

# Static Routing Exercise

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Scalable Infrastructure  
Workshop  
AfNOG 2011

# What will the exercise involve?

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- ❑ Unix network interface configuration
- ❑ Cisco network interface configuration
- ❑ Static routes
- ❑ Default route
- ❑ Testing

# Routing

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- ❑ 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

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- ❑ 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

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## □ Advantages

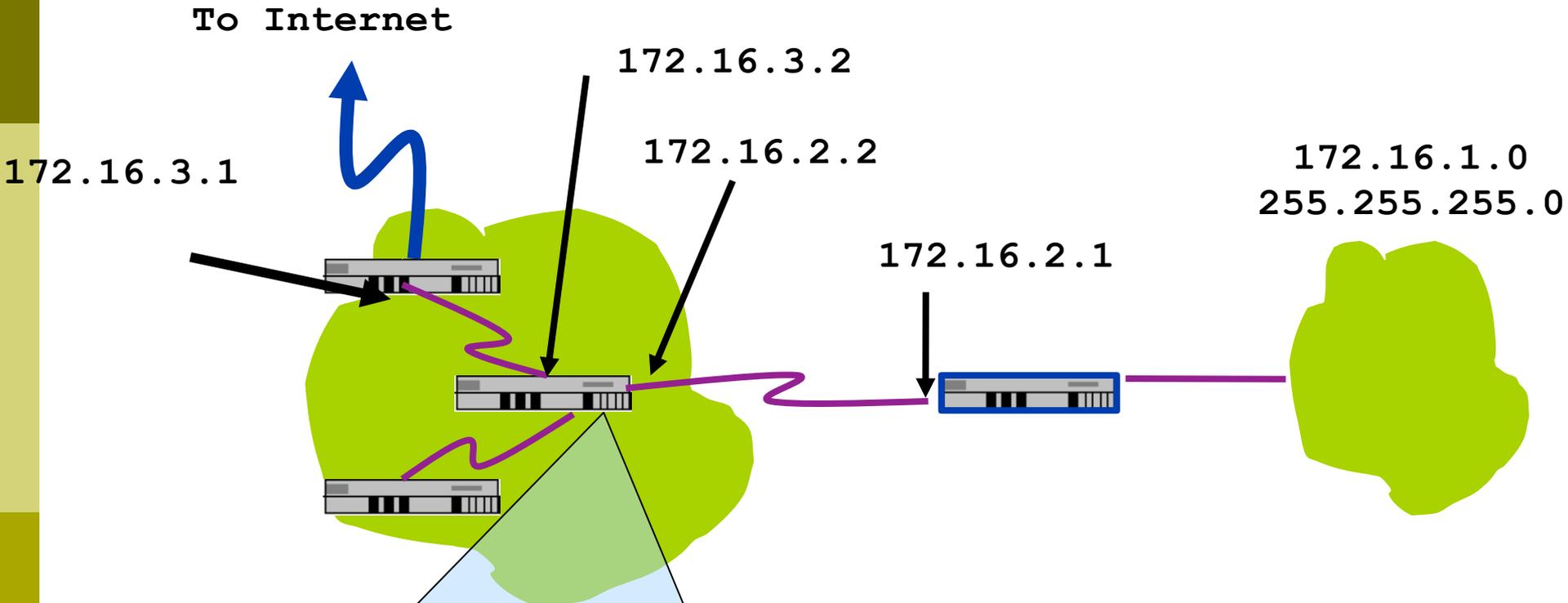
- Simple to configure and maintain
