Static Routing Exercise

Scalable Infrastructure
Workshop

AfNOG 2010

What will the exercise involve?

- Unix network interface configuration

- Cisco network interface configuration

- Static routes

- Default route

- Testing

Routing

- Routing is done based on destination IP address

- Without routing, an interface can only reach destinations that are on their local network segment.

- A device with at least 2 interfaces can route

Routing

- **Static route**
  - specifically instructs router on which route to take to a particular destination network. This will almost always override anything else that the router knows.

- **Dynamic route**
  - learnt via routing protocols implemented on routers

- **Default route**
  - route that instructs a machine where to send packets for destinations that are not in the routing table. This is usually the 'last resort' that a router will take.

Static Routing

- Advantages
  - Simple to configure and maintain
  - Secure as only defined routes can be accessed
  - Bandwidth is not used for sending routing updates

- Disadvantages
  - Manual update of routes after changes
  - Explicit addition of routes for all networks
  - Potential for configuration mistakes

IP Routing Configuration
Static/default route example

To Internet

172.16.3.2

172.16.2.2

172.16.3.1

172.16.1.0
255.255.255.0
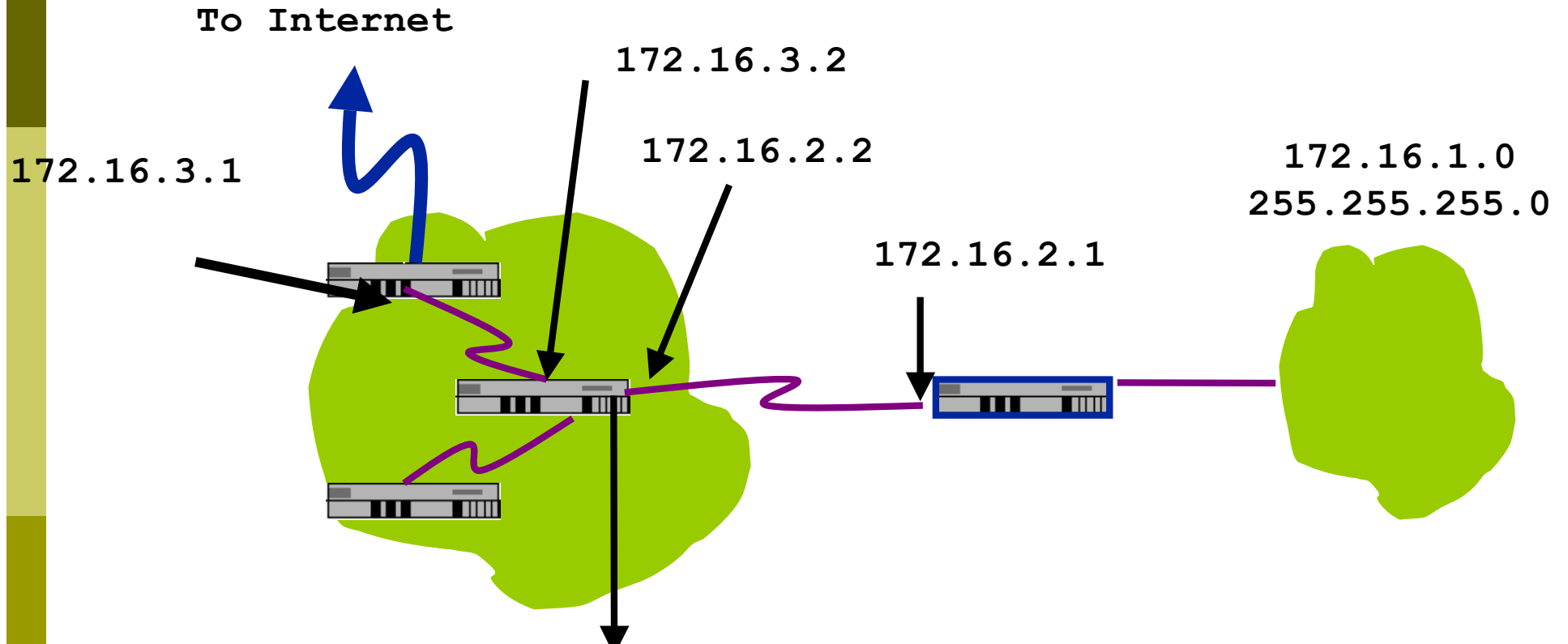
172.16.2.1

```
ip route 172.16.1.0 255.255.255.0 172.16.2.1  - STATIC

ip route 0.0.0.0 0.0.0.0 172.16.3.1 - DEFAULT
```

