Static Routing Exercise

Scalable Infrastructure Workshop

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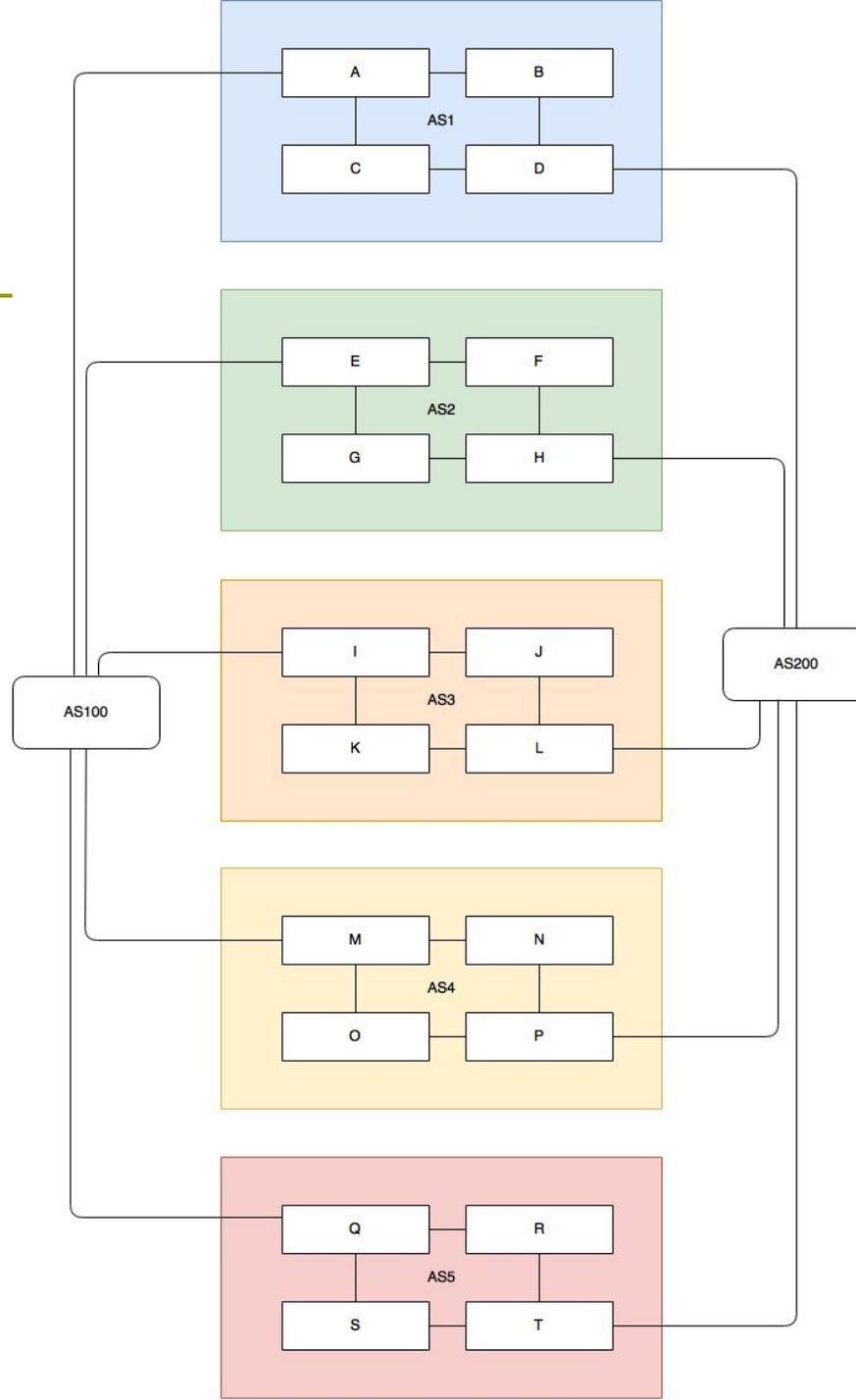
☐ **Disadvantages**
- Manual update of routes after changes
- Explicit addition of routes for all networks
- Potential for configuration mistakes