- Secure as only defined routes can be accessed
- Bandwidth is not used for sending routing updates

## □ Disadvantages

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

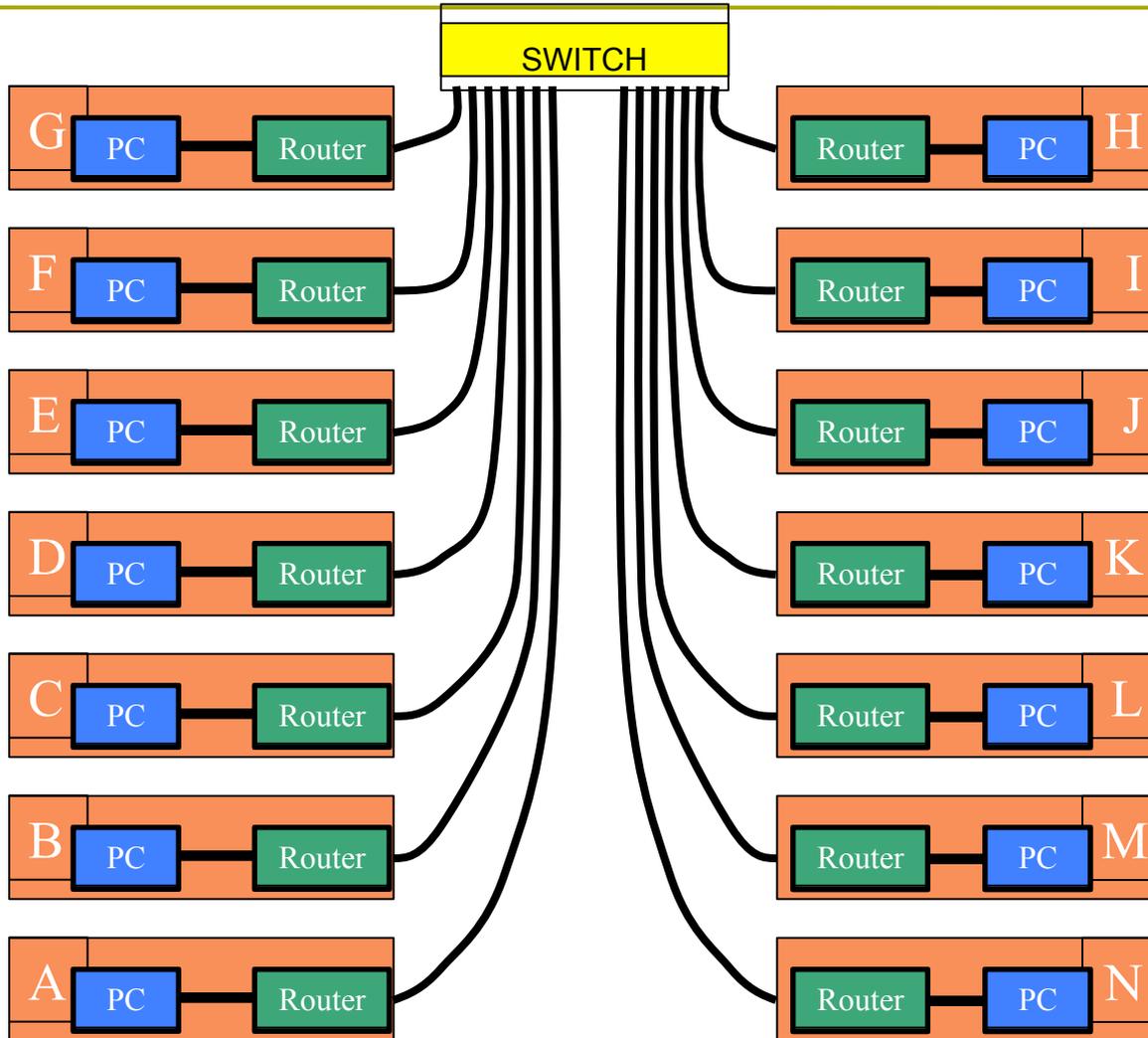
# IP Routing Configuration

## Static/default route example



```
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

**N**  
196.200.220.240/28

**M**  
196.200.220.224/28

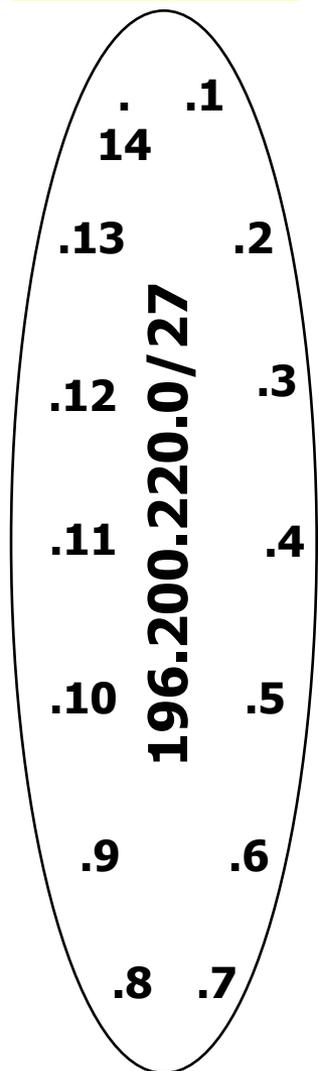
**L**  
196.200.220.208/28

**K**  
196.200.220.192/28

**J**  
196.200.220.176/28

**I**  
196.200.220.160/28

**H**  
196.200.220.144/28



**A**  
196.200.220.32/28

**B**  
196.200.220.48/28

**C**  
196.200.220.64/28

**D**  
196.200.220.80/28

**E**  
196.200.220.96/28

