Static Routing Exercise

Scalable Infrastructure Workshop

AfNOG 2011

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

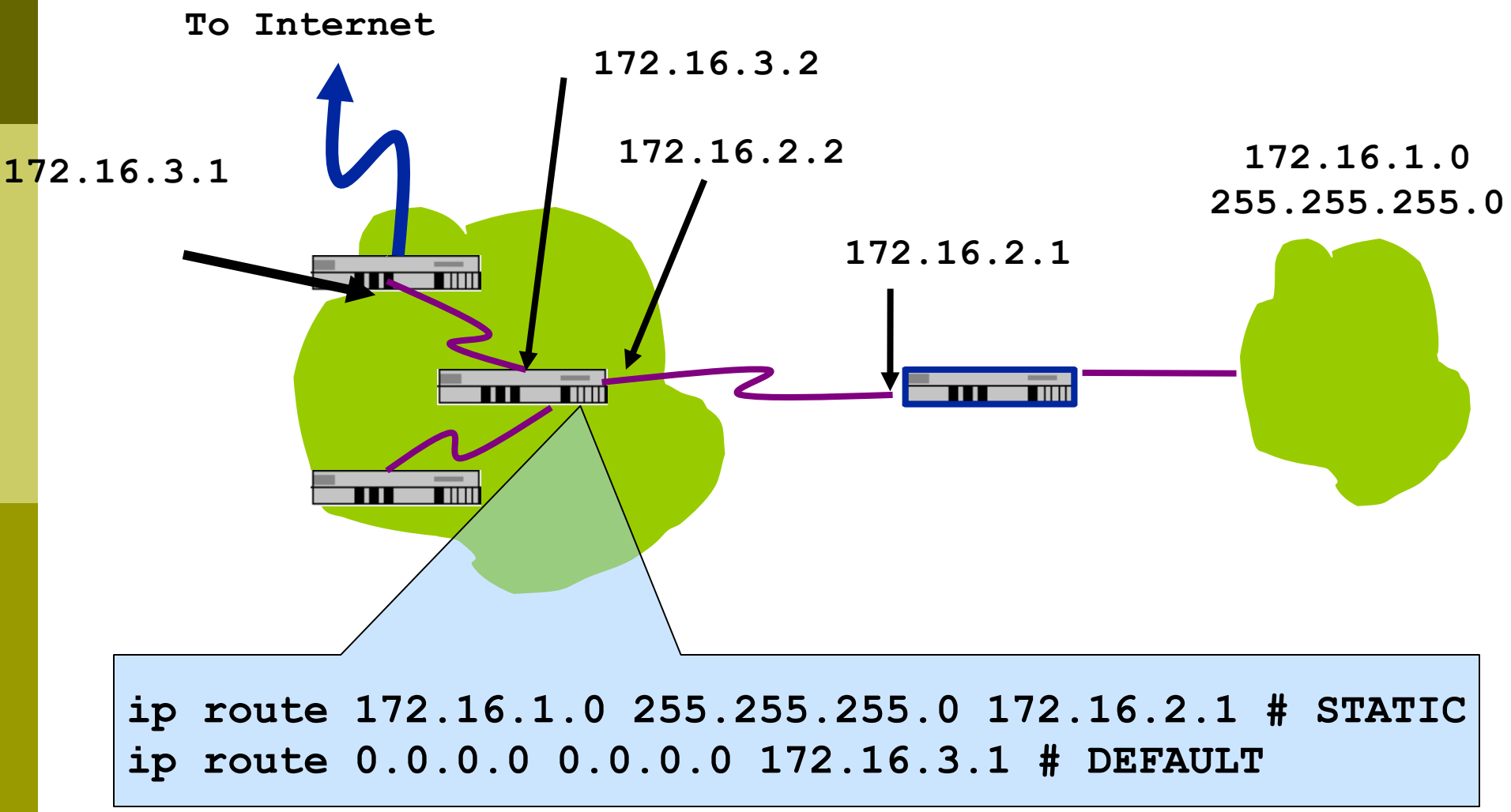
Routing

- 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.

