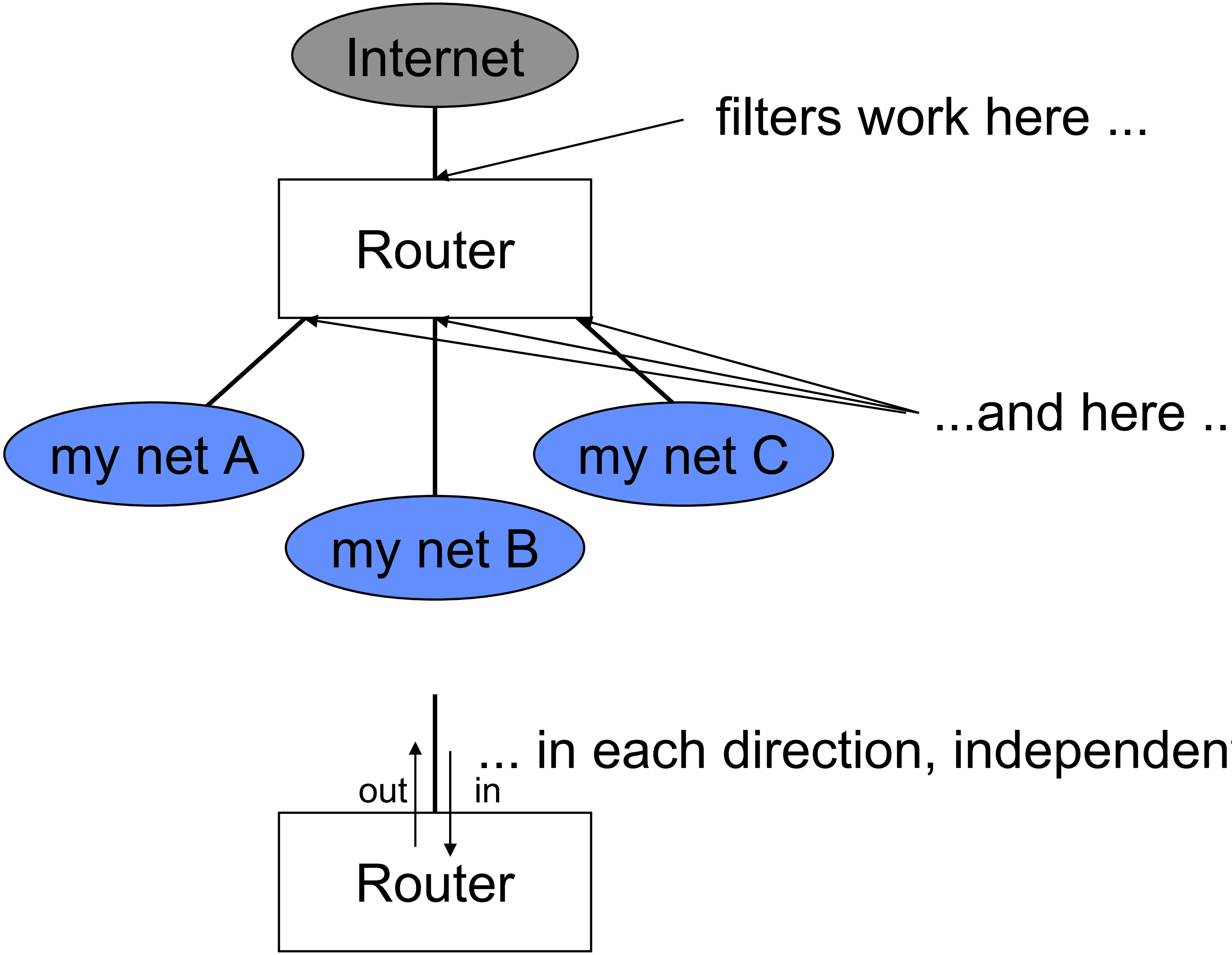
A *packet filter* is a set of rules that determine whether a packet gets through an interface, or gets dropped.

```
permit <test 1>
deny   <test 2>
deny   <test 3>
permit <test 4>
(deny <everything else>)
```

rules are evaluated in order;
    if test is true, action is taken;
    if test is not true , go to next rule

Packet filters are inherently paranoid --
packets are denied if not explicitly allowed

Packet Filter Locations



filters work here ...

