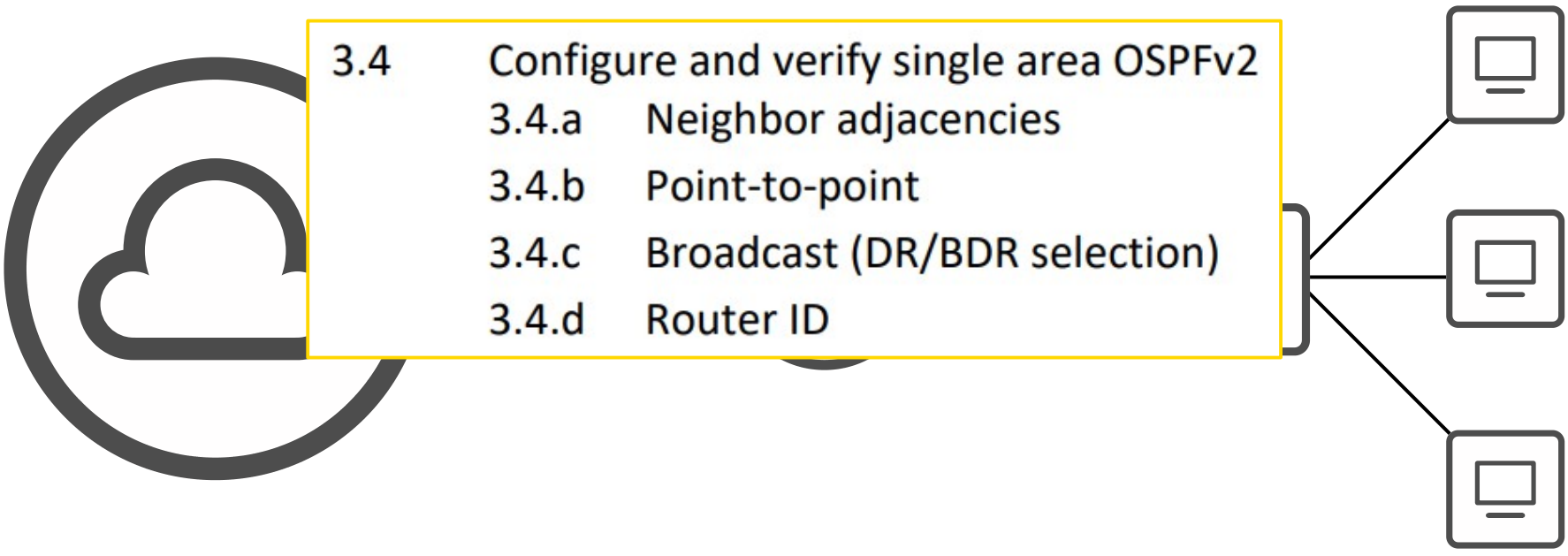
Jeremy's IT Lab

CCNA 200-301 Day 26

OSPF Part 1

3.4	Configure and verify single area OSPFv2	
	3.4.a	Neighbor adjacencies
	3.4.b	Point-to-point
	3.4.c	Broadcast (DR/BDR selection)
	3.4.d	Router ID