Classroom Network Layout
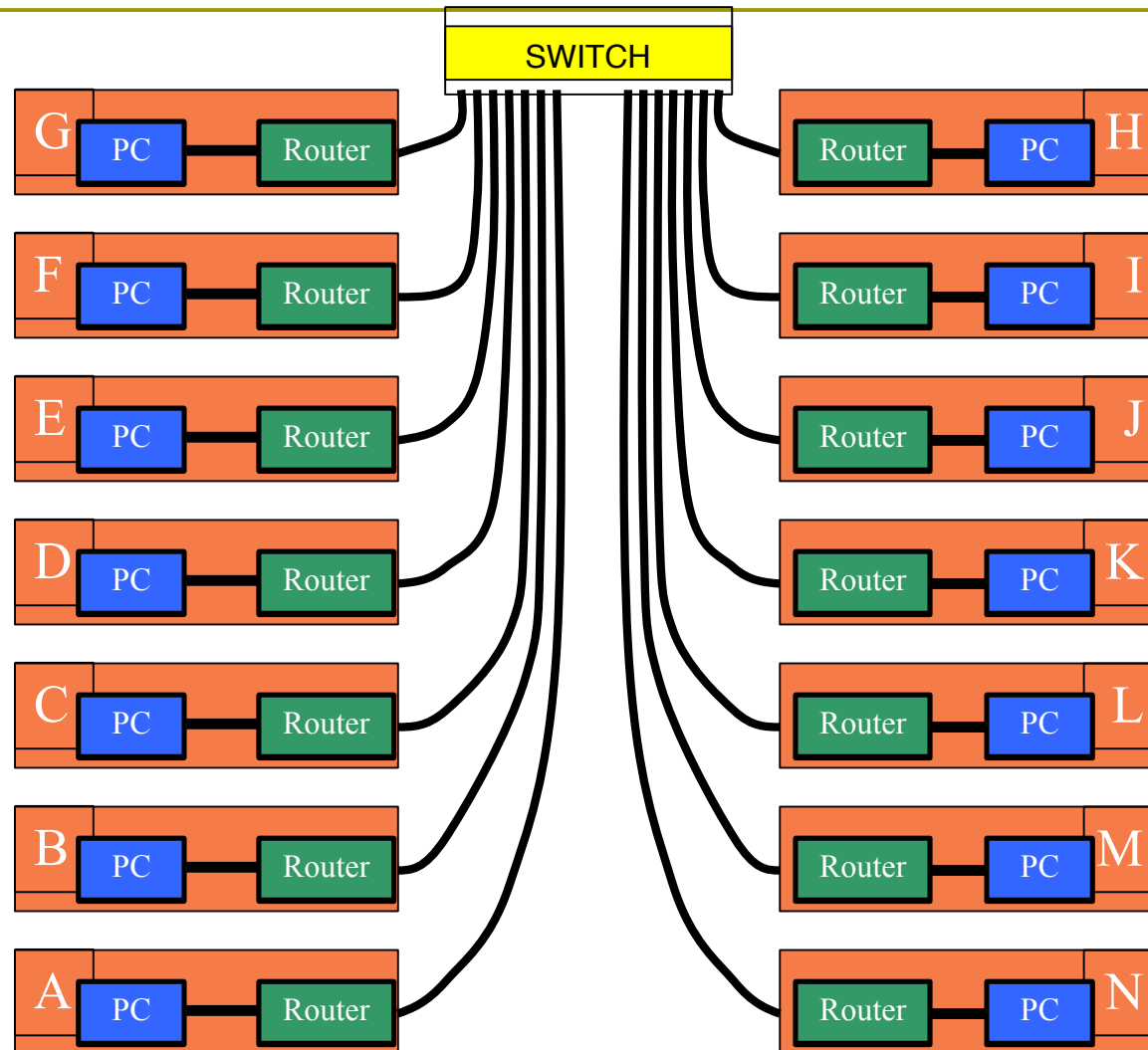
Exercise One

IPv4 Address Assignments

G
196.200.220.128/28

F
196.200.220.112/28

E
196.200.220.96/28

D
196.200.220.80/28

C
196.200.220.64/28

B
196.200.220.48/28

A
196.200.220.32/28

.7 .8
.6   .9
.5   .10
.4   .11
.3   .12
.2   .13
.1 .14

196.200.220.0/27

H
196.200.220.144/28

I
196.200.220.160/28

J
196.200.220.176/28