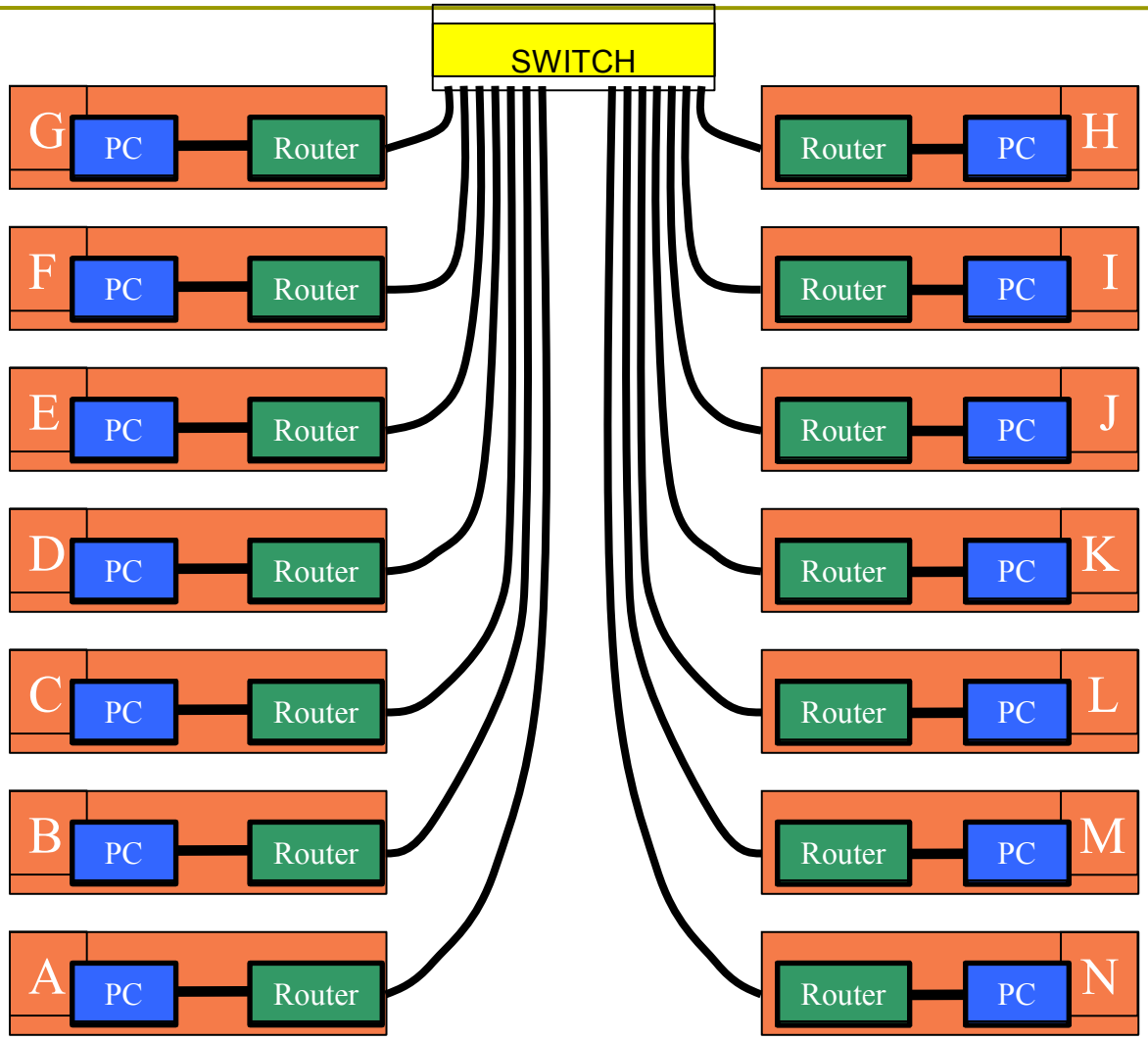
Static Routing

- 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

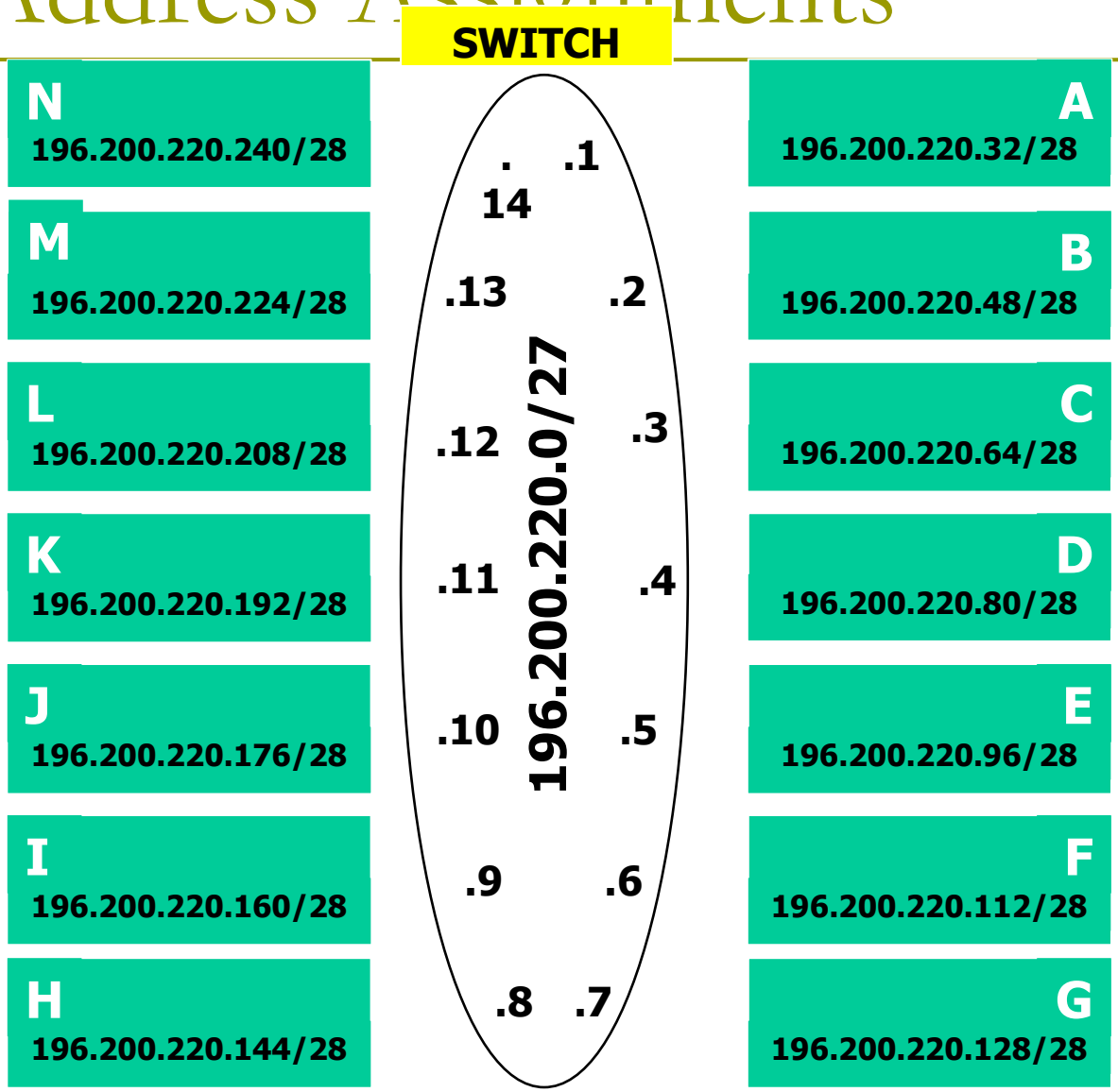


Classroom Network Layout



Exercise One

IPv4 Address Assignments