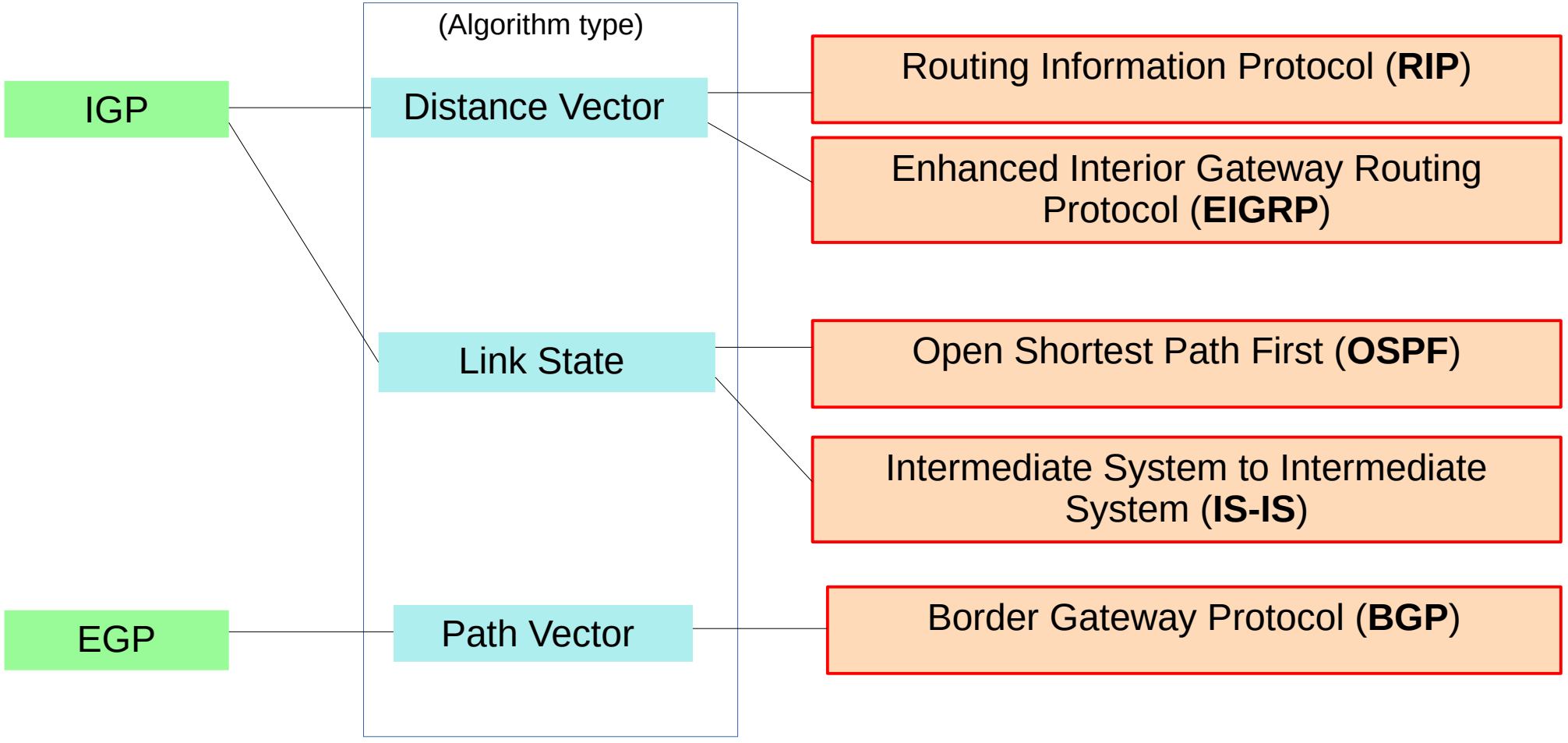


Things we'll cover

- Basic OSPF Operations (introduction)
- OSPF Areas
- Basic OSPF Configuration

Jeremy's IT Lab

Types of Dynamic Routing Protocols



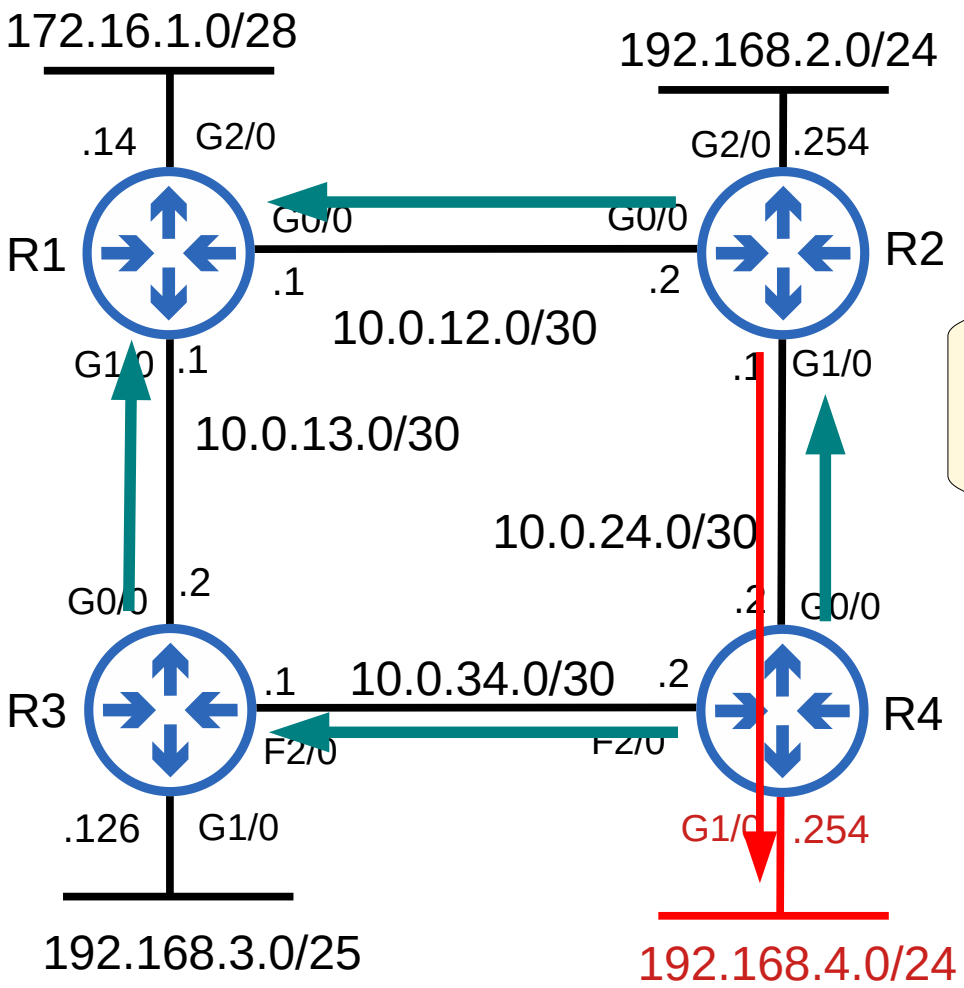
Link State Routing Protocols

- When using a **link state** routing protocol, every router creates a ‘connectivity map’ of the network.
- To allow this, each router advertises information about its interfaces (connected networks) to its neighbors. These advertisements are passed along to other routers, until all routers in the network develop the same map of the network.
- Each router independently uses this map to calculate the best routes to each destination.
- Link state protocols use more resources (CPU) on the router, because more information is shared.
- However, link state protocols tend to be faster in reacting to changes in the network than distance vector protocols.

OSPF

- Stands for **Open Shortest Path First**
- Uses the **Shortest Path First** algorithm of Dutch computer scientist Edsger Dijkstra. (aka **Dijkstra's algorithm** ← remember that name!)
- Three versions:
  OSPFv1 (1989): OLD, not in use anymore
  OSPFv2 (1998): Used for IPv4
  OSPFv3 (2008): Used for IPv6 (can also be used for IPv4, but usually v2 is used)
- Routers store information about the network in LSAs (Link State Advertisements), which are organized in a structure called the LSDB (Link State Database).
- Routers will **flood** LSAs until all routers in the OSPF *area* develop the same map of the network (LSDB).

LSA Flooding



- OSPF is enabled on R4's G1/0 interface.
- R4 creates an LSA to tell its neighbors about the network on G1/0.

Each LSA has an aging timer (30 min by default). The LSA will be flooded again after the timer expires.

LSA
RID: 4.4.4.4
IP: 192.168.4.0/24
Cost: 1

LSDB

LSA	LSA	LSA	LSA
LSA	LSA	LSA	LSA

OSPF

- In OSPF, there are three main steps in the process of sharing LSAs and determining the best route to each destination in the network.

1) **Become neighbors** with other routers connected to the same segment.