K
196.200.220.192/28

L
196.200.220.208/28

M
196.200.220.224/28

N
196.200.220.240/28
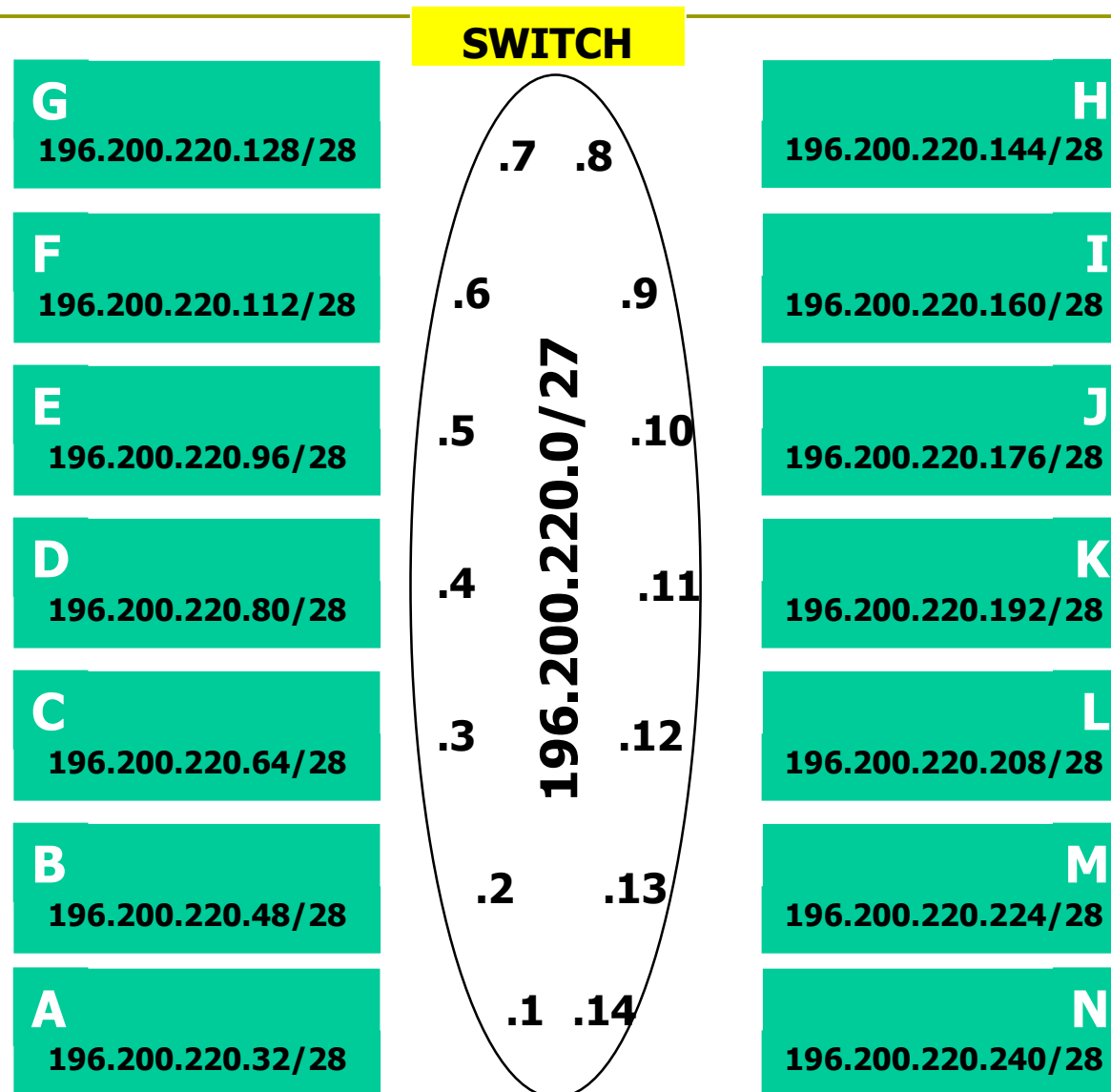
IPv4 Address Assignment

- You already have an IP address for your router's backbone link (A=.1, B=.2, …)

- You have a /28 for your local network (PC and router connected back to back)

- Assign your own host addresses from your /28 to your local network.