**F**  
196.200.220.112/28

**G**  
196.200.220.128/28

# IPv4 Address Assignment

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- ❑ 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

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□ 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

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- ❑ 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

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- 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

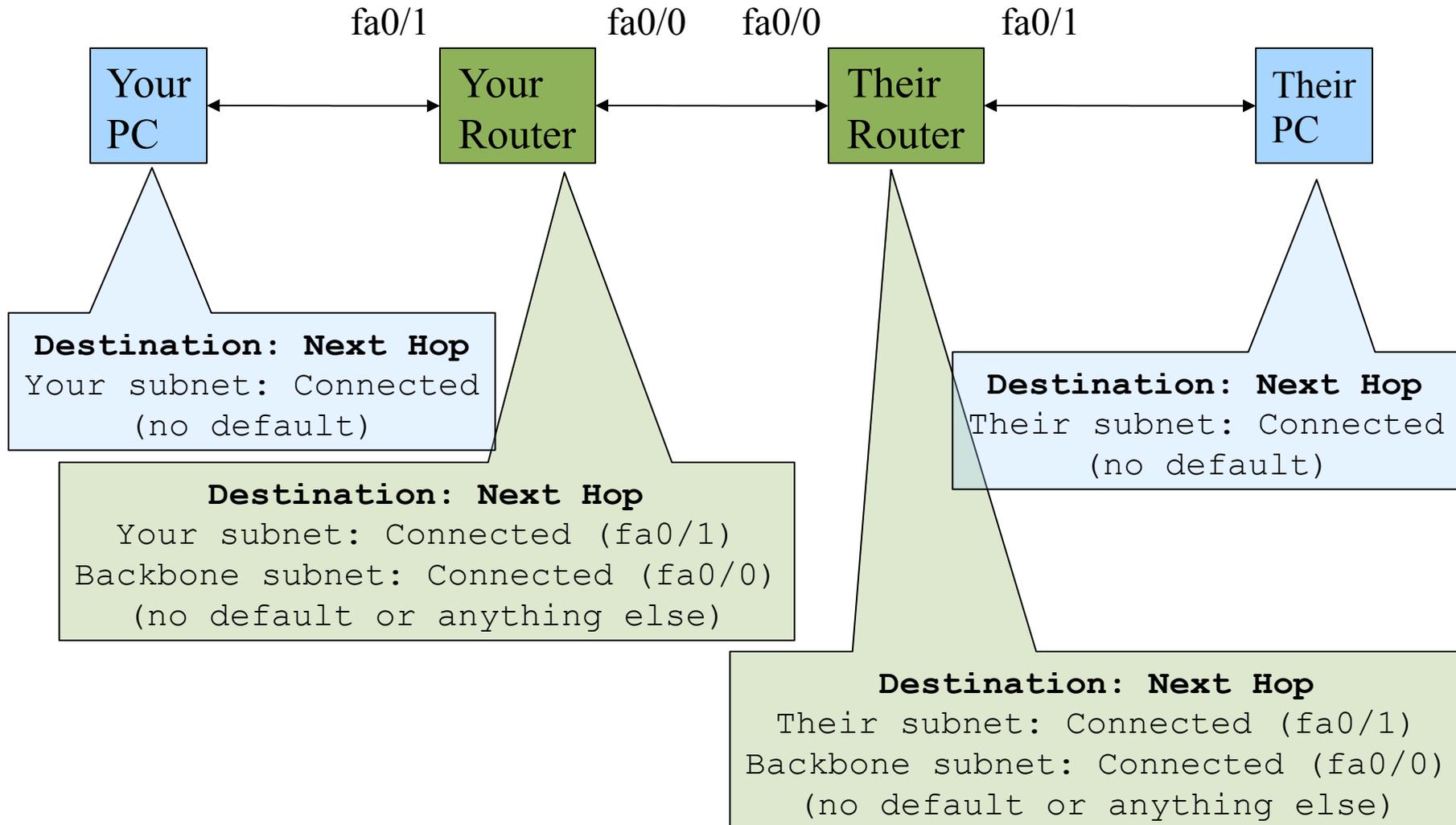
- Now configure the local interface on your router that connects to your PC (ie. Fa0/1). Use the IP address assignments that you made 3 slides ago.