2) **Exchange LSAs** with neighbor routers.

3) **Calculate the best routes** to each destination, and insert them into the routing table.

OSPF Areas

- OSPF uses **areas** to divide up the network.

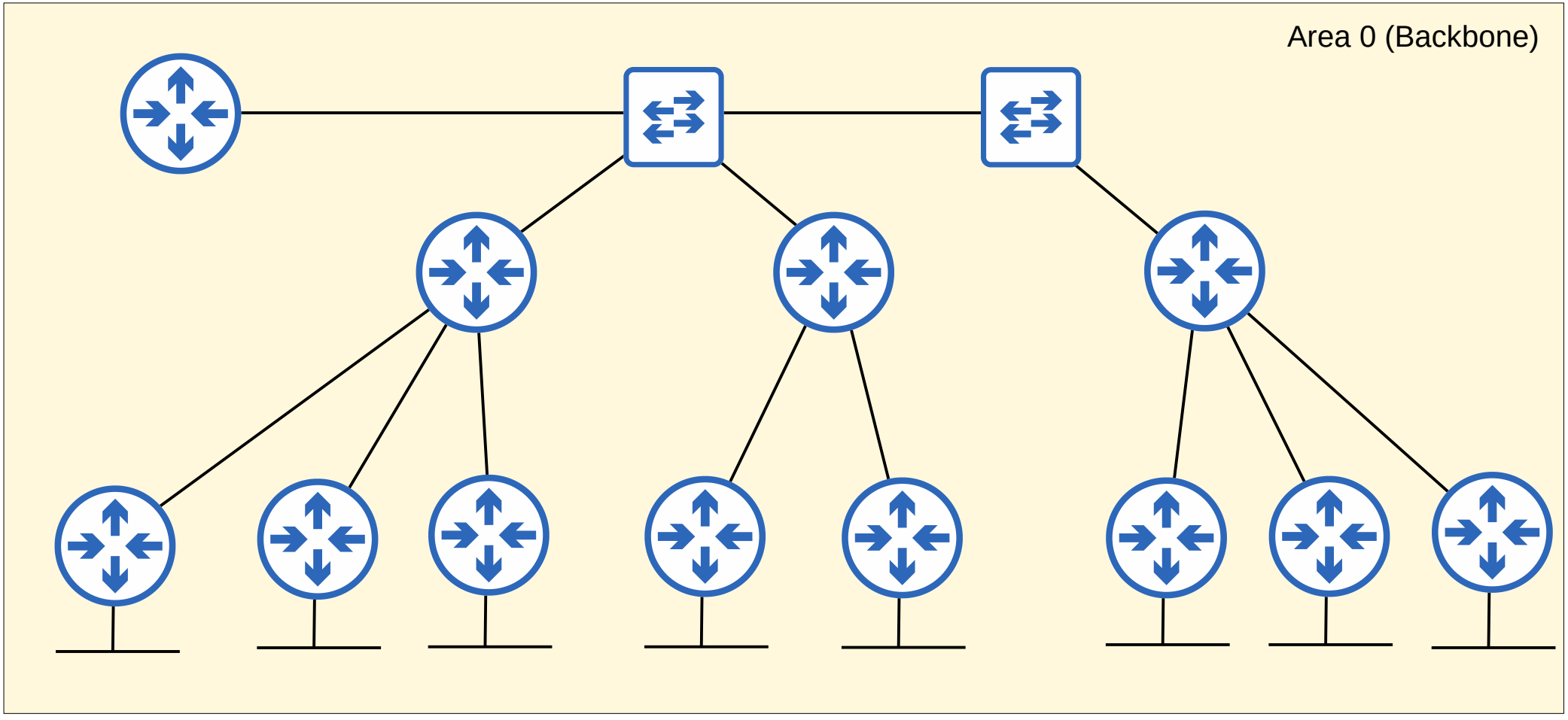
- Small networks can be *single-area* without any negative effects on performance.

