Static Routing Exercise

Mark Tinka
&
Isatou Jah

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, interface can only reach destinations via ARP

- Cannot reach a destination on another separate network without going through an intermediate device

- A device with at least 2 interfaces can route

Routing

- Static routes
  - specifically instructs router on which route to take to a particular destination network
- dynamic routes
  - learnt via routing protocols implemented on routers
- default routes
  - route that instructs a machine where to send packets for destinations that are not in the routing table

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
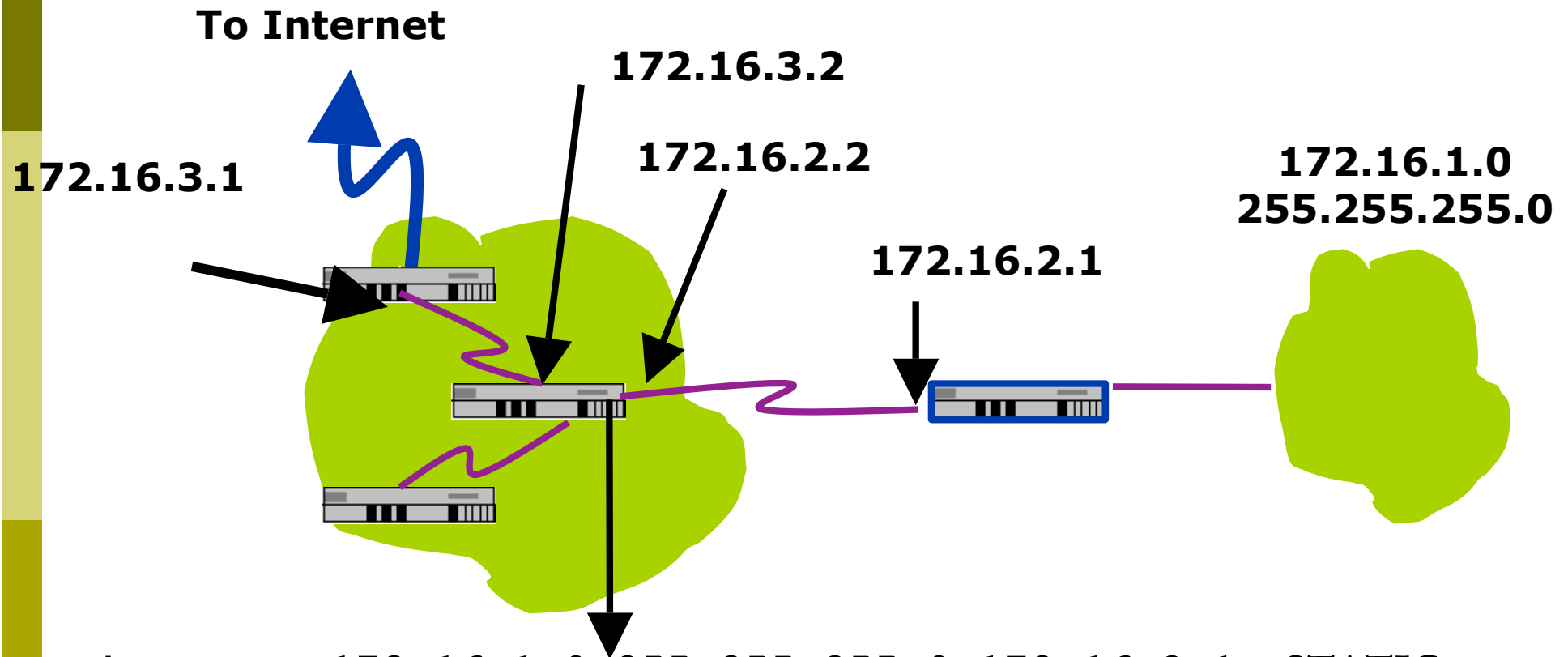
172.16.2.1
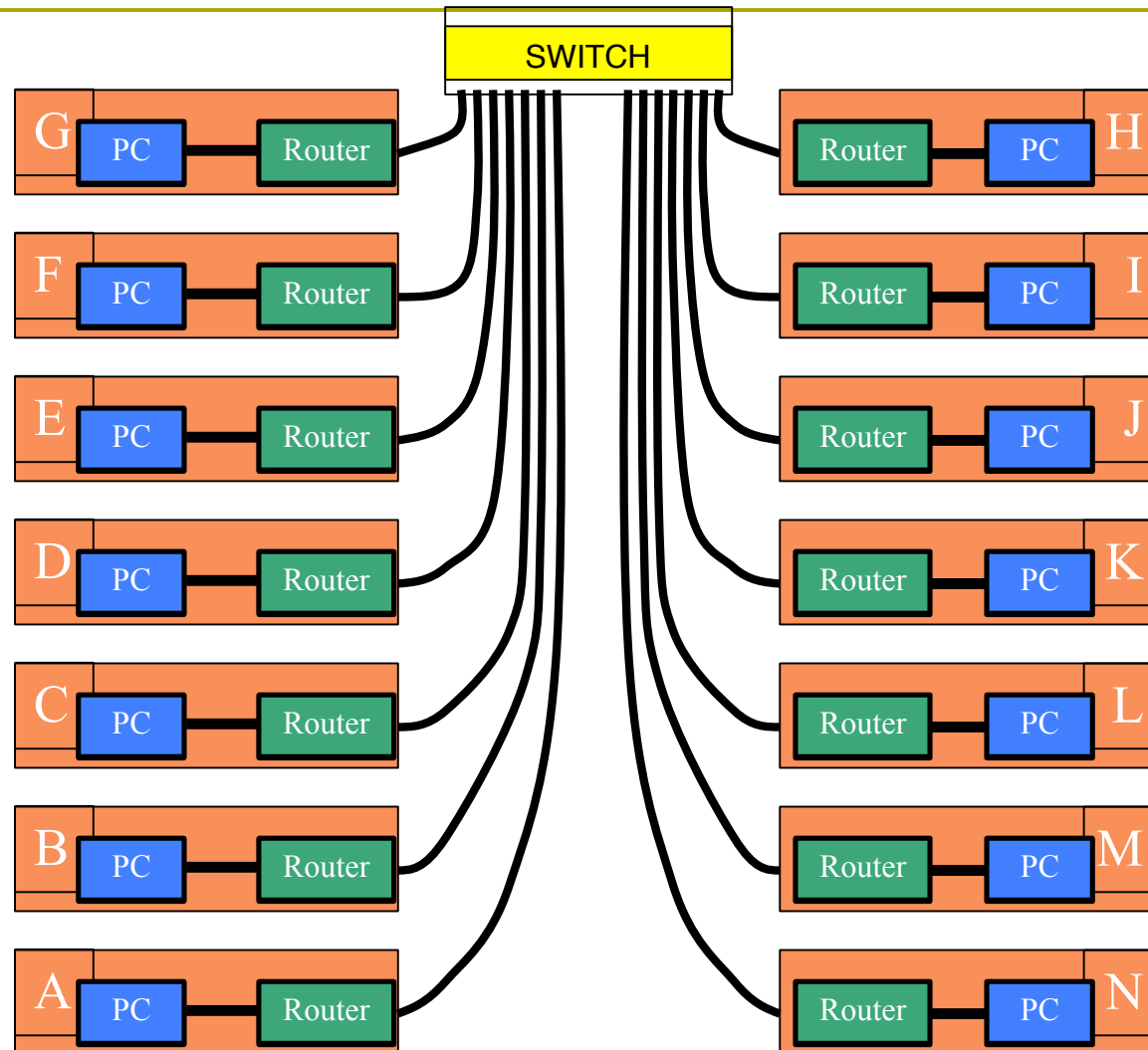
```
ip route 172.16.1.0 255.255.255.0 172.16.2.1 - STATIC

ip route 0.0.0.0 0.0.0.0 172.16.3.1 - DEFAULT
```