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
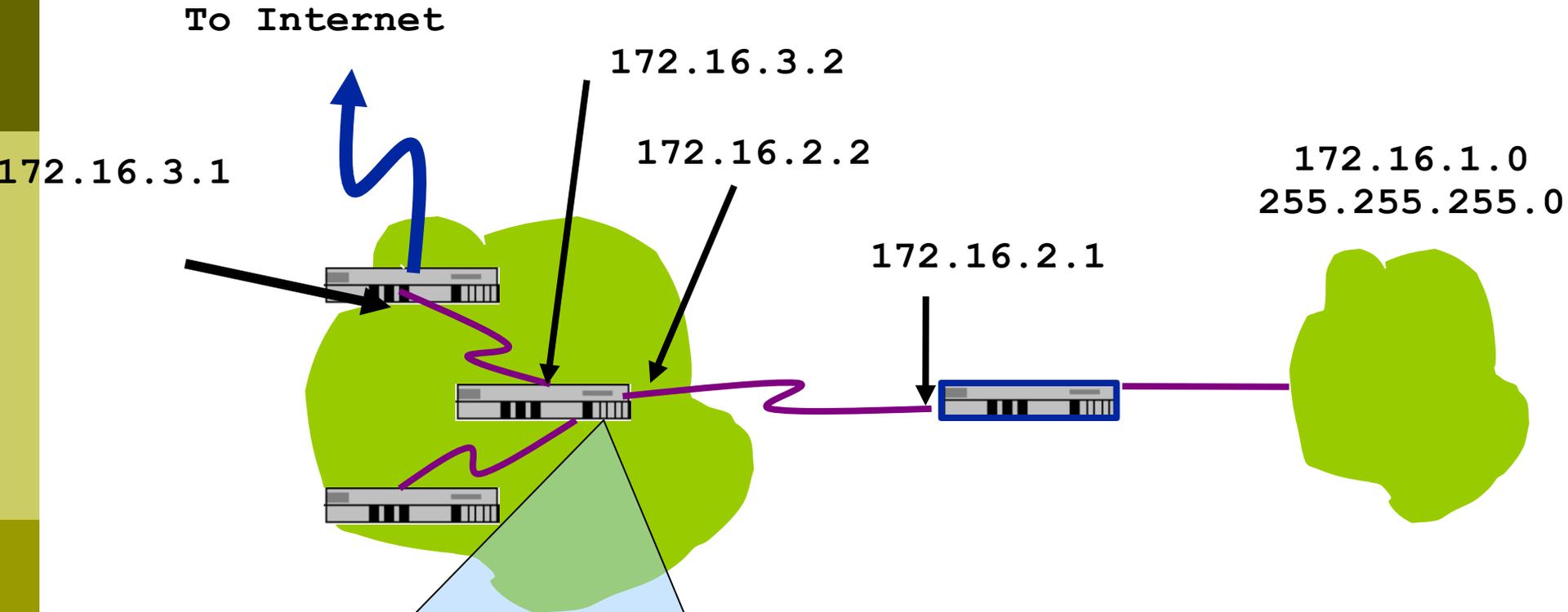
172.16.2.1

```
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
```