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

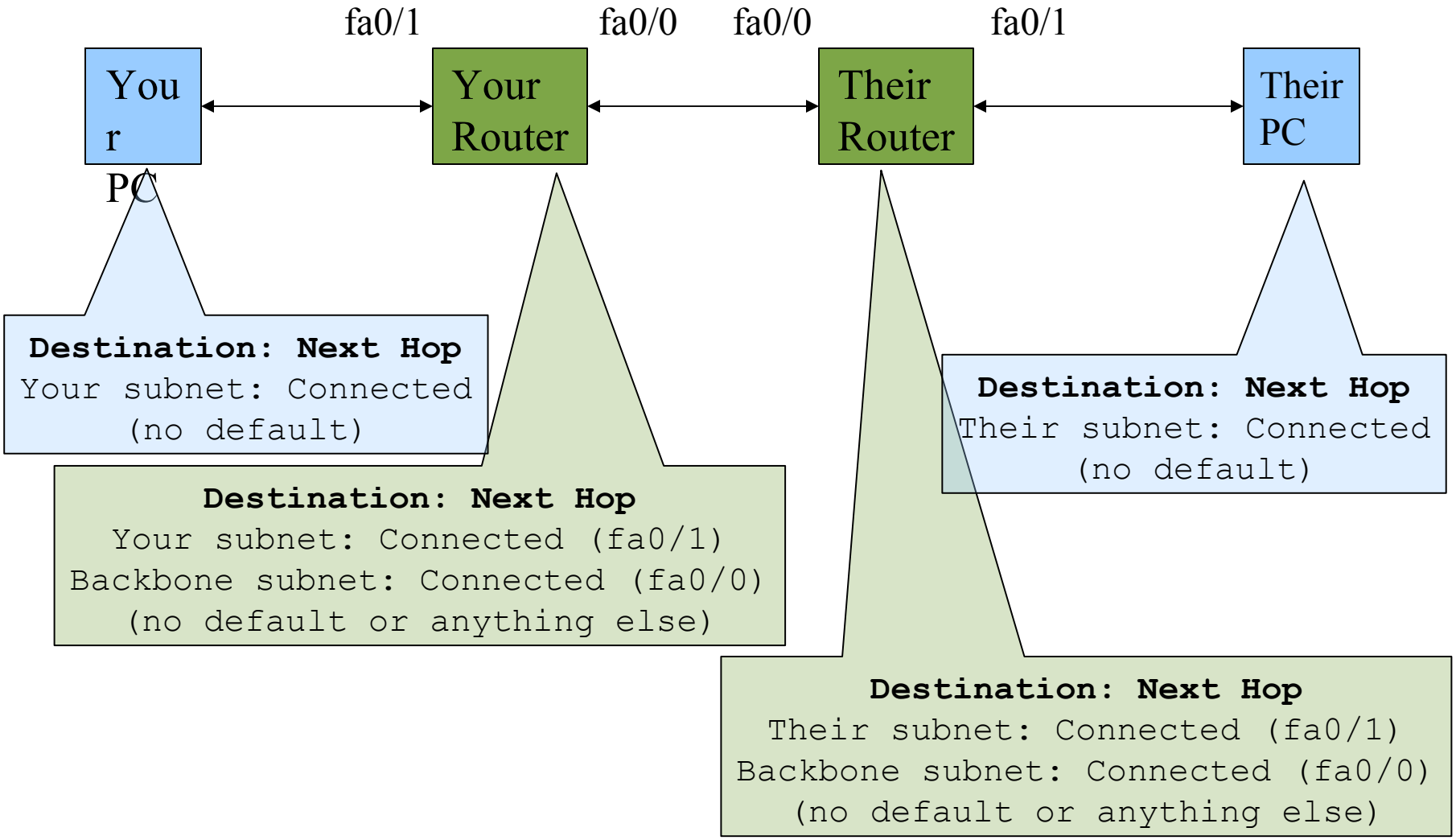
- Cisco global config should always include:

```
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
```