# Cisco Router Network Interface Configuration

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- ❑ 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

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- ❑ 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

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- Add route on PC

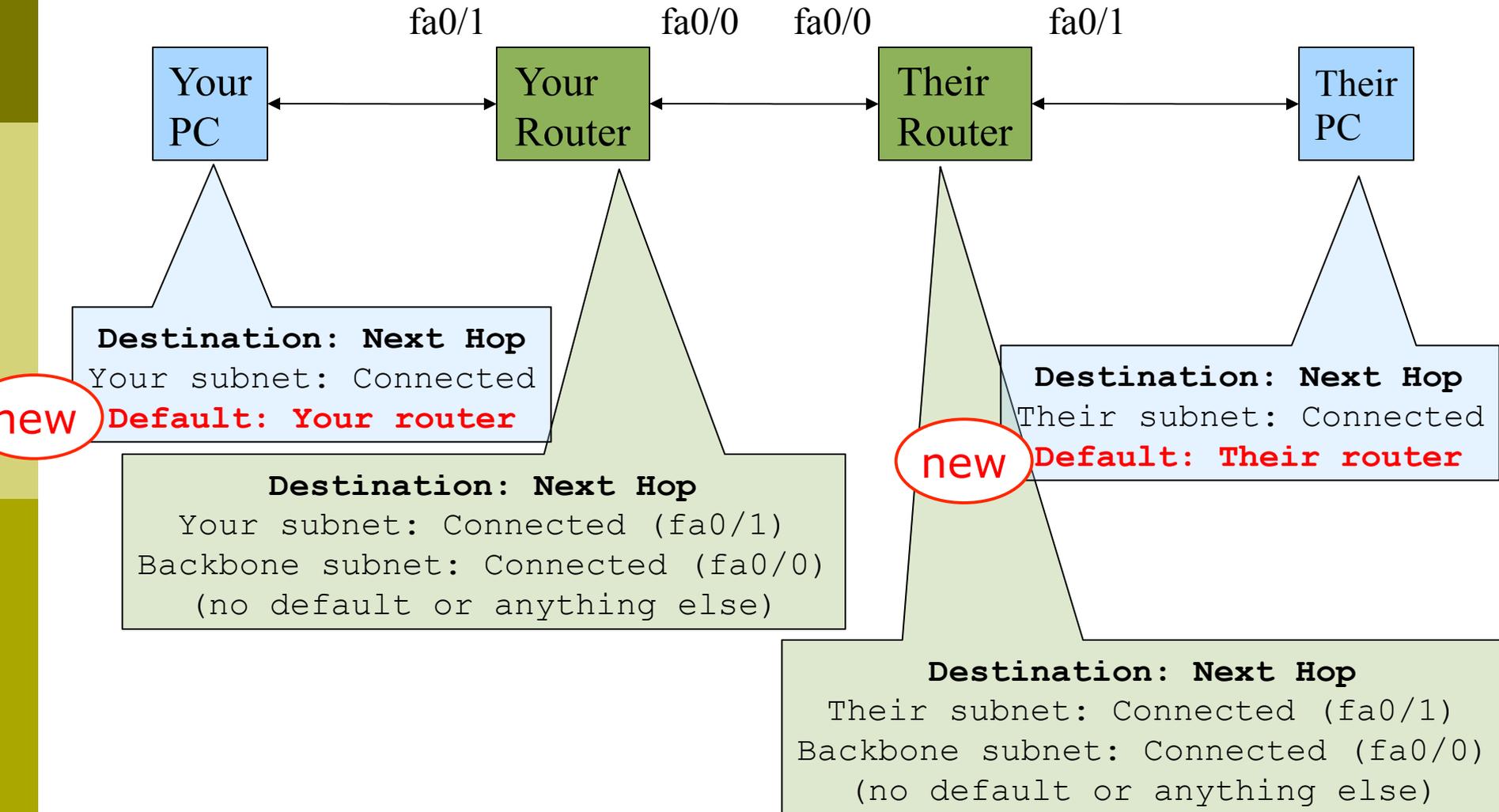
```
route add default g.g.g.g
```

**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...

PING

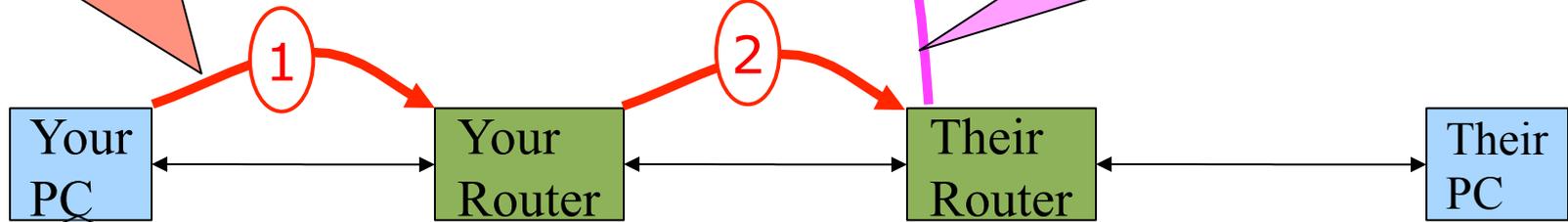
src = Your PC

dst = Their Router (backbone address)

REPLY

src = Their Router (backbone address)

dst = Your PC



**Destination: Next Hop**

Your subnet: Connected

**1** **Default: Your router**

**Destination: Next Hop**

Your subnet: Connected (fa0/1)

**2** **Backbone subnet: Connected (fa0/0)**  
(no default or anything else)

**Destination: Next Hop**

Their subnet: Connected

Default: Their router

**Destination: Next Hop**

Their subnet: Connected (fa0/1)

Backbone subnet: Connected (fa0/0)

(no default or anything else)