Exercise One

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 Unix 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`
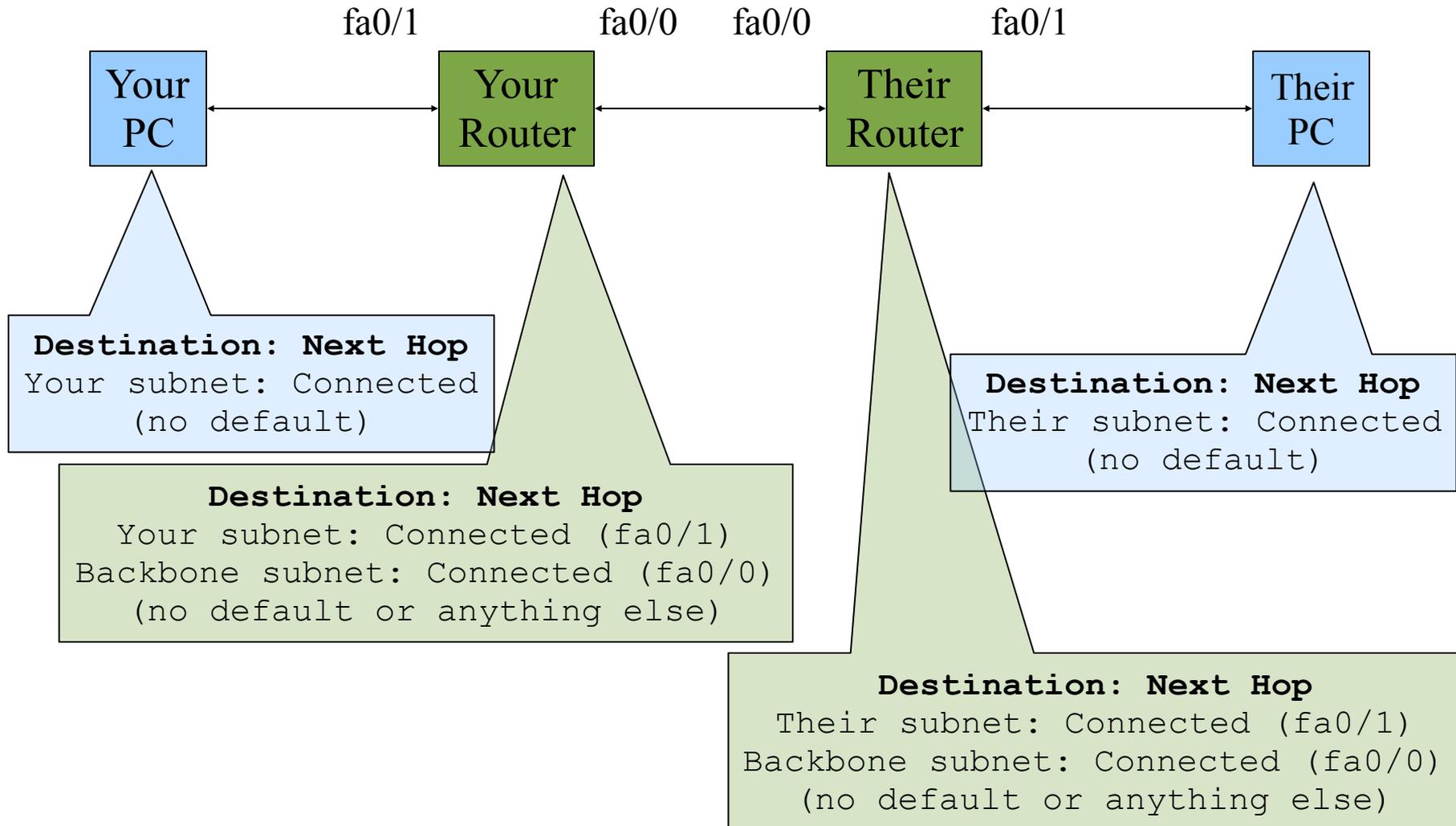
`no ip proxy-arp`

`no ip redirects`

`no ip directed-broadcast`

Forwarding Tables at this point in the exercise

fa0/1   fa0/0   fa0/0   fa0/1

| Your PC | | Your Router | | Their Router | | Their PC |

Destination: Next Hop
Your subnet: Connected
(no default)

Destination: Next Hop
Your subnet: Connected (fa0/1)
Backbone subnet: Connected (fa0/0)
(no default or anything else)

Destination: Next Hop
Their subnet: Connected
(no default)

Destination: Next Hop
Their subnet: Connected (fa0/1)
Backbone subnet: Connected (fa0/0)
(no default or anything else)