Forwarding Tables at this point in the exercise



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

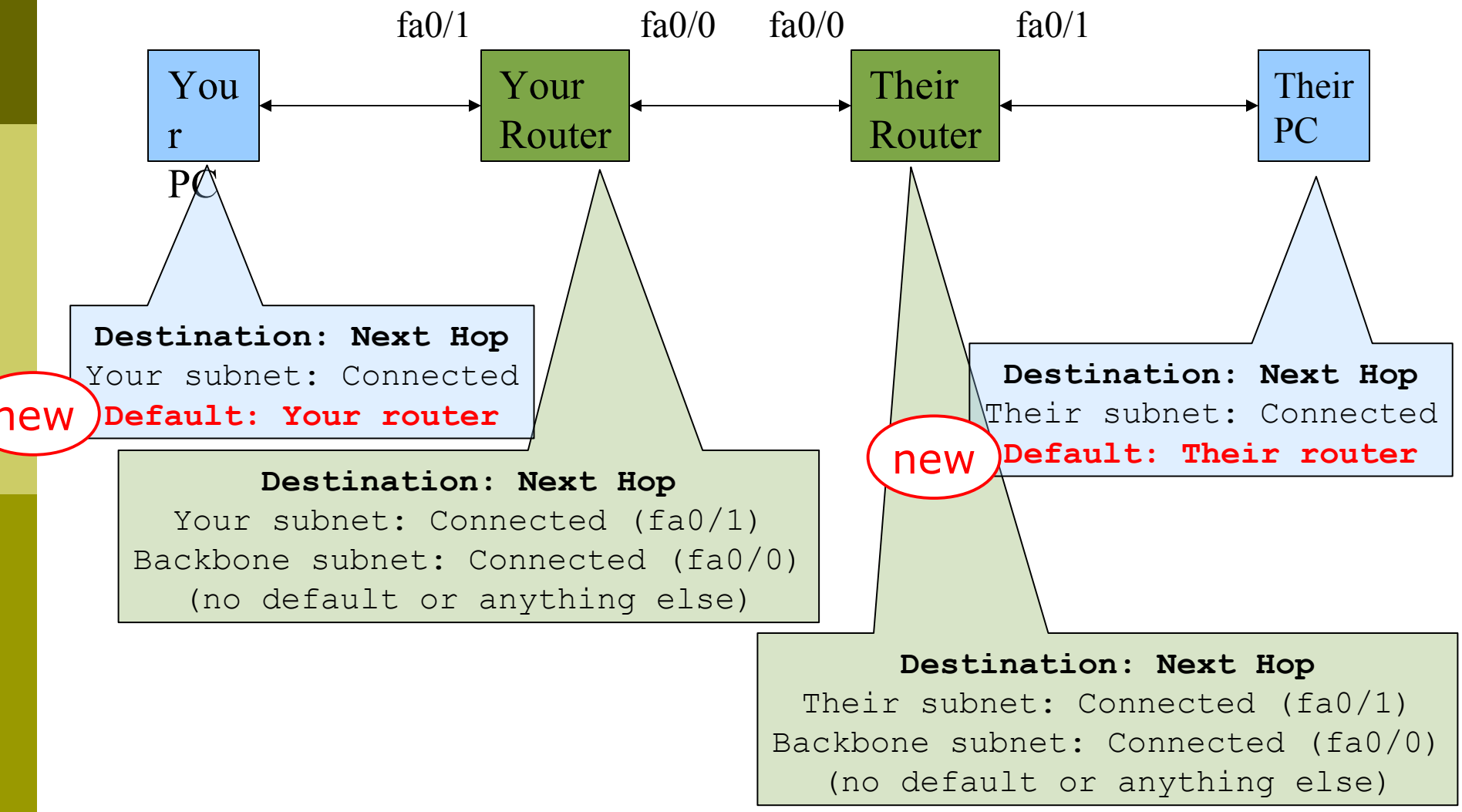
route add default g.g.g.g

g.g.g.g is the IP address of your gateway, which will be the IP address of your router's interface to your subnet. (Don't use your router's backbone IP address.)

- Display forwarding table

netstat -rn

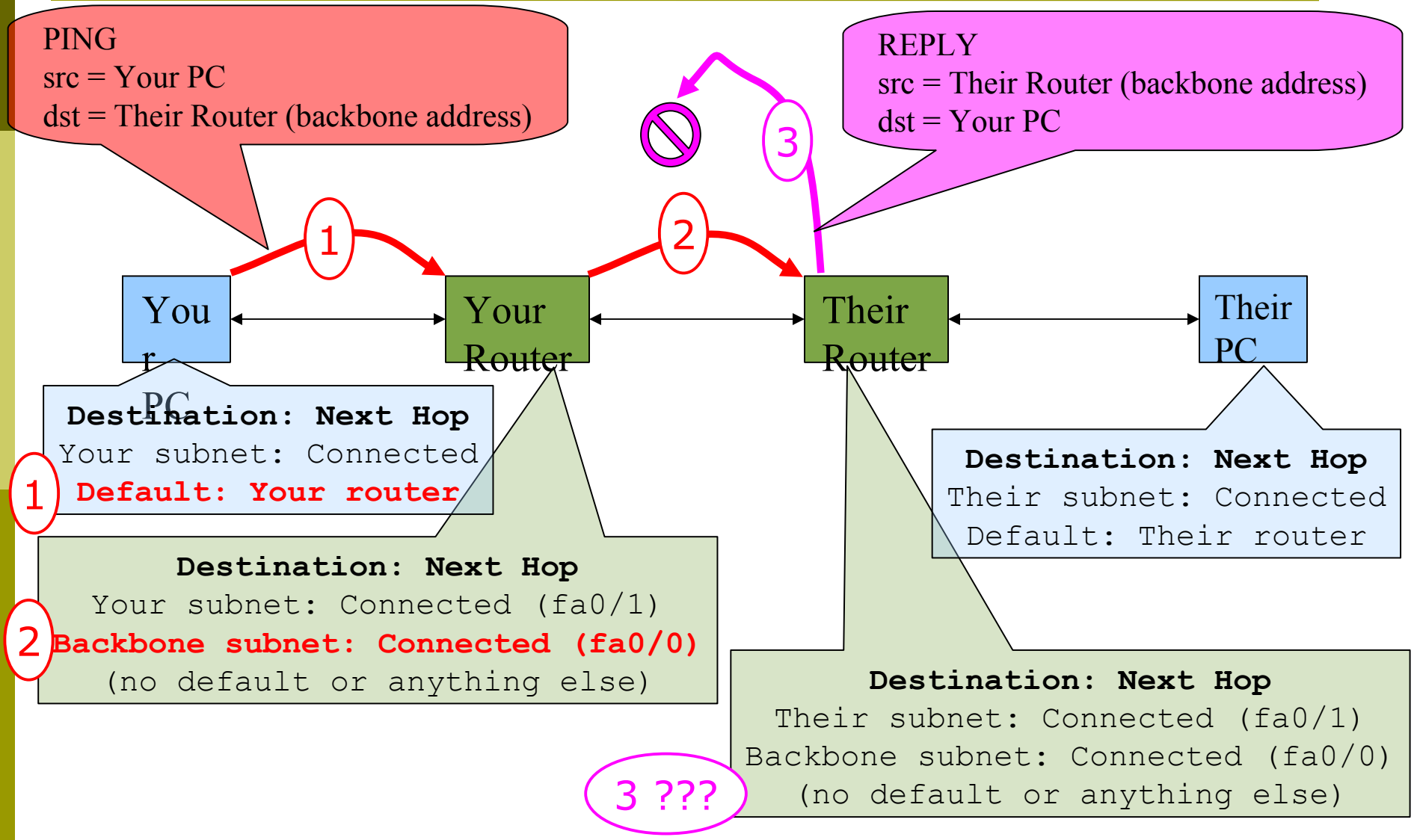
Forwarding Tables at this point in the exercise



Test connectivity

- All PCs should now be able to reach the backbone IP address of their own routers.
- But, you still can’t reach other PCs, or other routers.
  - why?

When you ping their router...