...and here ..

... in each direction, independen

Rules

a packet filter rule looks like this:

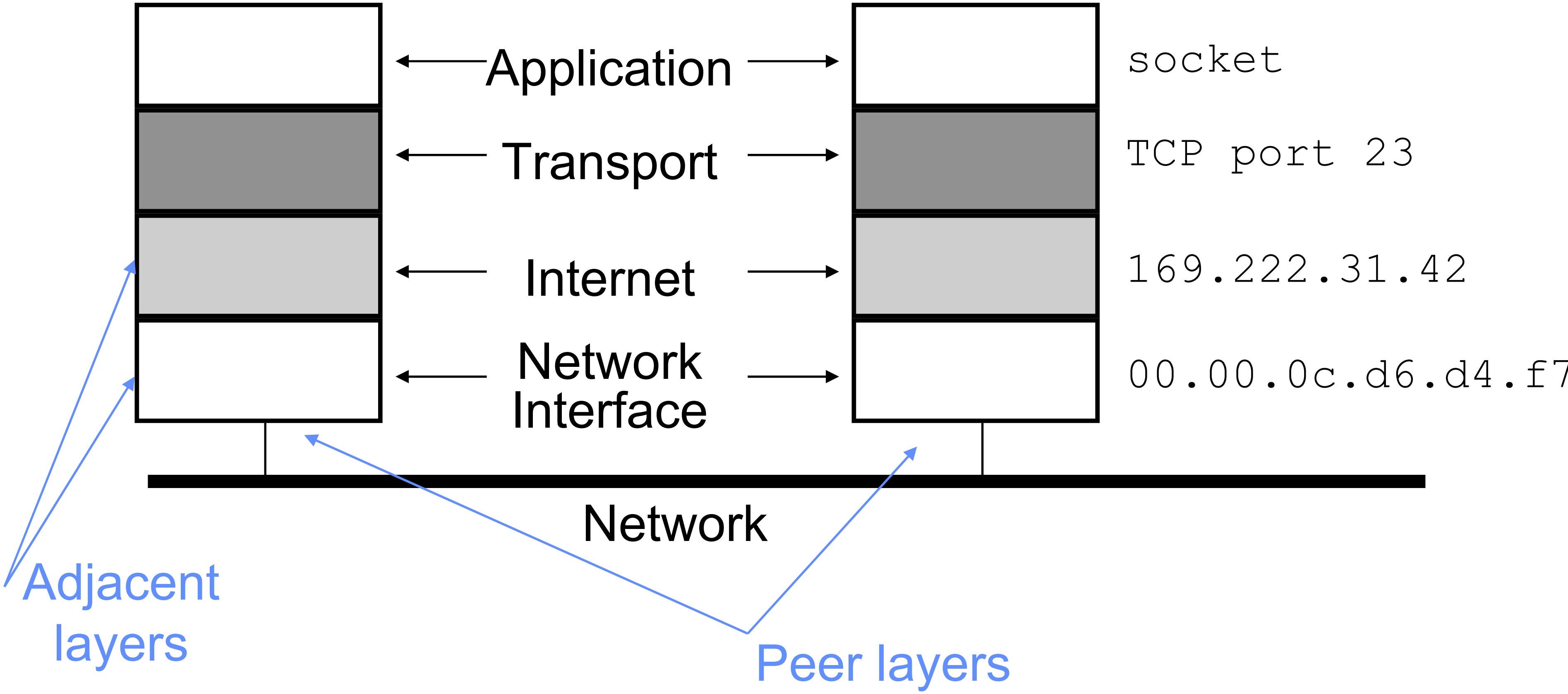
```
permit <src-ip, src-port> <dst-ip, dst-port>
deny   <src-ip, src-port> <dst-ip, dst-port>
```

to block TFTP packets:

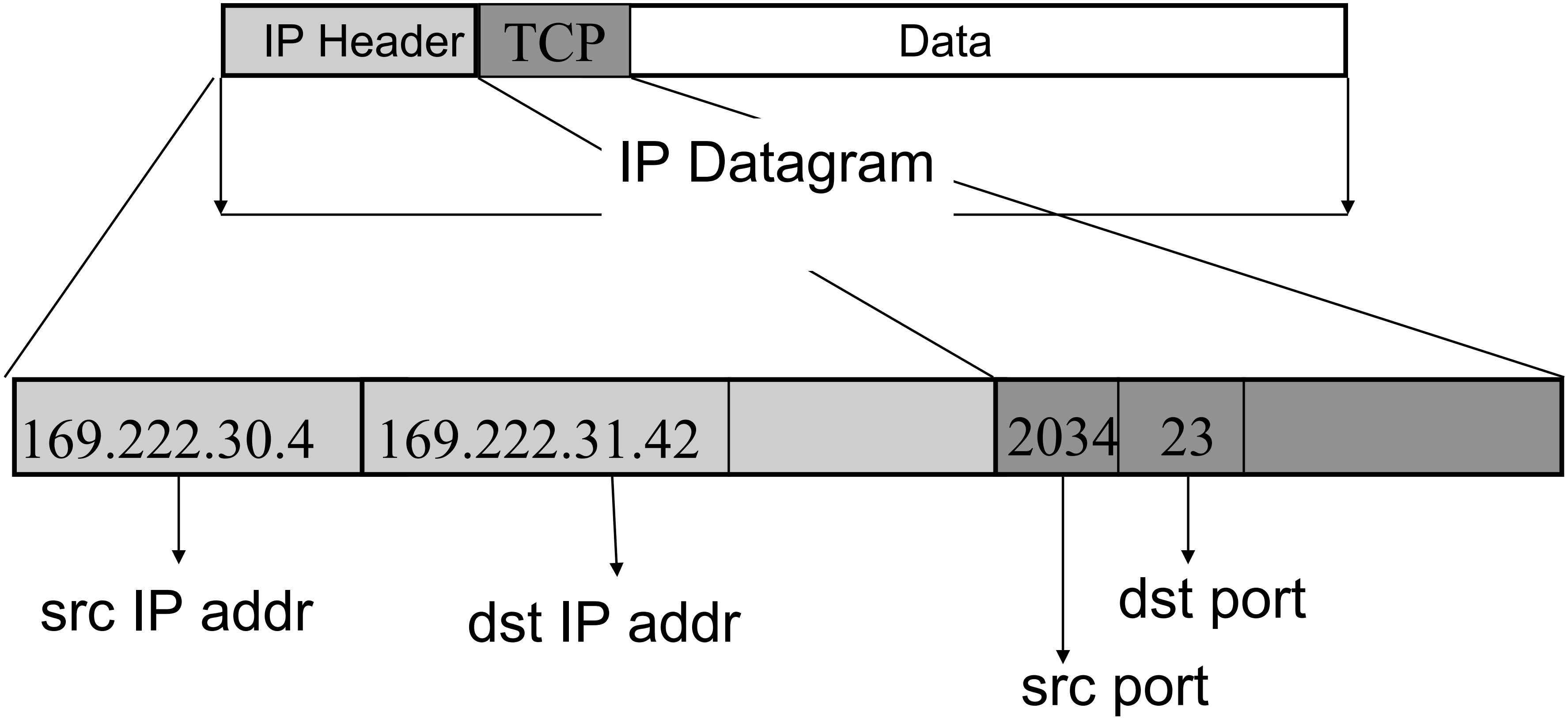
```
filter1 = {
   deny any any any udp-port 69;
   permit any any any any;
}

apply filter1 in interface 1;
apply filter1 out interface 1;
```

The IP Stack


Application
Transport
Internet
Network Interface
Network
socket
TCP port 23
169.222.31.42
00.00.0c.d6.d4.f7
Adjacent layers
Peer layers