- In larger networks, a single-area design can have negative effects:
  -the SPF algorithm takes more time to calculate routes
  -the SPF algorithm requires exponentially more processing power on the routers
  -the larger LSDB takes up more memory on the routers
  -any small change in the network causes every router to flood LSAs and run the SPF algorithm again

- By dividing a large OSPF network into several smaller areas, you can avoid the above negative effects.

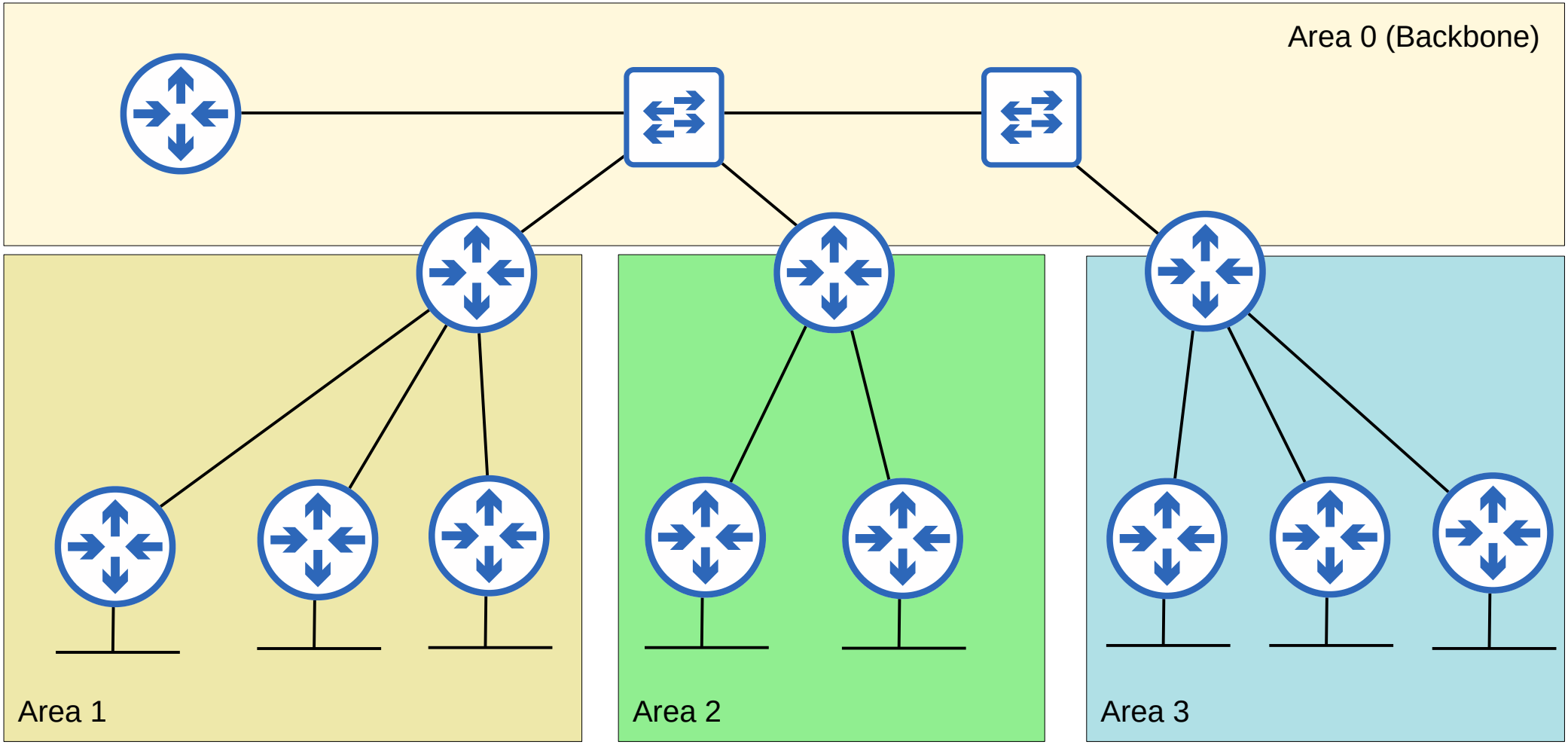
Jeremy's IT Lab

OSPF Areas



Jeremy's IT Lab

OSPF Areas

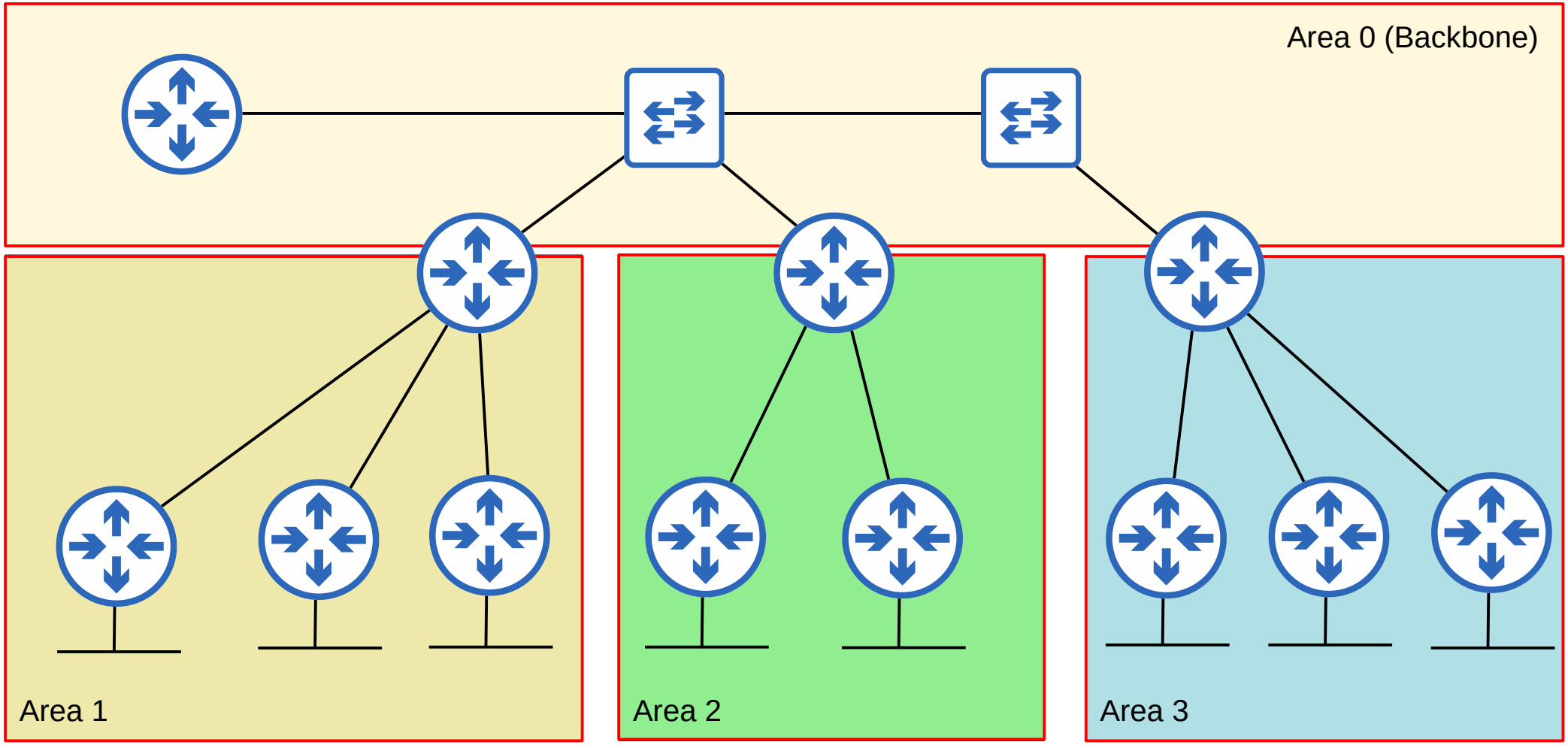


OSPF Areas

- An **area** is a set of routers and links that share the same LSDB.