Classroom Network Layout

Exercise One

IPv4 Address Assignments

SWITCH

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
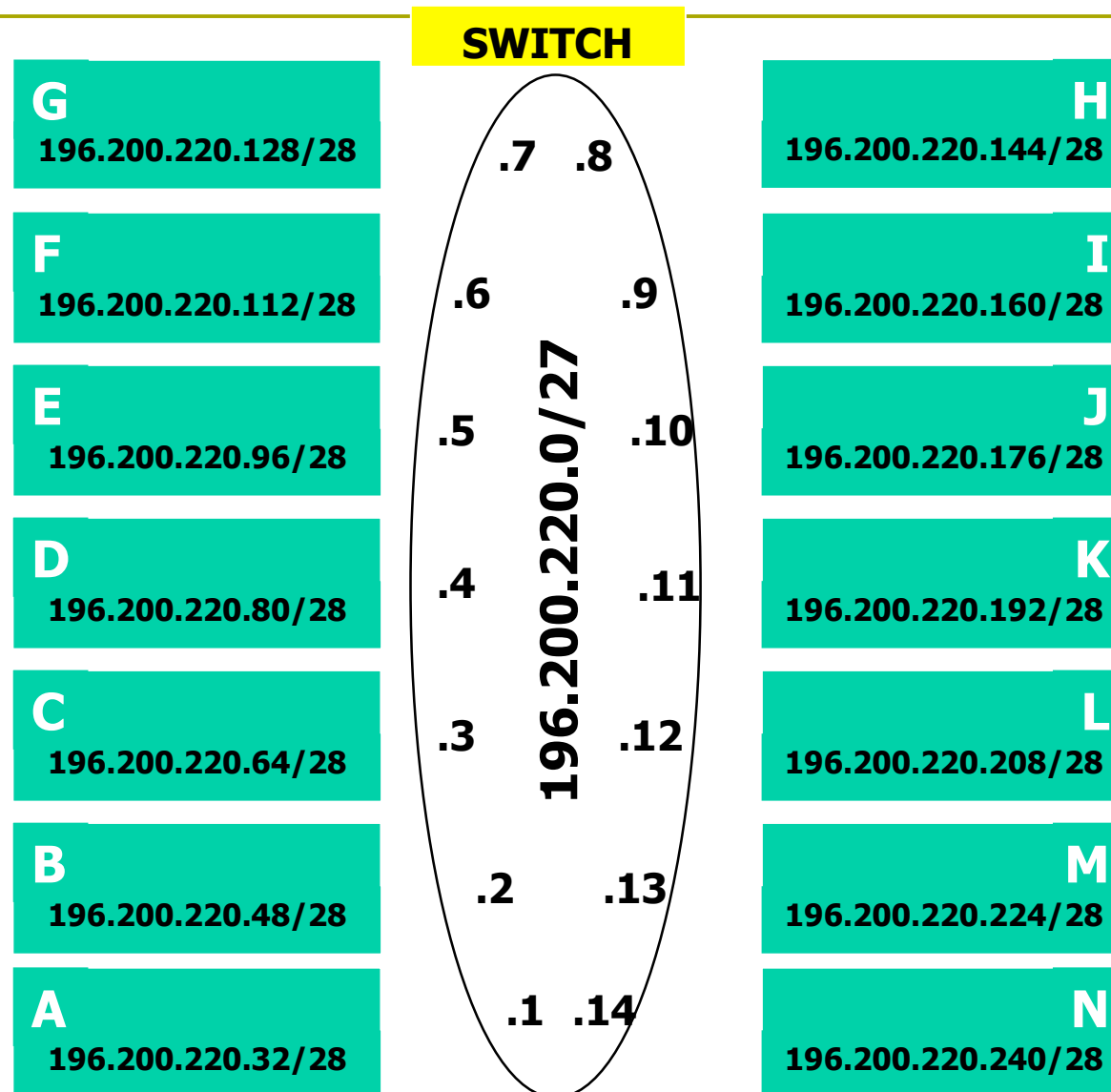
IPv4 Address Assignment