Configure static routes for the remaining classroom desks

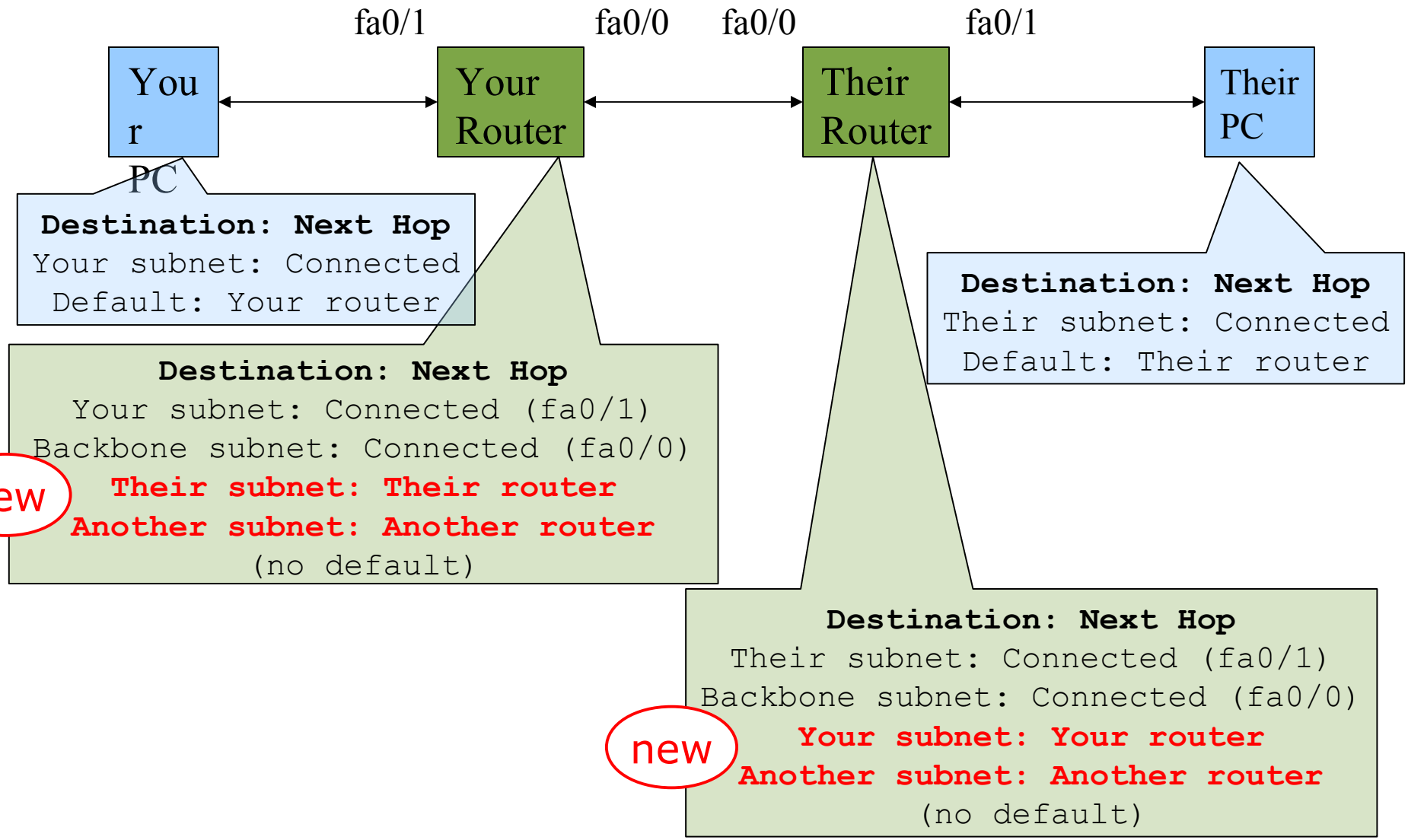
- On your router, add static routes to the other PCs, using their router's backbone IP addresses as the next-hop.

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

```
n.n.n.n m.m.m.m is their subnet and netmask
g.g.g.g is their router's address on the backbone
```

- Do this for every PC/router cluster in the class
  - **There are A LOT of them**. Cut and paste?
- Consult the map earlier to obtain the PC/router local subnet, and the corresponding router backbone IP address.

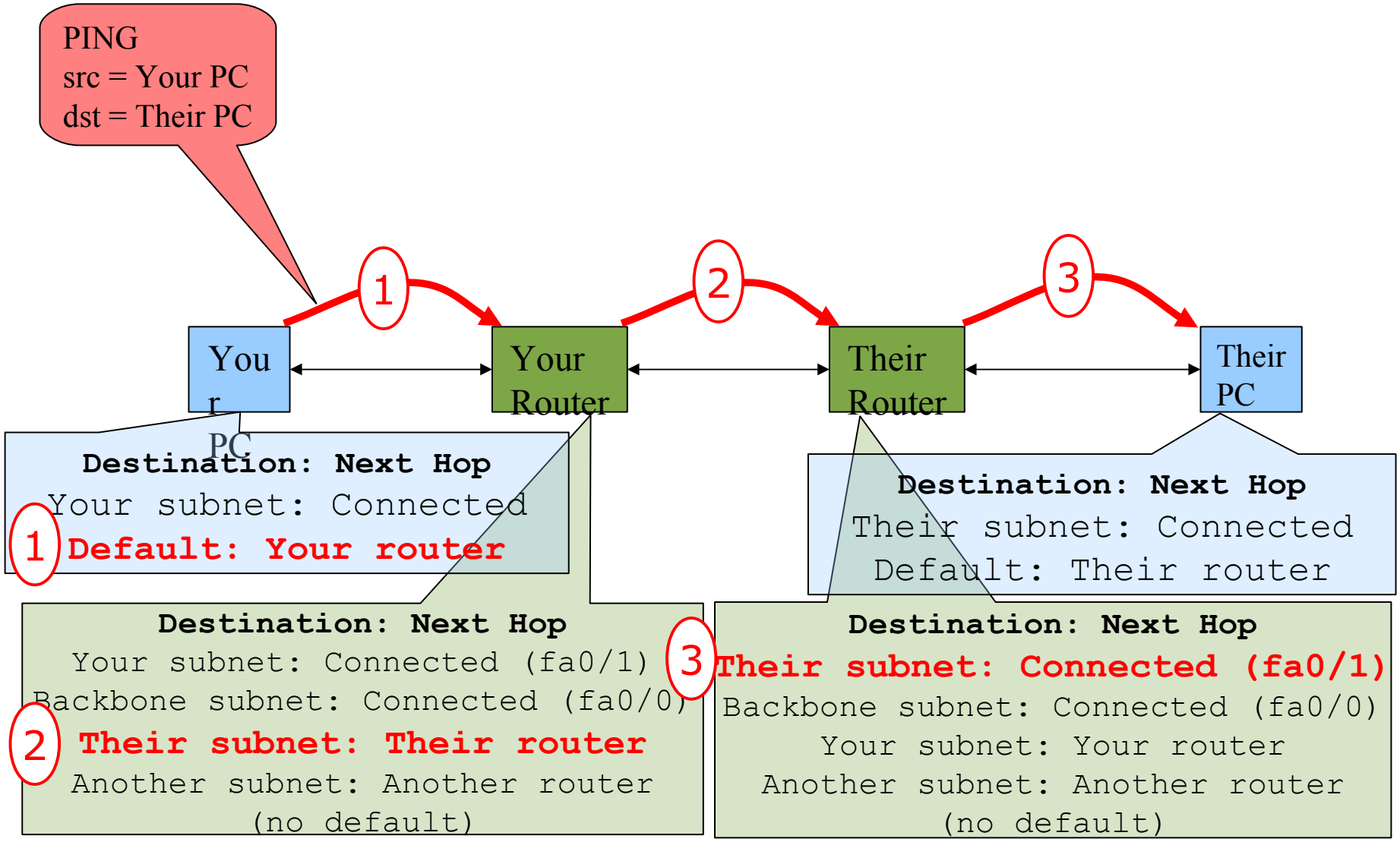
Forwarding Tables at this point in the exercise