IP Packet Encapsulation

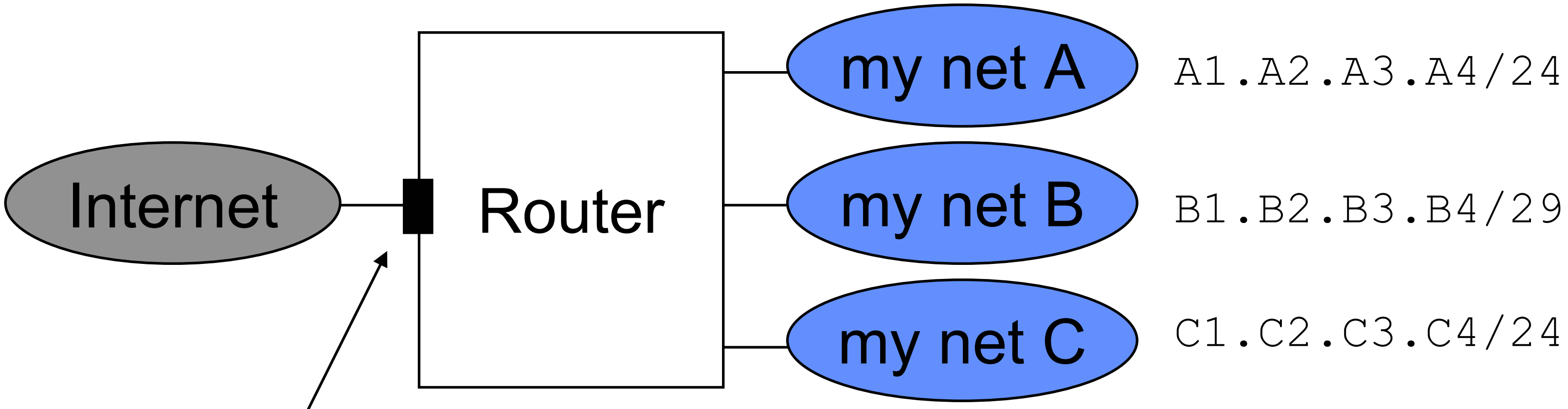


Packet is delivered from <src-ip, src-port> to <dst-ip, dst-port>

< 169.222.30.4 , 2034> ⟶ < 169.222.31.42 , 23>

IP spoofing filters

block inbound packets with source IP addresses belonging to inside nets

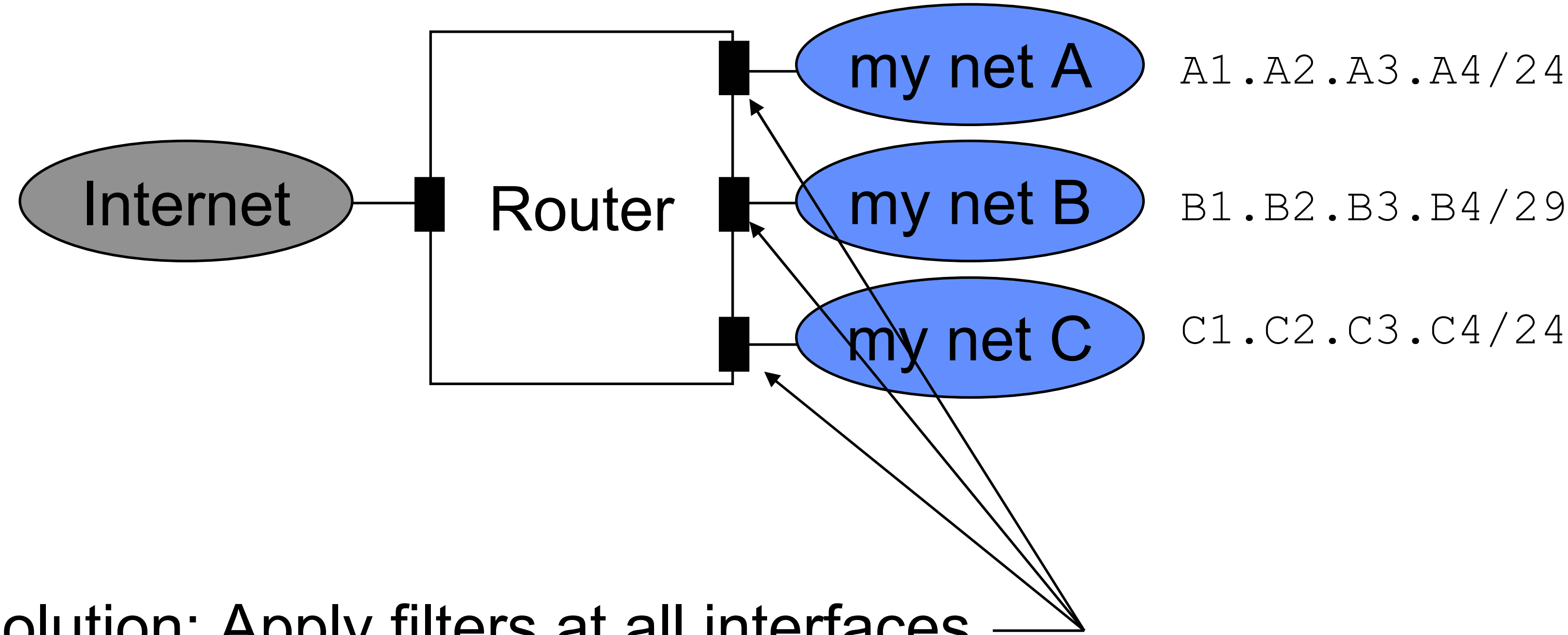


```
filter2 = {
    deny A1.A2.A3.A4/24 any any any;
    deny B1.B2.B3.B4/29 any any any;
    deny C1.C2.C3.C4/24 any any any;
    permit any any any any;
}

apply filter2 in interface 0;
```