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.
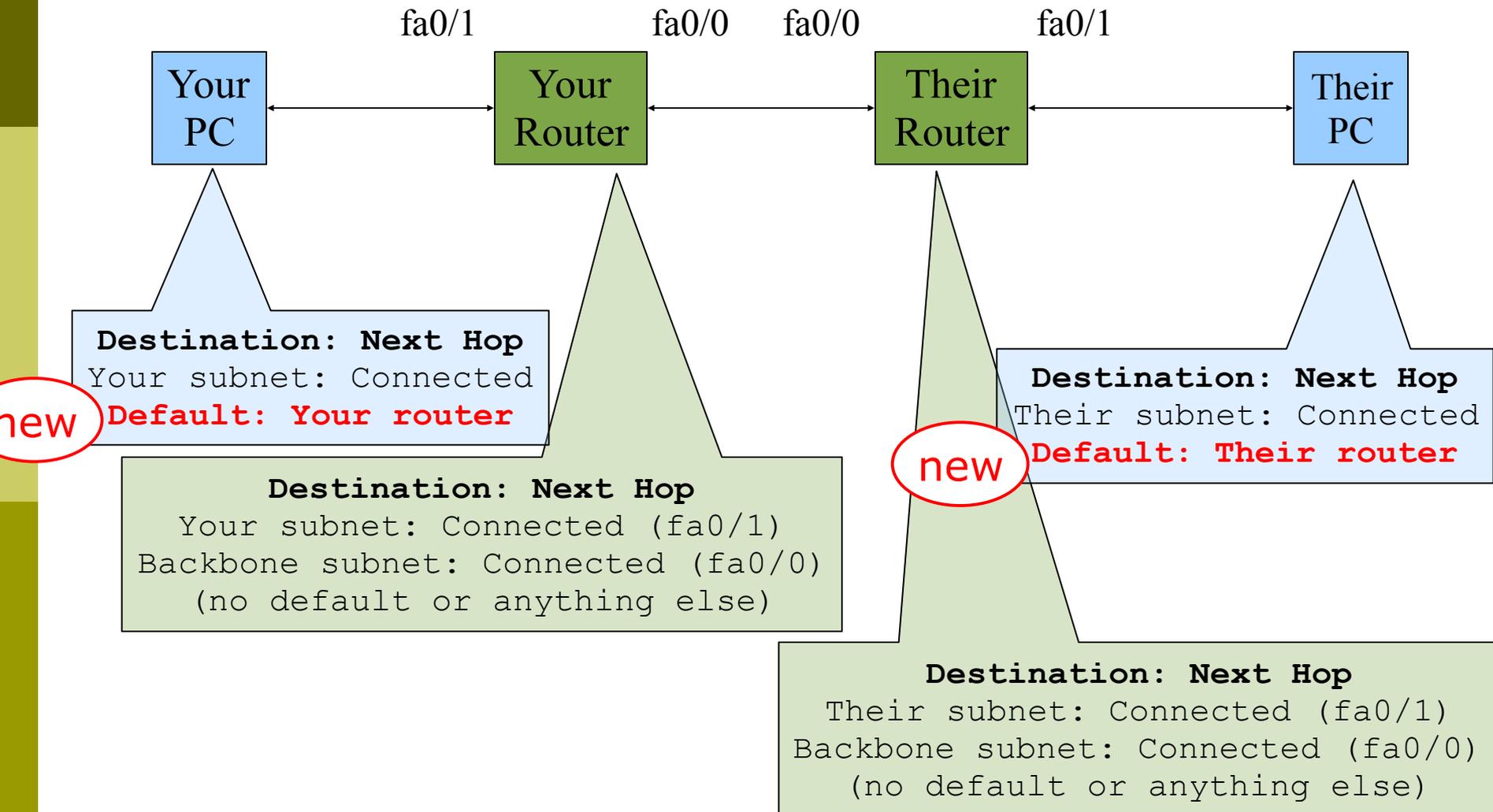
Configure a default route

☐ 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

fa0/1   fa0/0   fa0/0   fa0/1

Your PC ⟷ **Your Router** ⟷ **Their Router** ⟷ **Their PC**

Destination: Next Hop
Your subnet: Connected
Default: Your router

(new)

Destination: Next Hop
Your subnet: Connected (fa0/1)
Backbone subnet: Connected (fa0/0)
(no default or anything else)

Destination: Next Hop
Their subnet: Connected
Default: Their router

(new)

Destination: Next Hop
Their subnet: Connected (fa0/1)
Backbone subnet: Connected (fa0/0)
(no default or anything else)