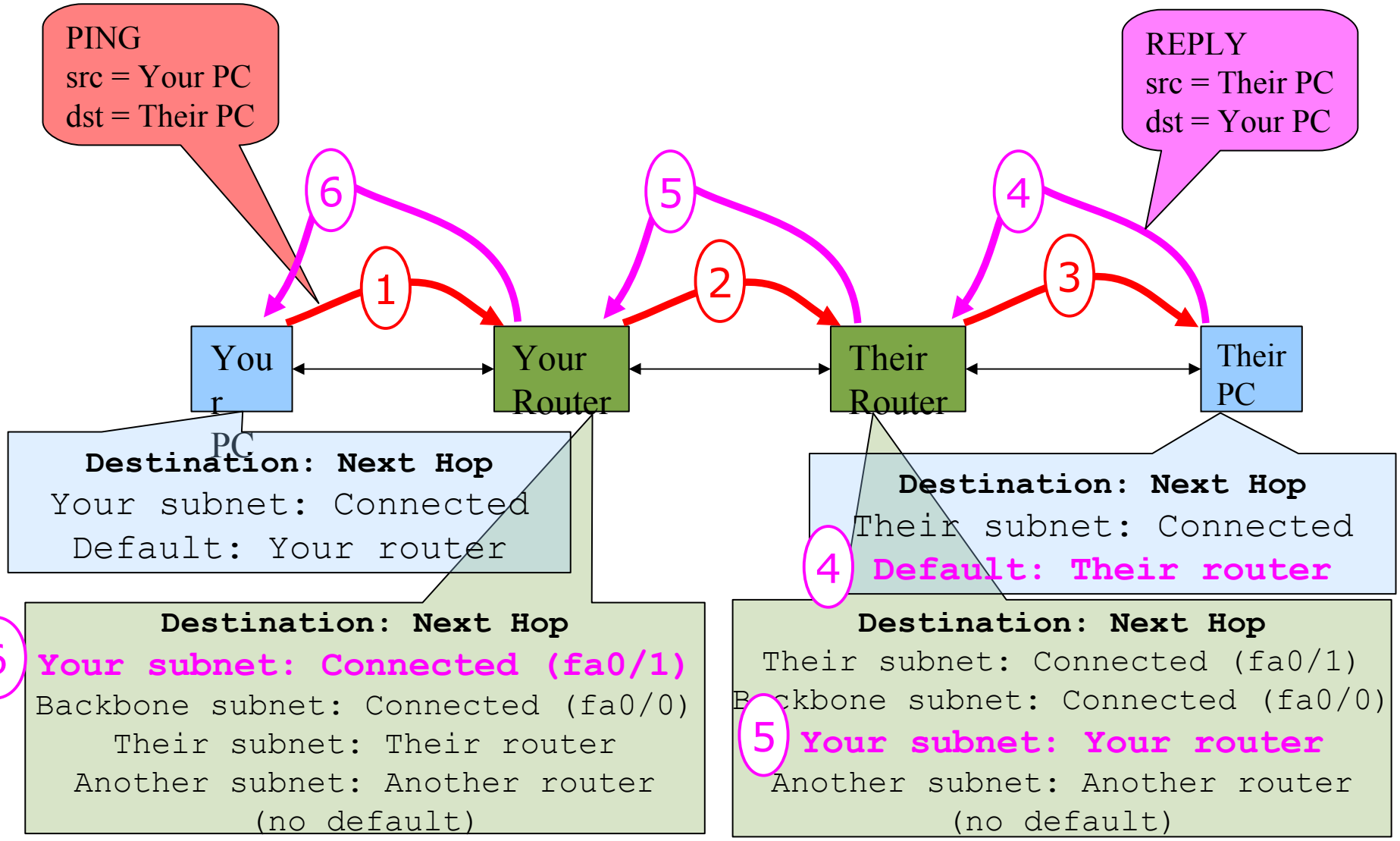
Test Connectivity

- 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

When your PC pings their PC...