IP spoofing filters (cont.)

Problem: net A can attack net B or C



Solution: Apply filters at all interfaces

But this leads to increased complexity of configuration; and therefore increased maintenance and greater probability of error.

simple access-list filters

simple access lists (1-99) use only the source IP address:

```
permit src-ip mask
deny   src-ip mask
```

e.g.:

```
access-list 1 permit 169.222.30.8
access-list 1 permit 169.222.30.9
access-list 1 permit 169.222.30.10
access-list 1 permit 169.222.30.11
access-list 1 permit 169.222.30.12
access-list 1 permit 169.222.30.13
access-list 1 permit 169.222.30.14
access-list 1 permit 169.222.30.14
access-list 1 deny any any
```

on the cisco documentation cd:

```
file:///cdrom/data/doc/software/11_1/rrout/4rip.htm#REF30724
```

cisco wildcard masks

problem: access-lists must match long list of IP addresses; too much work to type them all in:

```
access-list 1 permit 169.222.30.9
access-list 1 permit 169.222.30.10
access-list 1 permit 169.222.30.11
access-list 1 permit 169.222.30.12
access-list 1 permit 169.222.30.13
access-list 1 permit 169.222.30.14
```

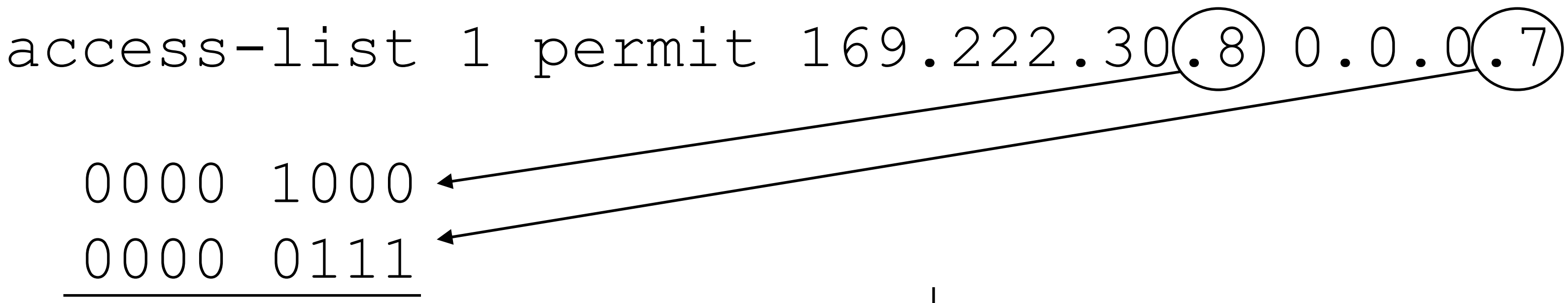
solution: wildcard masks --

0 indicates that the corresponding bit in the address must match the rule;