Jeremy's IT Lab

OSPF Areas

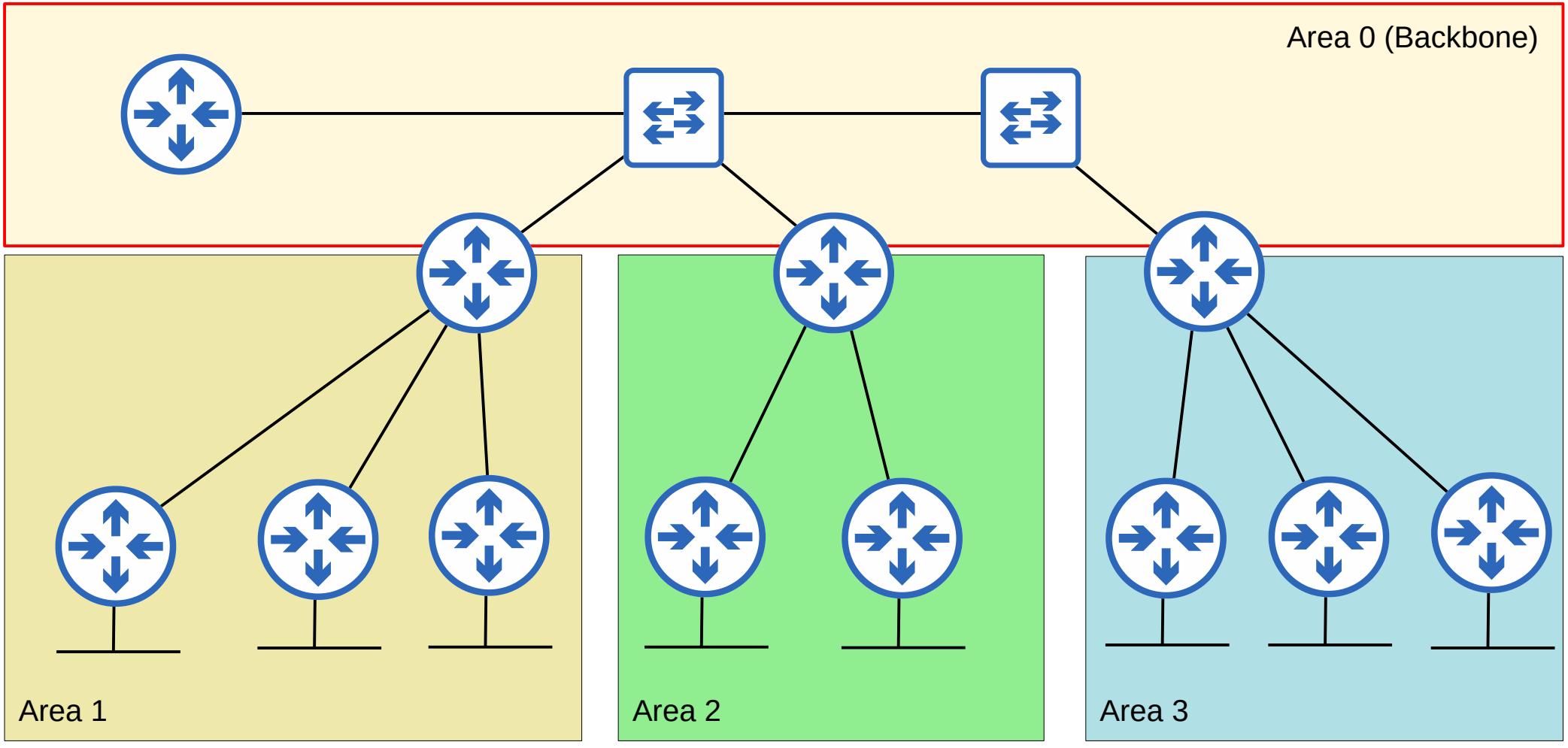


OSPF Areas

- An **area** is a set of routers and links that share the same LSDB.
- The **backbone area** (area 0) is an area that all other areas must connect to.