**3** ???

# Configure static routes for the remaining classroom desks

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

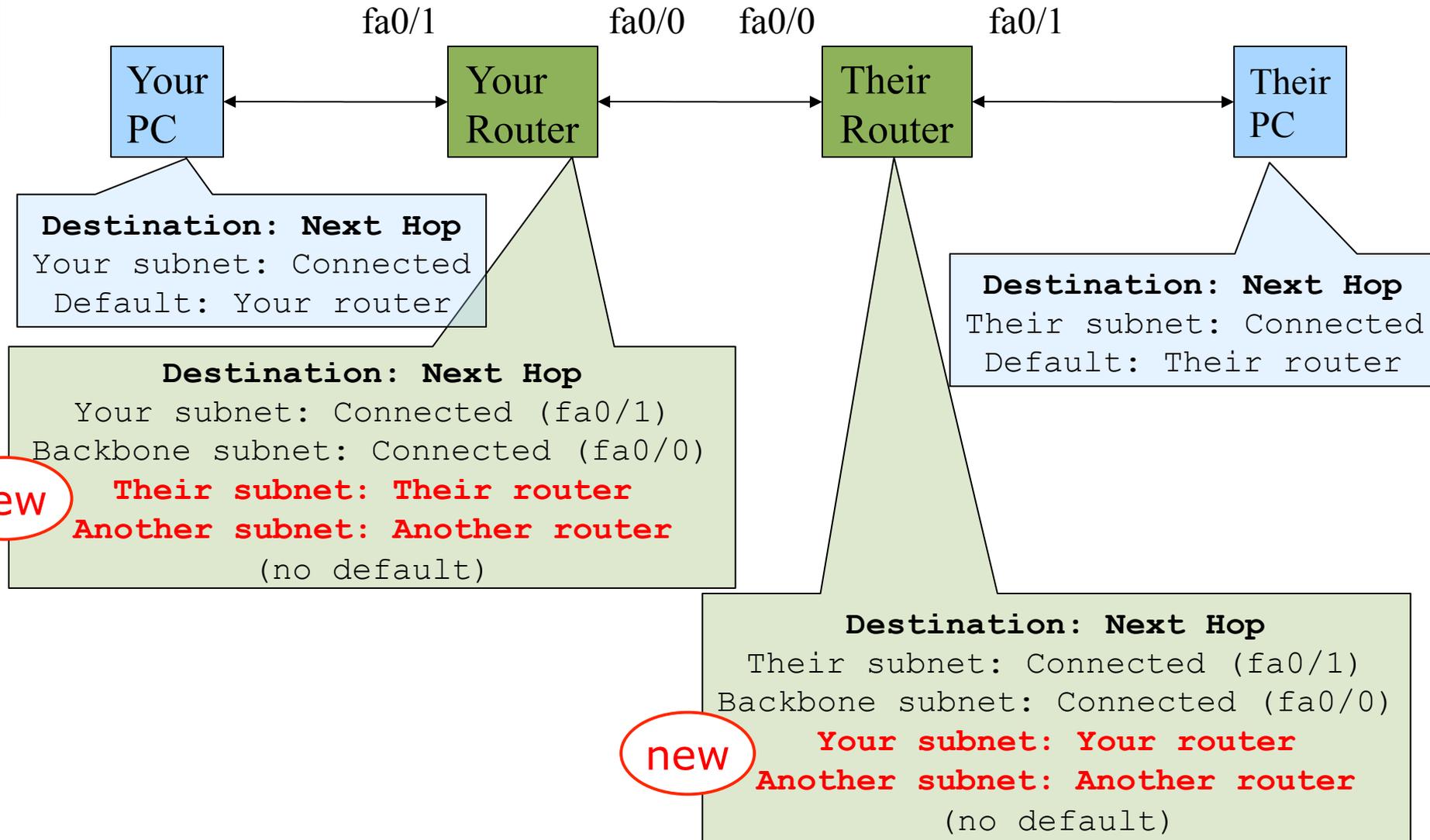
```
ip route n.n.n.n m.m.m.m g.g.g.g
```

**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

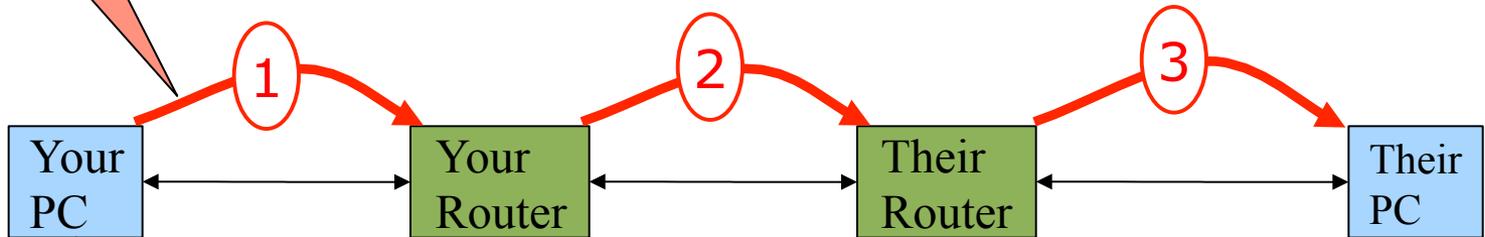
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- ❑ All routers can reach all PCs
- ❑ All PCs can reach all backbone IP addresses
- ❑ All PCs can reach PCs in other rows
- ❑ Test with traceroute