1 indicates "don't care."

```
access-list 1 permit 169.222.30.8 0.0.0.7
```

wildcard matching lists example



```
access-list 1 permit 169.222.30.8 0.0.0.7

   0000 1000
   0000 0111
  ___________
   0000 1xxx
```

```
     which includes:
   0000 1000    =   .8
   0000 1001    =   .9
   0000 1010    =   .10
   0000 1011    =   .11
   0000 1100    =   .12
   0000 1101    =   .13
   0000 1110    =   .14
   0000 1111    -   .15
```

```
therefore,
169.222.30.8 0.0.0.7
matches:
169.222.30.8
169.222.30.9
169.222.30.10
169.222.30.11
169.222.30.12
169.222.30.13
169.222.30.14
169.222.30.15
```

more wildcard matching lists examples

```
169.222.30.0 0.0.0.255 matches 169.222.30.0/24

128.32.0.0 0.0.255.255. matches 128.32.0.0/16

10.0.0.0 0.0.255.255.255 matches 10.0.0.0/8

0.0.0.0 255.255.255.255 matches everything

169.222.31.42 0.0.0.0 matches 169.222.31.42
```

extended access-list filters

extended access lists (100-199) use the source IP address, destination IP address, protocol, destination port:

```
permit proto scr-ip mask op src-prt dst-ip mask op dst-port
deny   proto scr-ip mask op src-prt dst-ip mask op dst-port
```

e.g.:

```
access-list 101 permit udp 169.222.30.8 0.0.0.7
      169.222.31.42 0.0.0.0 eq 53
access-list 101 permit tcp 169.222.30.8 0.0.0.7
      169.222.31.42 0.0.0.0 eq 53
access-list 101 deny ip 169.222.30.8 0.0.0.7
      169.222.31.42 0.0.0.0
access-list 101 permit any any
```

on the cisco documentation cd:

```
file:///cdrom/data/doc/software/11_1/rrout/4rip.htm#REF24774
```

cisco access-list filters

some shorthand notations can be used:

```
<ip-addr mask> = x.x.x.x 0.0.0.0
       can be written as “host x.x.x.x”
```

so:

```
access-list 101 permit udp 169.222.30.8 0.0.0.7
      169.222.31.42 0.0.0.0 eq 53
```

becomes:

```
access-list 101 permit udp 169.222.30.8 0.0.0.7
      host 169.222.31.42 eq 53
```

```
<ip-addr mask> = x.x.x.x 255.255.255.255
       can be written as “any”
```

so:

```
access-list 101 permit ip 0.0.0.0 255.255.255.255
      0.0.0.0 255.255.255.255
```

becomes:

```
access-list 101 permit ip any any
```

managing access lists

Access lists can become long; for example, more than 4 statements.

Since rules are evaluated in order, order is very important. It may be necessary at times to change rules or re-order them.

Access lists cannot be (gracefully) edited on the router itself: the only way to modify an existing rule is to delete it and add the modified rule back. But deleting and adding an existing rule has unexpected results.

Therefore, we need to edit access lists off-line, on a Unix host for example. Later, we can copy it to the router.

Access List Exercise #1 (slide 1/2)

We will create a short access list to prevent telnet from a host in each row.

1. Select a host in your row for the exercise. Make sure you know the host’s IP address.

2. Verify that the host can telnet to another host off the net, i.e. a bsdi PC in a different row.

3. Telnet to the router and create the access list:

```
router(config)#access-list 101 deny tcp host <your-ip>
         host <target-ip> eq 23
router(config)#access-list 101 permit ip any any
router(config)#^z
```

Access List Exercise #1 (slide 2/2)

4. Check it:

```
    router#sho access-lists
```

5. Finally, apply the access-list to the router's ethernet interface on the row (e0).

```
    router(config-if)#access-group 101 in
```

6. Verify that you can no longer telnet to the other host.

7. To remove the access list:

```
    router(config-if)#no access-group 101 in
```

Access List Exercise #2

We will create a short access list to prevent **all** telnets from a host.

1. Verify that your host can telnet to another host off the net, i.e. a bsdi PC in a different row.

2. Telnet to the router and create the access list:

```
    access-list 101 deny tcp host <your-ip> any eq 23
    access-list 101 permit tcp any any
    ^z
```