FreeBSD Network Interface Configuration

- configure interface on Unix host
  - `ifconfig em0 inet n.n.n.n netmask m.m.m.m`
  (you need to be root to change the IP address)

  - em0 is the interface name
  - n.n.n.n is IP address
  - m.m.m.m is netmask

Connect PC to router console port

- Connect cable to console port on router, serial port on FreeBSD box
- Use the tip command to connect your keyboard and screen to the serial port
    - e.g. `bash$ tip com1`
- You may have to edit `/etc/remote`
- See man pages for tip(1) and remote(5)
    - HINT: to exit tip, type ~.

Cisco Router Network Interface Configuration

- configure backbone interface on cisco router

  ```
  conf  t

  interface  fastethernet0/0

    ip address n.n.n.n  m.m.m.m
  ```

  fastethernet0/0 is interface name

  n.n.n.n is IP address

  m.m.m.m is netmask

- Now configure the local interface on your router that connects to your PC (ie. Fa0/1). Use the IP address assignments that you made 3 slides ago.

Cisco Router Network Interface Configuration

- Cisco global config should always include:

  ```
  ip classless

  ip subnet-zero

  ip cef
  ```

- Cisco interface config should usually include:

  ```
  no shutdown

  no ip proxy-arp

  no ip redirects

  no ip directed-broadcast
  ```

Test Connectivity

- PC can ping local interface of router
- Router can ping PC
- Router can ping other routers

- PC cannot ping backbone interface of router
- PC cannot ping other routers or other PCs
- Router cannot ping other PCs.

Configure a default route

- Add route on PC

  `route add default g.g.g.g`

  > g.g.g.g is the IP address of your gateway
  >
  > (which should be the local interface on your router)

- Display forwarding table

  `netstat -rn`

Test connectivity

- All PCs should now be able to reach the backbone IP address of the other routers.

- But, you still can't reach other PCs.
  - why?
  - Run a "traceroute" to troubleshoot

Configure static routes for the remaining classroom desks

- On your router, add static routes to the other PCs, using their router IP addresses as the next-hop.

  ```
  ip route n.n.n.n m.m.m.m g.g.g.g
  ```

- Do this for every PC/router cluster in the class.
- Consult the map earlier to obtain the PC/router local subnet, and the corresponding router backbone IP address.

Test Connectivity

- All routers can reach all PCs
- All PCs can reach all backbone IP addresses
- All PCs can reach PCs in other rows
- Test with traceroute