# When your PC pings their PC...

PING

src = Your PC  
dst = Their PC



**Destination: Next Hop**

Your subnet: Connected

**1 Default: Your router**

**Destination: Next Hop**

Your subnet: Connected (fa0/1)

Backbone subnet: Connected (fa0/0)

**2 Their subnet: Their router**

Another subnet: Another router  
(no default)

**Destination: Next Hop**

Their subnet: Connected

Default: Their router

**Destination: Next Hop**

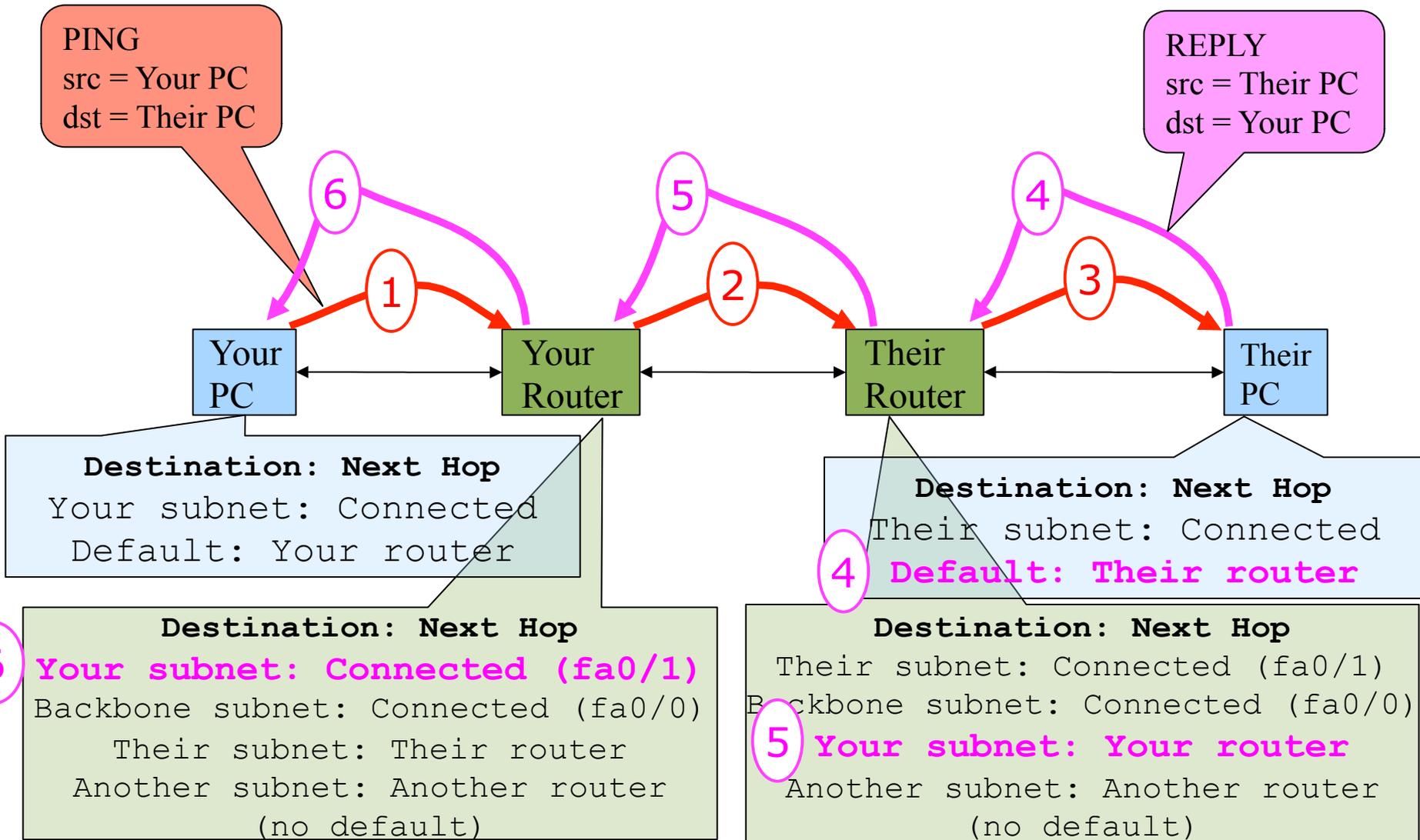
**3 Their subnet: Connected (fa0/1)**

Backbone subnet: Connected (fa0/0)

Your subnet: Your router

Another subnet: Another router  
(no default)

# ... and the reply from their PC



# Static Exercise using IPv6

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- 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 B use 2001:43f8:220:0::2/64