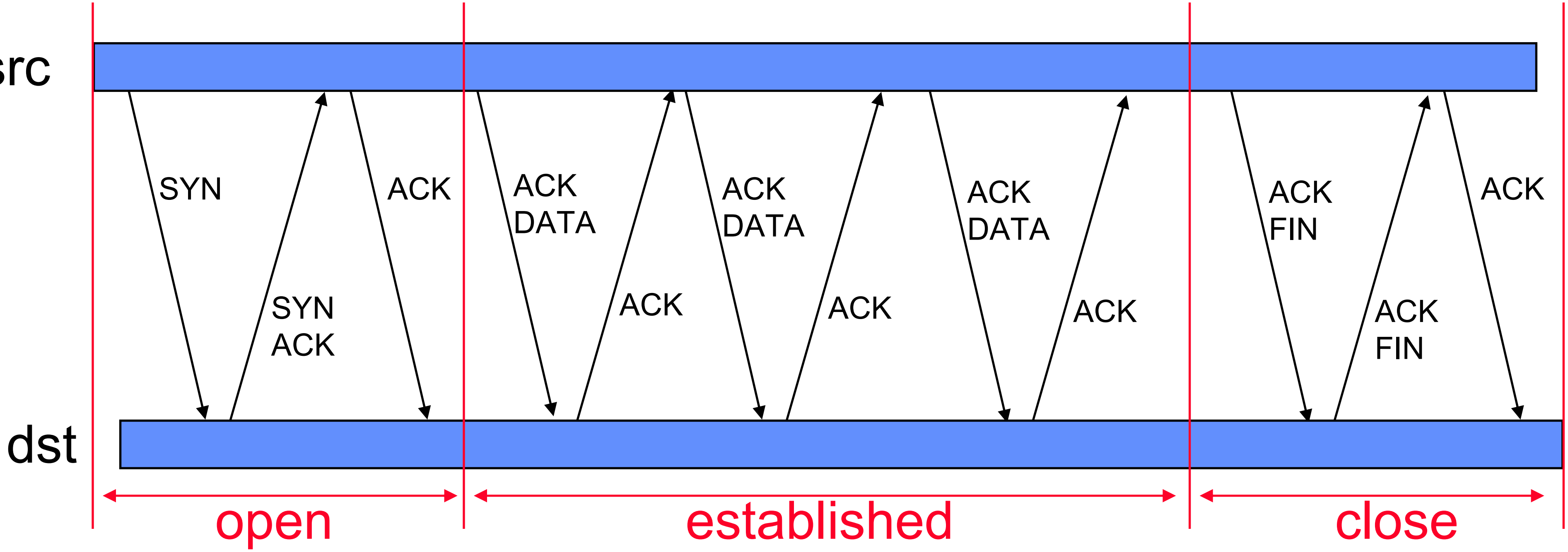
3. Check it **(think!)** and apply to the router’s ethernet interface as in the previous exercise.

4. Verify that you can no longer telnet to the other host.

a more complicated example

Extended access lists allow some additional tests; see the page on the cisco documentation cd (bottom of slide 13).

E.g. the “established” keyword tests whether the ACK or RST bit is set in the TCP header. The first packet in a TCP open will not match.



Access List Exercise #3 (slide 1/2)

We will create a short access list to prevent mail from cyberpromo.com

```
access-list 111 permit tcp
           205.199.212.0 0.0.0.255 any eq 25 established
access-list 111 deny   tcp 205.199.212.0 0.0.0.255 any eq 2
access-list 111 permit tcp
           205.199.2.0 0.0.0.255 any eq 25 established
access-list 111 deny   tcp 205.199.2.0 0.0.0.255 any eq 25
access-list 111 permit ip any any
```

Apply access list 111 to in-bound packets on external interface of your router. SMTP from cyberpromo is blocked, SMTP to cyberpromo is not blocked.

Not really very effective.

Access List Exercise #3 (slide 2/2)

On a PC with TFTP enabled, create a file in /tftp with these lines (choose your own number for *xxx*):

```
access-list xxx permit tcp
           205.199.212.0 0.0.0.255 any eq 25 established
access-list xxx deny   tcp 205.199.212.0 0.0.0.255 any eq 25
access-list xxx permit tcp
           205.199.2.0 0.0.0.255 any eq 25 established
access-list xxx deny   tcp 205.199.2.0 0.0.0.255 any eq 25
access-list xxx permit ip any any
end
```

On your router, use `copy tftp run` to create the access list.

Examine the access list using `show ip access-lists`.

Install the access-list on the router:

```
router(config-if)#ip access-group xxx in
```

other uses for access lists

Access lists can be used for purposes other than packet filtering:

- restricting route announcements
- restricting routes accepted
- controlling route redistribution between protocols
- in route-maps, for the above purposes