Static Exercise using IPv6

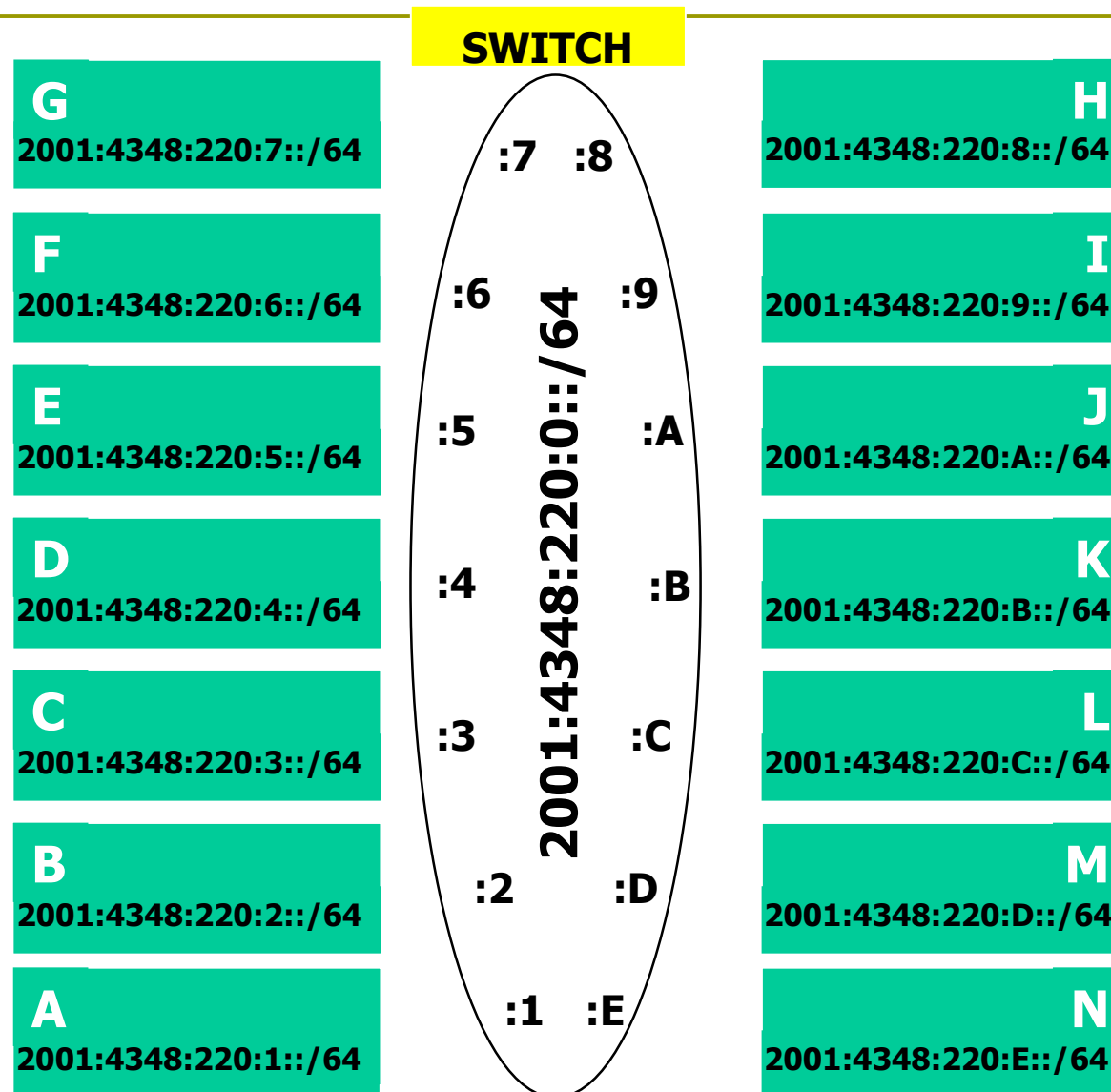- Now let's repeat this exercise using IPv6 addressing

- Consult addressing plan for IPv6 addresses
    - Link between router and PC gets a /64
        - Group A use 2001:4348:220:1::/64
        - Group B use 2001:4348:220:2::/64
        - etc
    - Backbone is numbered from 2001:4348:220:0::/64

Big Hint!

- If you are not using COPY/PASTE or the TFTP method to upload your config, you are wasting a lot of your time!

IPV6 Address Assignments

SWITCH

Left	Center (SWITCH)	Right
G 2001:4348:220:7::/64	:7 :8	**H** 2001:4348:220:8::/64
F 2001:4348:220:6::/64	:6 :9	**I** 2001:4348:220:9::/64
E 2001:4348:220:5::/64	:5 :A	**J** 2001:4348:220:A::/64
D 2001:4348:220:4::/64	:4 :B	**K** 2001:4348:220:B::/64
C 2001:4348:220:3::/64	:3 :C	**L** 2001:4348:220:C::/64
B 2001:4348:220:2::/64	:2 :D	**M** 2001:4348:220:D::/64
A 2001:4348:220:1::/64	:1 :E	**N** 2001:4348:220:E::/64

2001:4348:220:0::/64

FreeBSD Network Interface Configuration

- ☐ configure interface on Unix host

  `ifconfig em0 inet6 n:n:n:n/m`

  em0 is interface name

  n:n:n:n is IPv6 address

  m is netmask

Cisco Router Network Interface Configuration

- Configure the backbone interface on your router

```
conf t
ipv6 unicast-routing
interface fastethernet0/0
  ipv6 address n:n:n:n/m
```

   fastethernet0/0 is interface name
   n:n:n:n is IPv6 address
   m is netmask

- Now configure local (lan-facing) interface on your router too.