- 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 local /28 network

FreeBSD Network Interface Configuration

- configure interface on Unix host
  - **ifconfig** em0 **inet** *n.n.n.n* **netmask** *m.m.m.m*
  - em0 is 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
- configure local interface on cisco router
  - fastethernet0/1

Cisco Router Network Interface Configuration

- Cisco **global** config should always include:
  - **ip classless**
  - **ip subnet-zero**
  - **no ip domain-lookup**
  - **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
- PC cannot ping backbone interface of router
- Router can ping other routers
- PC cannot ping other routers or other PCs

Configure a default route

- Add route on PC
  - **route add default** *g.g.g.g*
    - g.g.g.g is IP address of gateway (which is on Cisco router)
- Display forwarding table
  - **netstat -rn**

Test connectivity

- All PCs can now reach backbone IP address of own row
- Still can't reach other rows
  - why?
  - Run a "traceroute" to troubleshoot

Configure static routes for the remaining classroom desks

- On router, add static routes to other rows
  - next hop is backbone interface of other row's router
    - **ip route n.n.n.n m.m.m.m g.g.g.g**
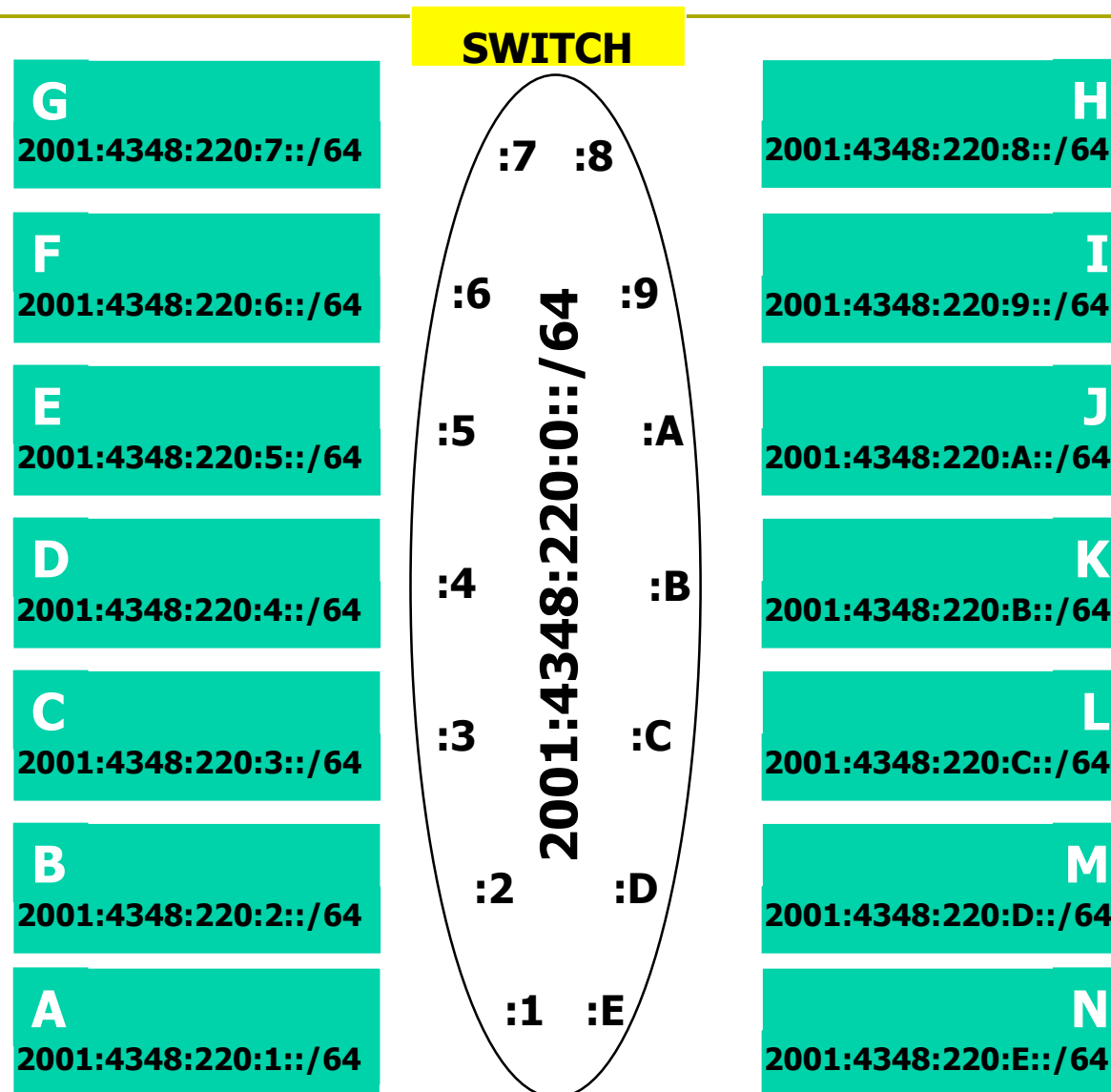- Repeat several times until complete