… and the reply from their PC



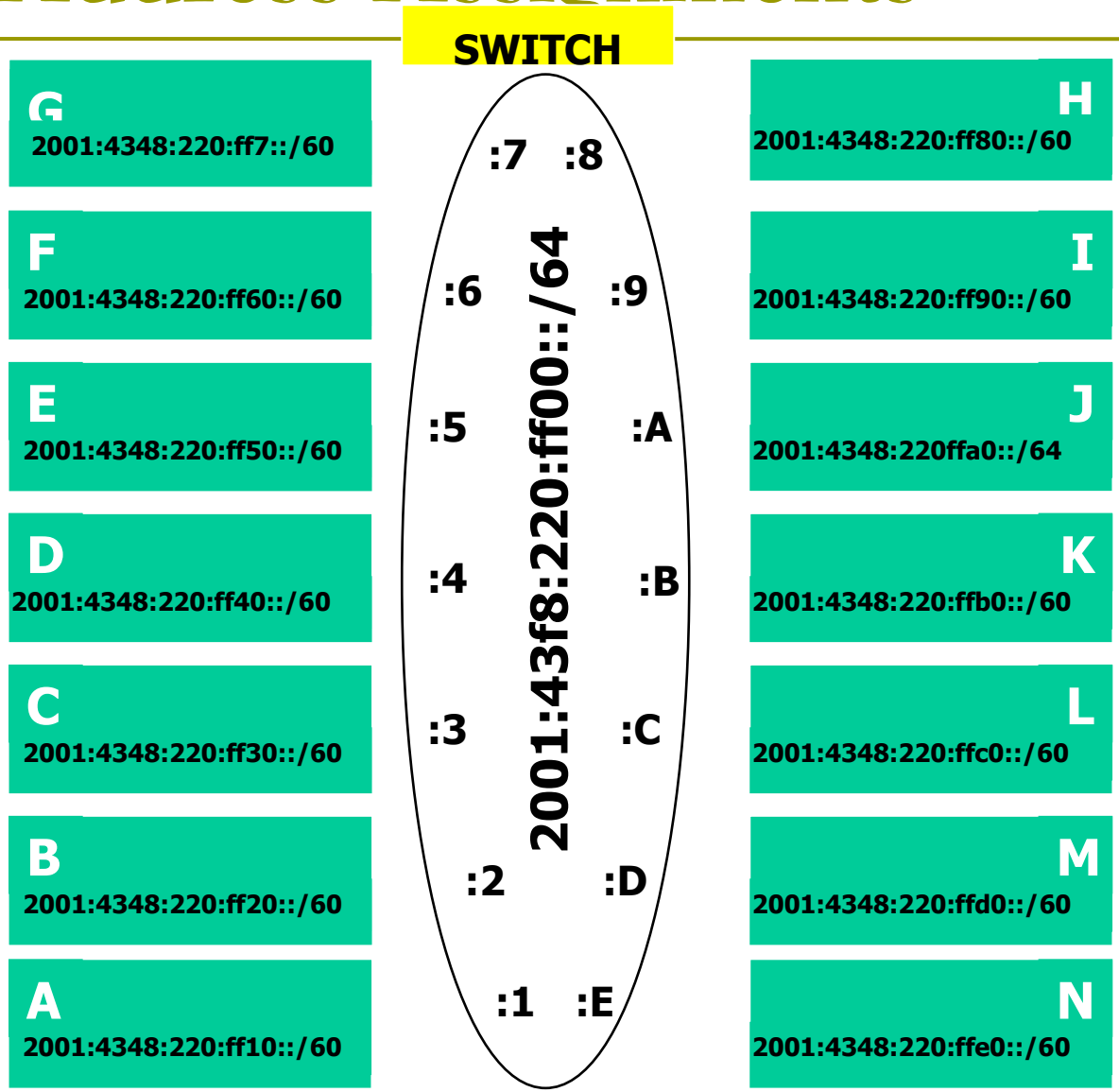
Static Exercise using IPv6

- Now let's repeat this exercise using IPv6 addressing
- Consult addressing plan for IPv6 addresses
  - Link between router and PC gets a /60
    - Group A use 2001:43f8:220:10::/60
    - Group B use 2001:43f8:220:20::/60
    - etc
  - Backbone is numbered from 2001:43f8:220:0::/64
    - Group A use 2001:43f8:220:0::1/64
    - Group A use 2001:43f8:220:0::2/64