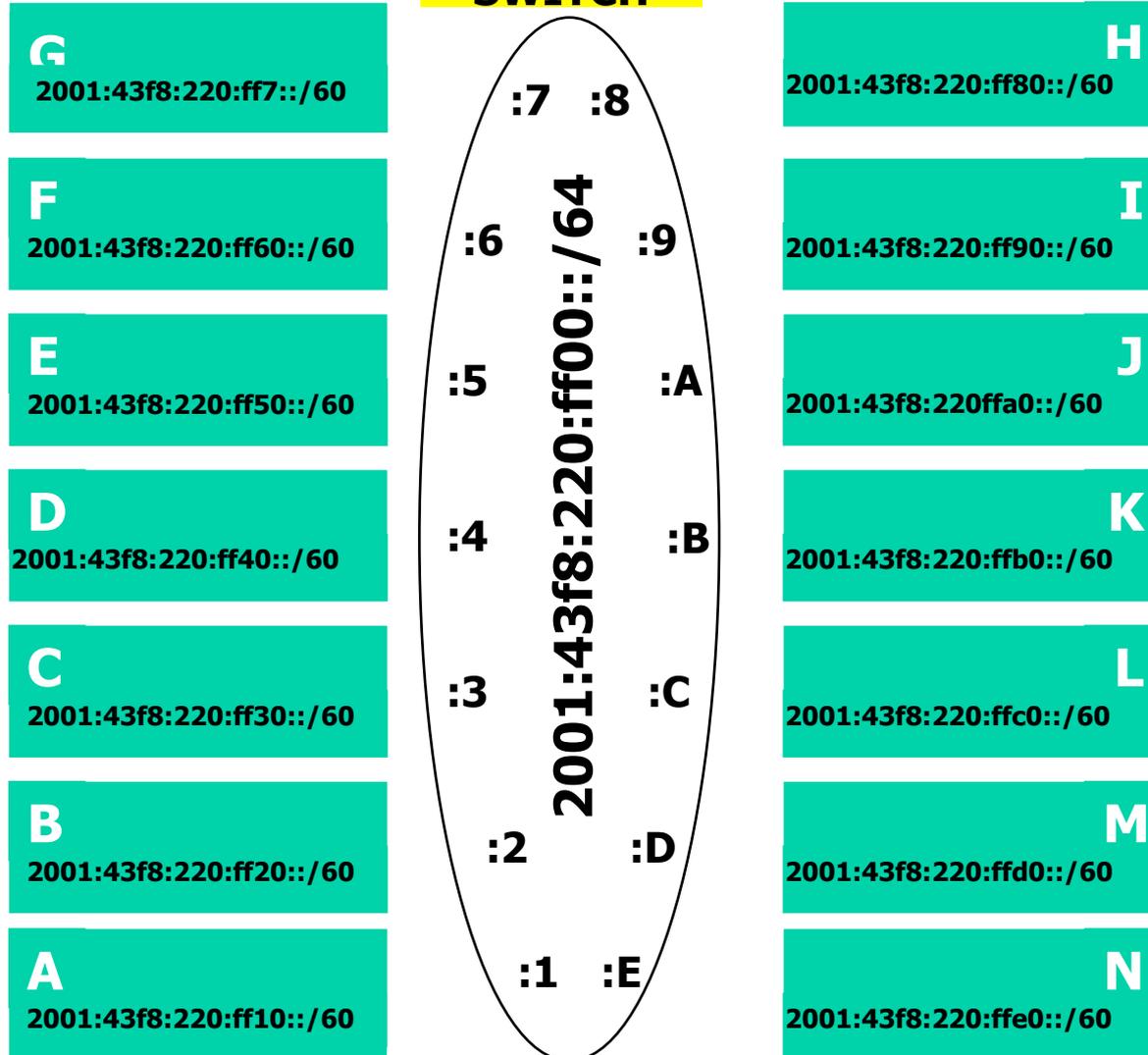
# Big Hint!

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- ❑ 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



# 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

SIE Router  
196.200.220.30/27

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