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

Static Exercise using IPv6

- Now 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

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 backbone interface on cisco 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

- configure local interface on cisco 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 router, add static routes to other rows
  - next hop is backbone interface of other row's router
    - **ipv6 route n:n:n:n/m g:g:g:g**
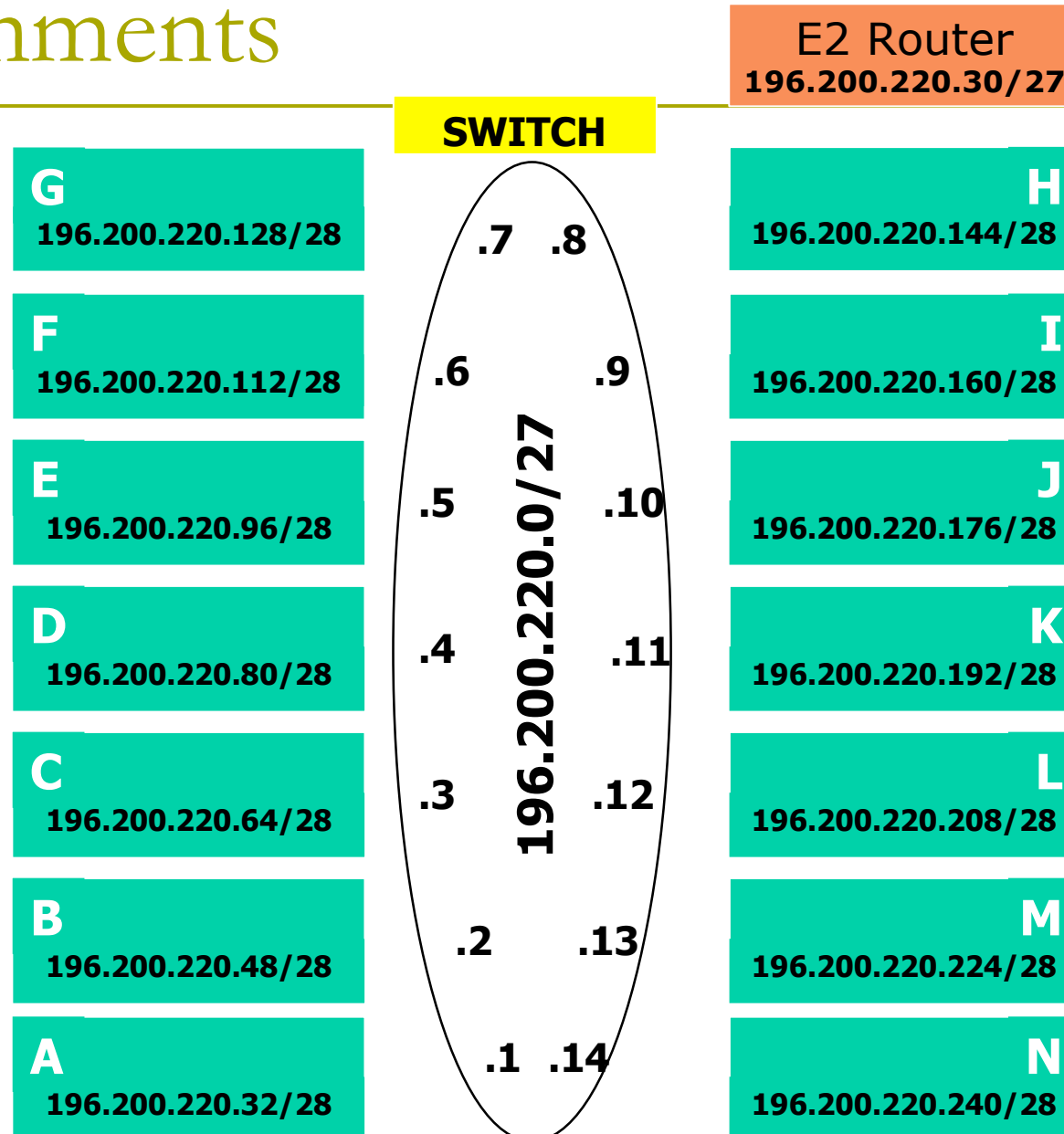- Repeat several times until complete