Cisco Router Network Interface Configuration

- Cisco ipv6 global config should always include:
  - `no ipv6 source-route`
  - `ipv6 cef`
- Cisco interface config should additionally include:
  - `no ipv6 redirects`

Configure a default route

- Add route on PC

  `route add -inet6 default g:g:g:g`

  - g:g:g:g is IPv6 address of gateway (which is on Cisco router)

  - -inet6 tells FreeBSD that this is an IPv6 route

- Display forwarding table

  `netstat -rn`

Configure static routes for the remaining classroom desks

- On your router, add static routes to the other clusters, similar to how you did for ipv4.
  - next hop is backbone interface of other row's router

    ```
    ipv6 route n:n:n:n/m g:g:g:g
    ```
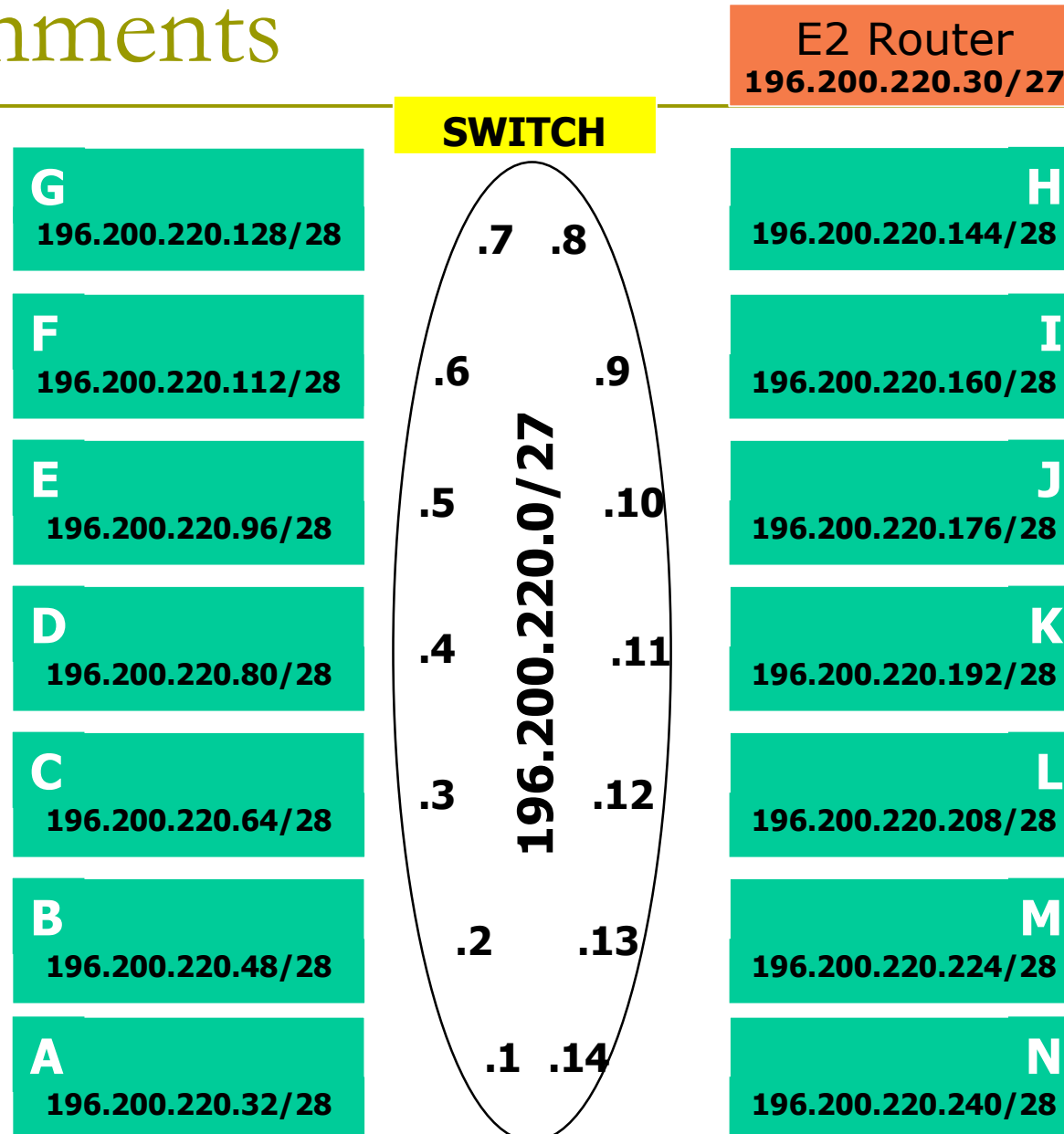
- Repeat several times until complete