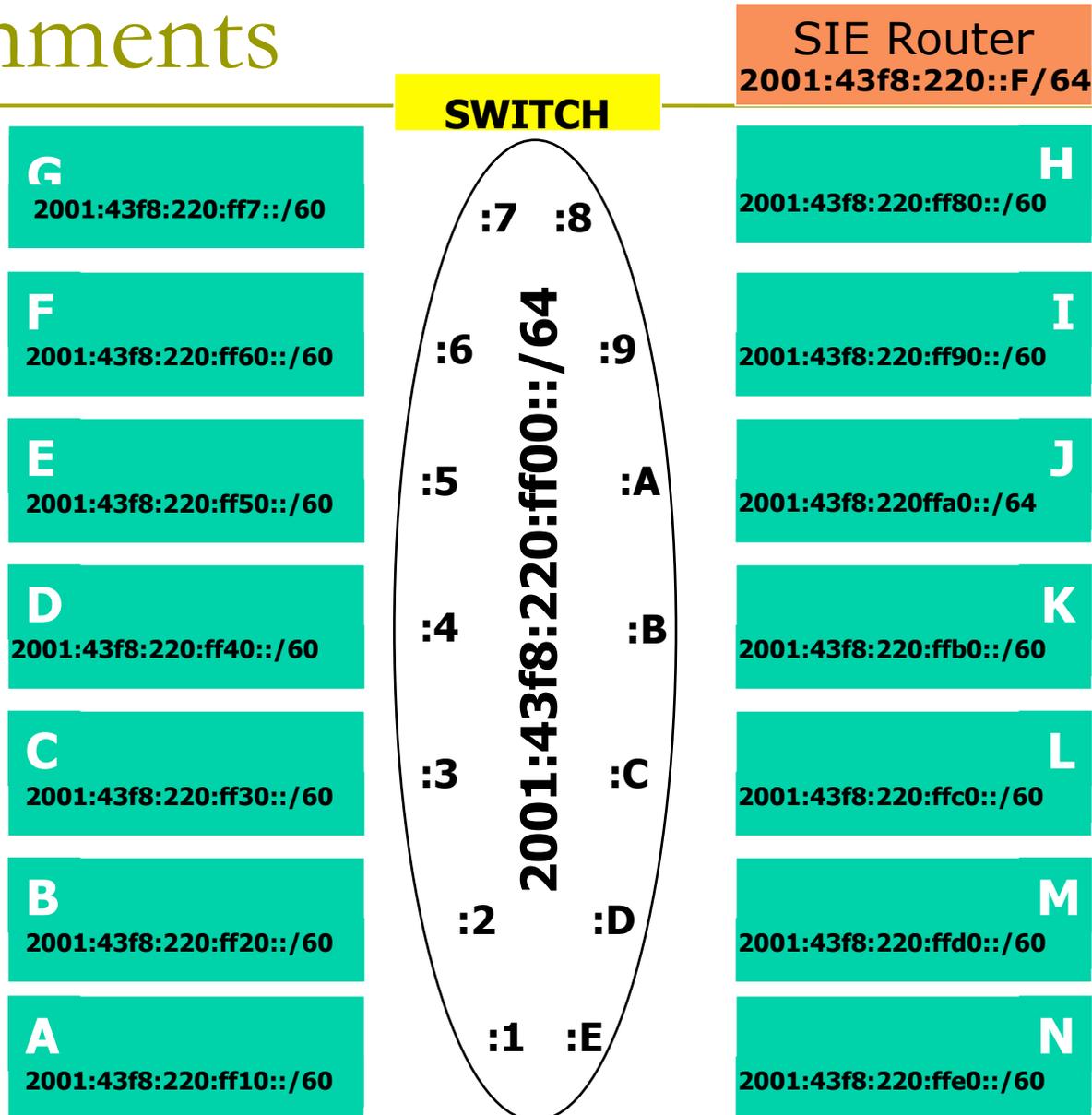
**K**  
196.200.220.192/28

**L**  
196.200.220.208/28

**M**  
196.200.220.224/28

**N**  
196.200.220.240/28

# 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

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- ❑ 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