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



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
```

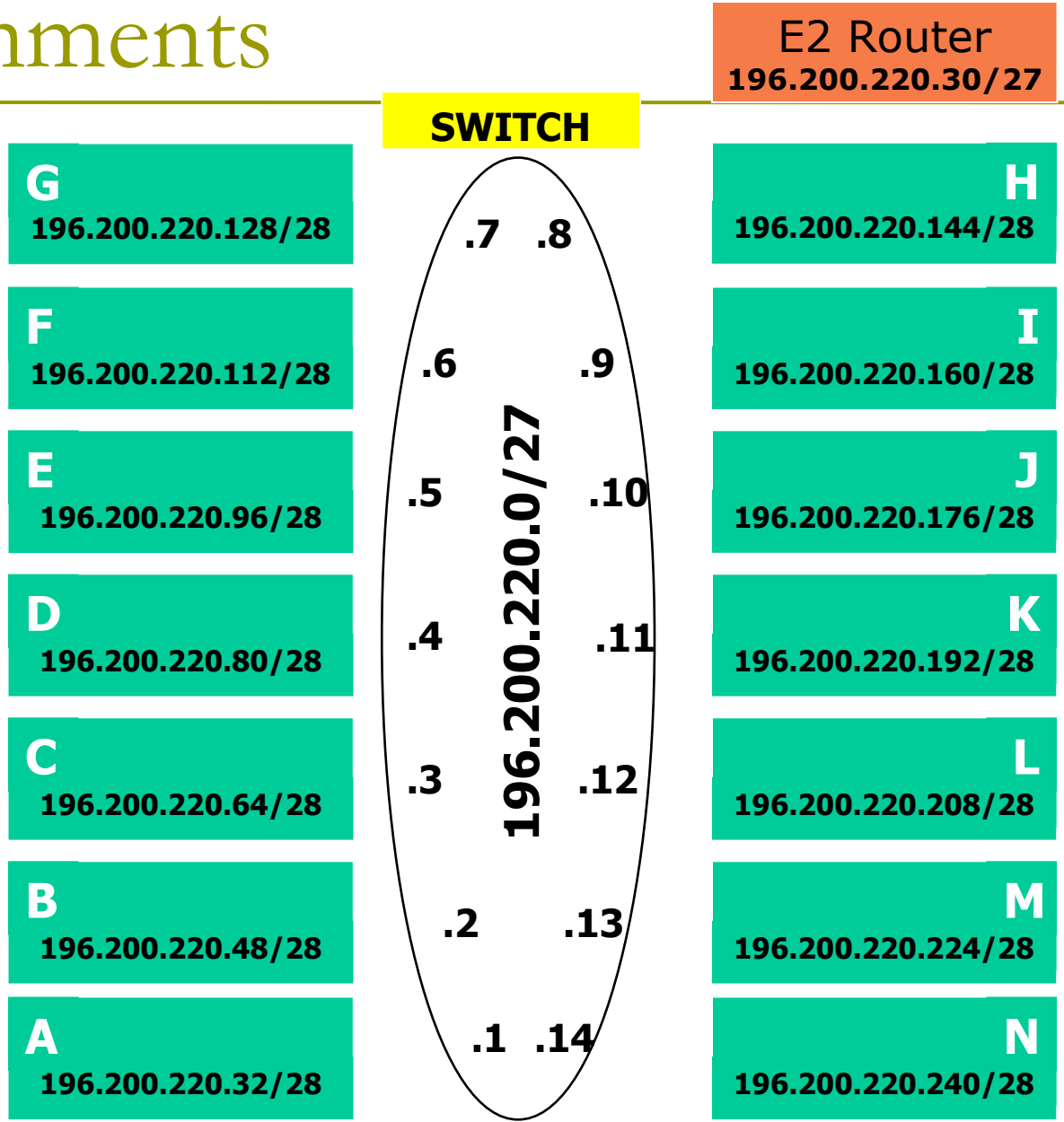
- Repeat several times until complete

Test Connectivity

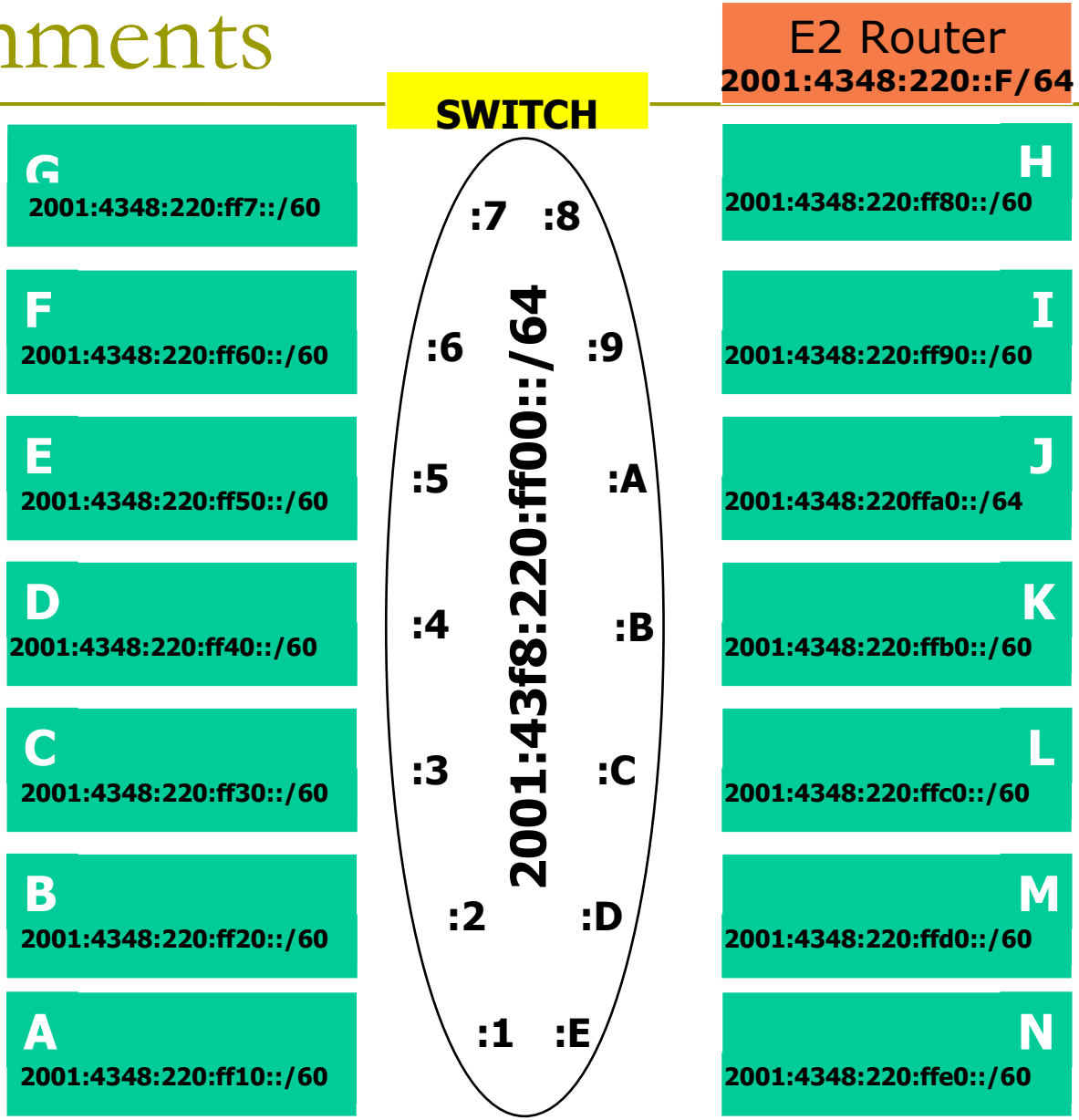
- All routers can reach all PCs
- All PCs can reach all backbone IP addresses
- All PCs can reach PCs in other rows
- Test with traceroute

Exercise Two

IPv4 Address Assignments



IPv6 Address Assignments



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