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?
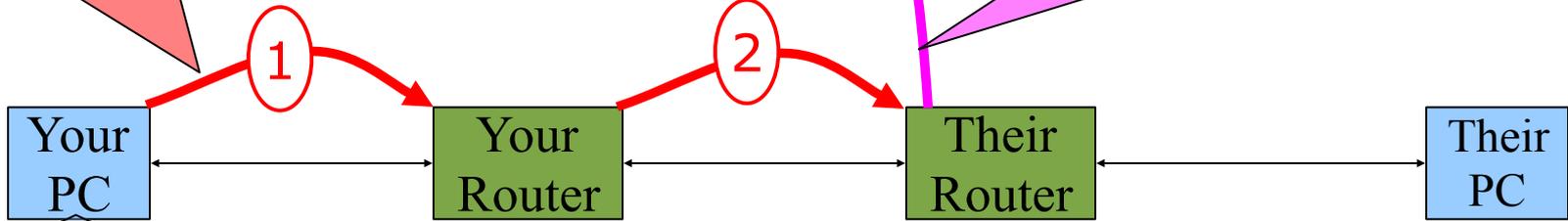
When you ping their router...

PING
src = Your PC
dst = Their Router (backbone address)

REPLY
src = Their Router (backbone address)
dst = Your PC

1

2

3

Your PC

Your Router

Their Router

Their PC

Destination: Next Hop
Your subnet: Connected
Default: Your router

1

Destination: Next Hop
Your subnet: Connected (fa0/1)
Backbone subnet: Connected (fa0/0)
(no default or anything else)

2

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

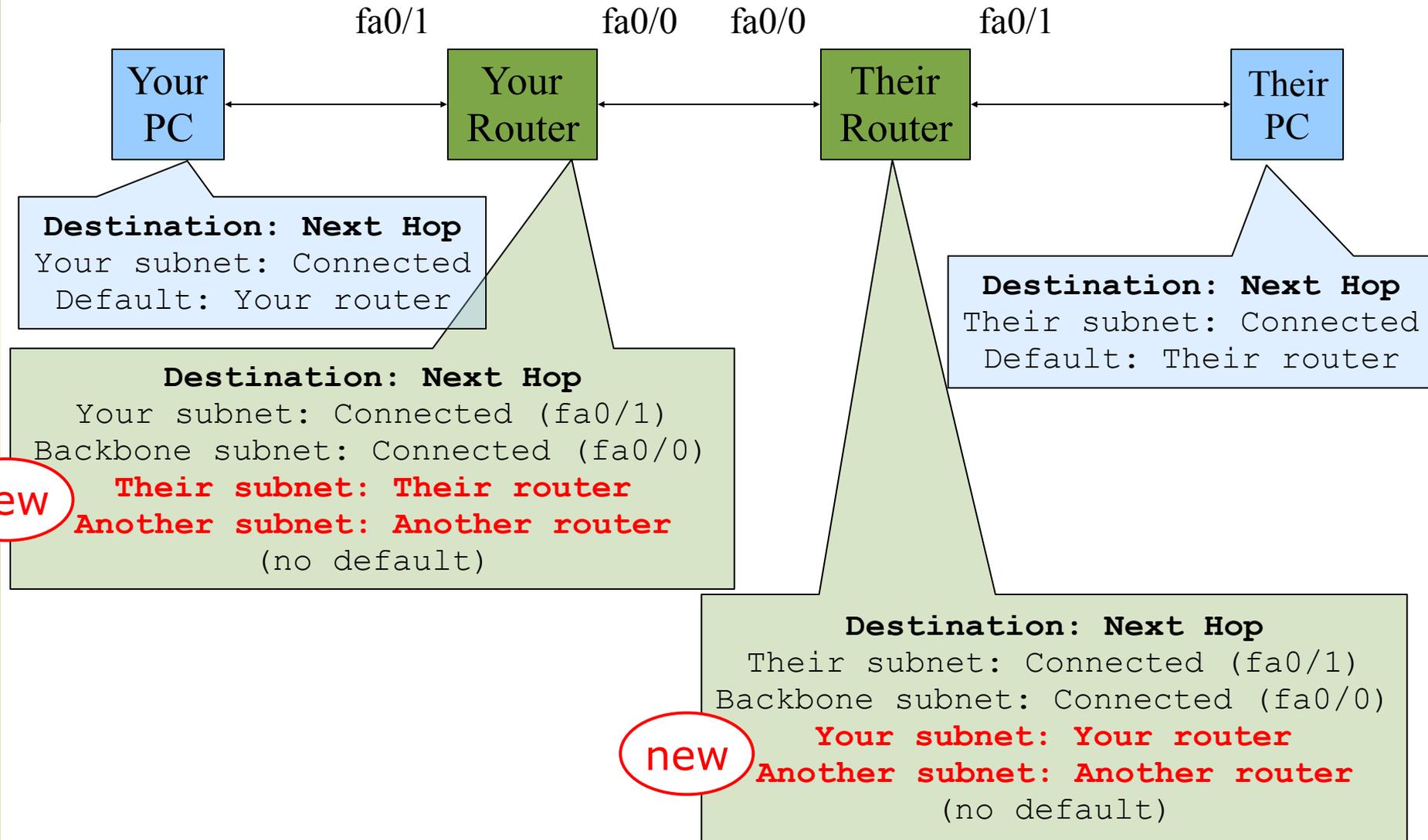☐ On your router, add static routes to the other PCs, using their router's backbone IP addresses as the next-hop.