Test Connectivity

- All routers can reach all PCs
- All PCs can reach all backbone IP addresses
- All PCs can reach PCs in other rows
- Test with traceroute

Exercise Two

IPv4 Address Assignments

E2 Router
196.200.220.30/27

SWITCH

196.200.220.0/27

.7 .8
.6 .9
.5 .10
.4 .11
.3 .12
.2 .13
.1 .14

G
196.200.220.128/28

F
196.200.220.112/28

E
196.200.220.96/28

D
196.200.220.80/28

C
196.200.220.64/28

B
196.200.220.48/28

A
196.200.220.32/28

H
196.200.220.144/28

I
196.200.220.160/28

J
196.200.220.176/28

K
196.200.220.192/28

L
196.200.220.208/28

M
196.200.220.224/28

N
196.200.220.240/28

IPv6 Address Assignments

E2 Router
2001:4348:220::F/64

SWITCH

2001:4348:220:0::/64

G
2001:4348:220:7::/64

F
2001:4348:220:6::/64

E
2001:4348:220:5::/64

D
2001:4348:220:4::/64

C
2001:4348:220:3::/64

B
2001:4348:220:2::/64

A
2001:4348:220:1::/64

:7   :8
:6   :9
:5   :A
:4   :B
:3   :C
:2   :D
:1   :E
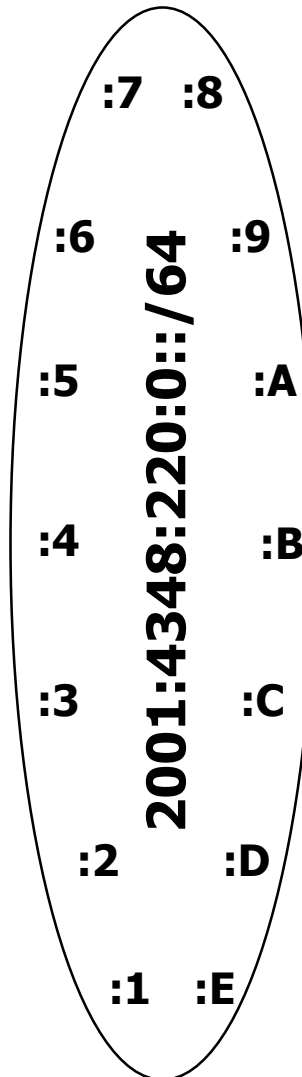
H
2001:4348:220:8::/64

I
2001:4348:220:9::/64

J
2001:4348:220:A::/64

K
2001:4348:220:B::/64

L
2001:4348:220:C::/64

M
2001:4348:220:D::/64

N
2001:4348:220:E::/64

Configure static routes to classroom router

- On your router, remove all static routes
  ```
  no ip route n.n.n.n m.m.m.m g.g.g.g
  ```
- Repeat until complete

- Add a default route point to the SIE classroom router
  - (next hop is backbone IP address of the SIE router)
    ```
    ip route 0.0.0.0 0.0.0.0 g.g.g.g
    ```
- Do the same for IPv6:
  ```
  no ipv6 route n:n:n:n/m g:g:g:g
  ipv6 route ::/0 g:g:g:g
  ```

Test Connectivity

- All routers can reach all PCs
- All PCs can reach all backbone IP addresses
- All PCs can reach PCs in other rows
- Test with traceroute
  - Test both IPv4 & Ipv6

- How is this working?
  - All static routes have been added to the classroom router.

Edit FreeBSD's '/etc/rc.conf' file

- On production machines, add lines to /etc/rc.conf to preserve network settings on reboot

  ```
  hostname="porcupine.tomato.example"
  ifconfig_em0="inet X.X.X.X netmask Y.Y.Y.Y"
  ipv6_ifconfig_em0="X:X:X:X prefixlen 64"
  defaultrouter="G.G.G.G"
  ipv6_defaultrouter="G:G:G:G"
  ```

- See /etc/default/rc.conf for more information

Static Routing Exercise

The End