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

SWITCH

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

2001:4348:220:0::/64
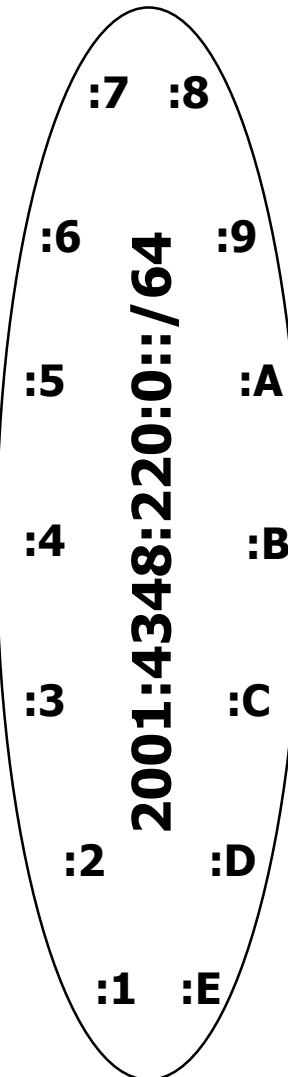
Left	Switch	Right
G 2001:4348:220:7::/64	:7 :8	**H** 2001:4348:220:8::/64
F 2001:4348:220:6::/64	:6 :9	**I** 2001:4348:220:9::/64
E 2001:4348:220:5::/64	:5 :A	**J** 2001:4348:220:A::/64
D 2001:4348:220:4::/64	:4 :B	**K** 2001:4348:220:B::/64
C 2001:4348:220:3::/64	:3 :C	**L** 2001:4348:220:C::/64
B 2001:4348:220:2::/64	:2 :D	**M** 2001:4348:220:D::/64
A 2001:4348:220:1::/64	:1 :E	**N** 2001:4348:220:E::/64

Configure static routes to classroom router

- On router, remove all static routes

  ```
  no ip route n.n.n.n m.m.m.m g.g.g.g
  ```

- Repeat until complete

- Add default route to classroom router

  - next hop is backbone 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
- All static routes have now been added on classroom router

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

- On production machines, add lines to /etc/rc.conf to configure network 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