`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

fa0/1   fa0/0   fa0/0   fa0/1

```
┌────────┐        ┌────────┐        ┌────────┐        ┌────────┐
│  Your  │◄──────►│  Your  │◄──────►│ Their  │◄──────►│ Their  │
│   PC   │        │ Router │        │ Router │        │   PC   │
└────────┘        └────────┘        └────────┘        └────────┘
```

Destination: Next Hop
Your subnet: Connected
Default: Your router

Destination: Next Hop
Your subnet: Connected (fa0/1)
Backbone subnet: Connected (fa0/0)
Their subnet: Their router
Another subnet: Another router
(no default)

new

Destination: Next Hop
Their subnet: Connected
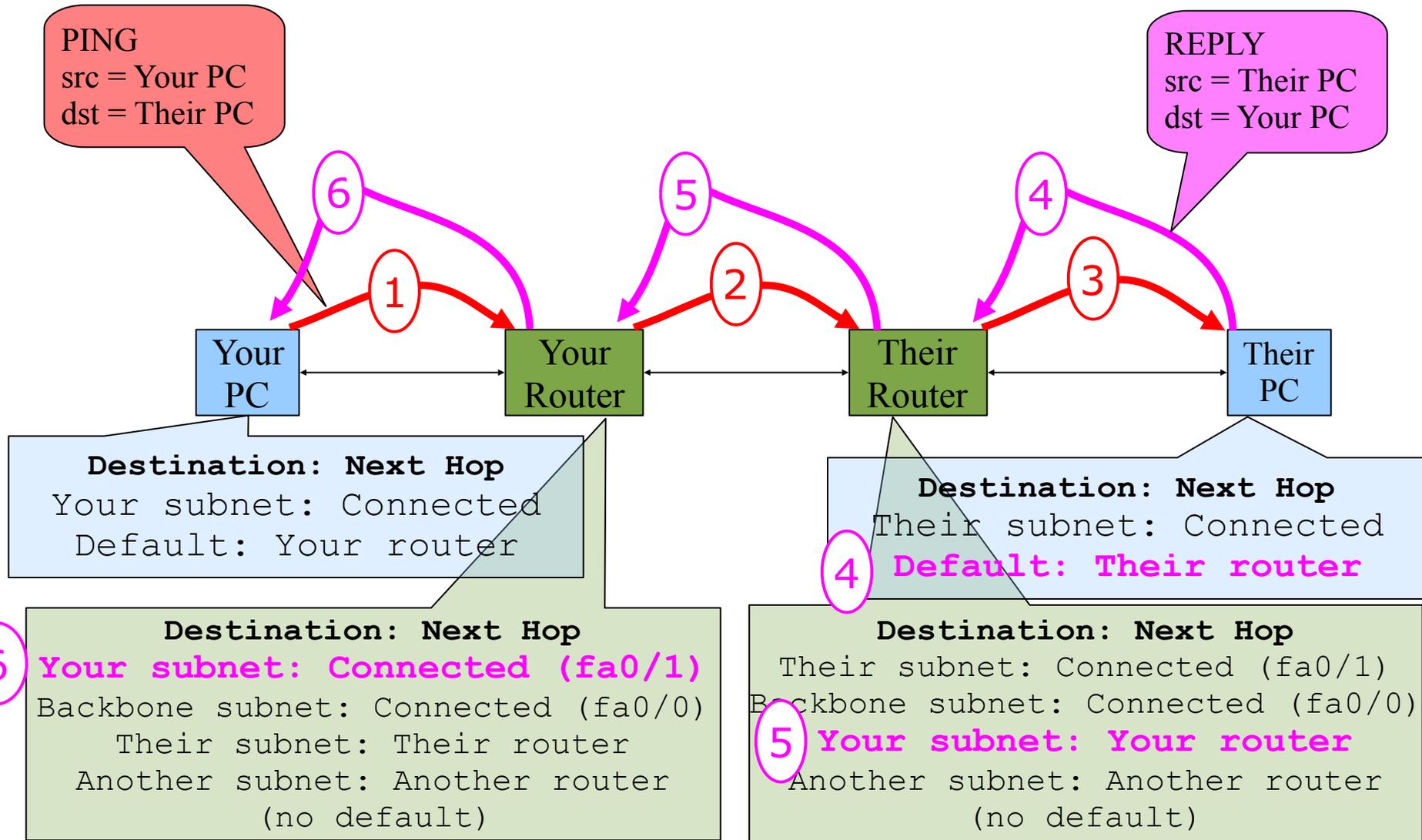Default: Their router

Destination: Next Hop
Their subnet: Connected (fa0/1)
Backbone subnet: Connected (fa0/0)
Your subnet: Your router
Another subnet: Another router
(no default)

new

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

PING
src = Your PC
dst = Their PC
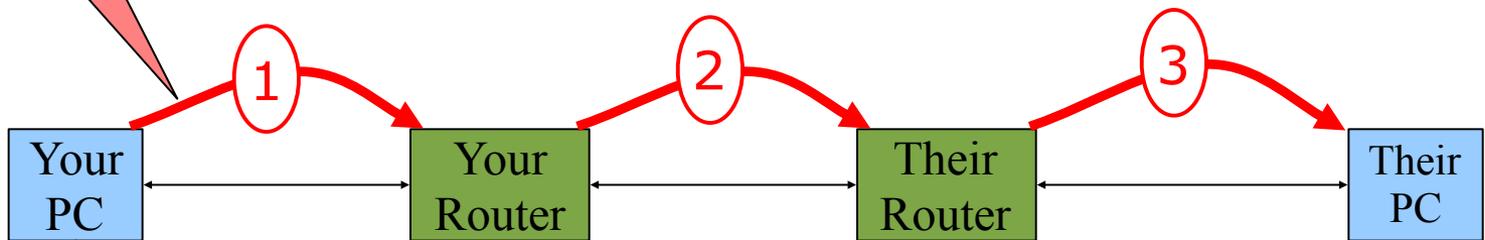
REPLY
src = Their PC
dst = Your PC

Destination: Next Hop
Your subnet: Connected
Default: Your router

Destination: Next Hop
Their subnet: Connected
Default: Their router

Destination: Next Hop
Your subnet: Connected (fa0/1)
Backbone subnet: Connected (fa0/0)
Their subnet: Their router
Another subnet: Another router
(no default)

Destination: Next Hop
Their subnet: Connected (fa0/1)
Backbone subnet: Connected (fa0/0)
Your subnet: Your router
Another subnet: Another router
(no default)

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 Buse 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!

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

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 routes to all other groups' blocks
`ip route n.n.n.n m.m.m.m g.g.g.g`

- ☐ 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 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