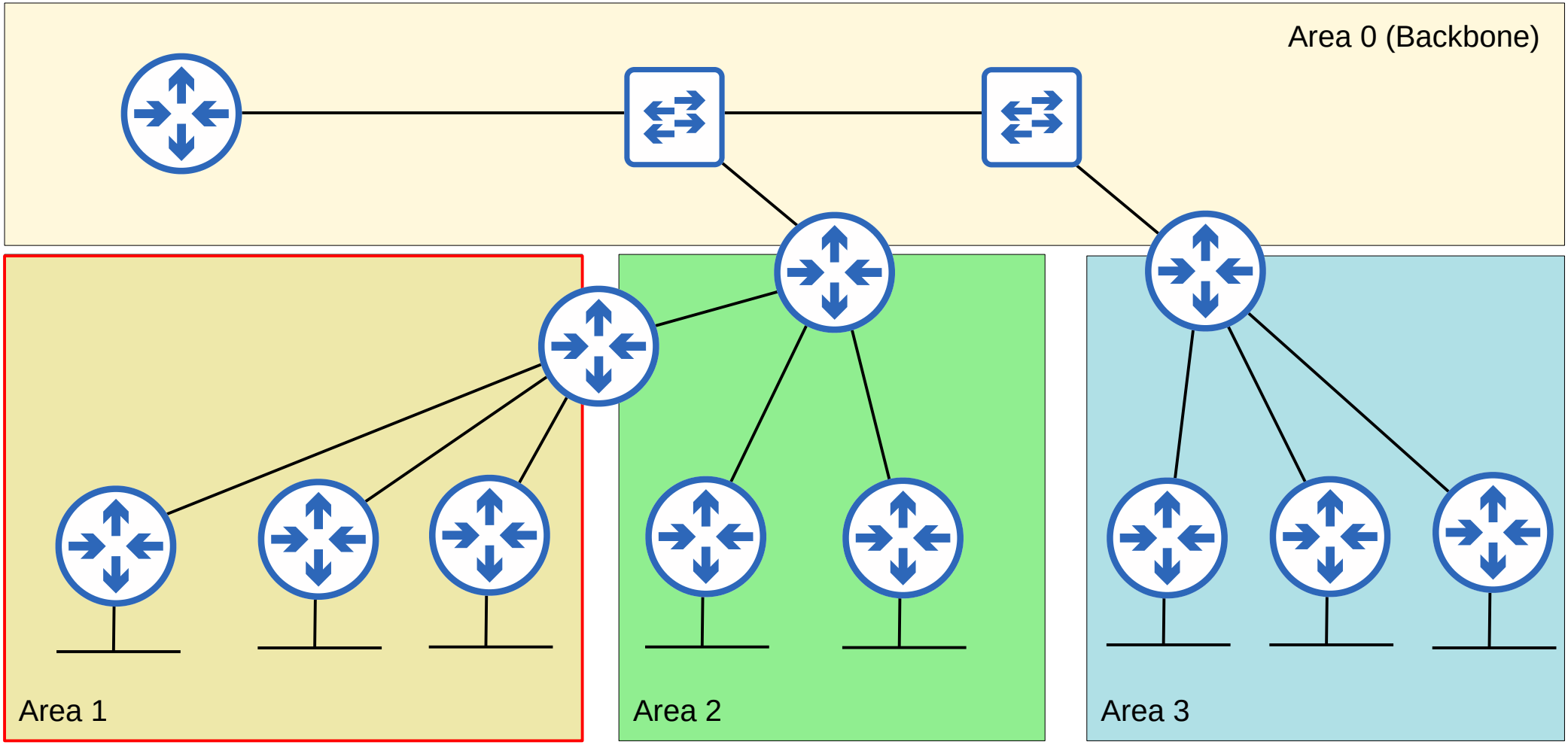
Jeremy's IT Lab

OSPF Areas



Jeremy's IT Lab

OSPF Areas

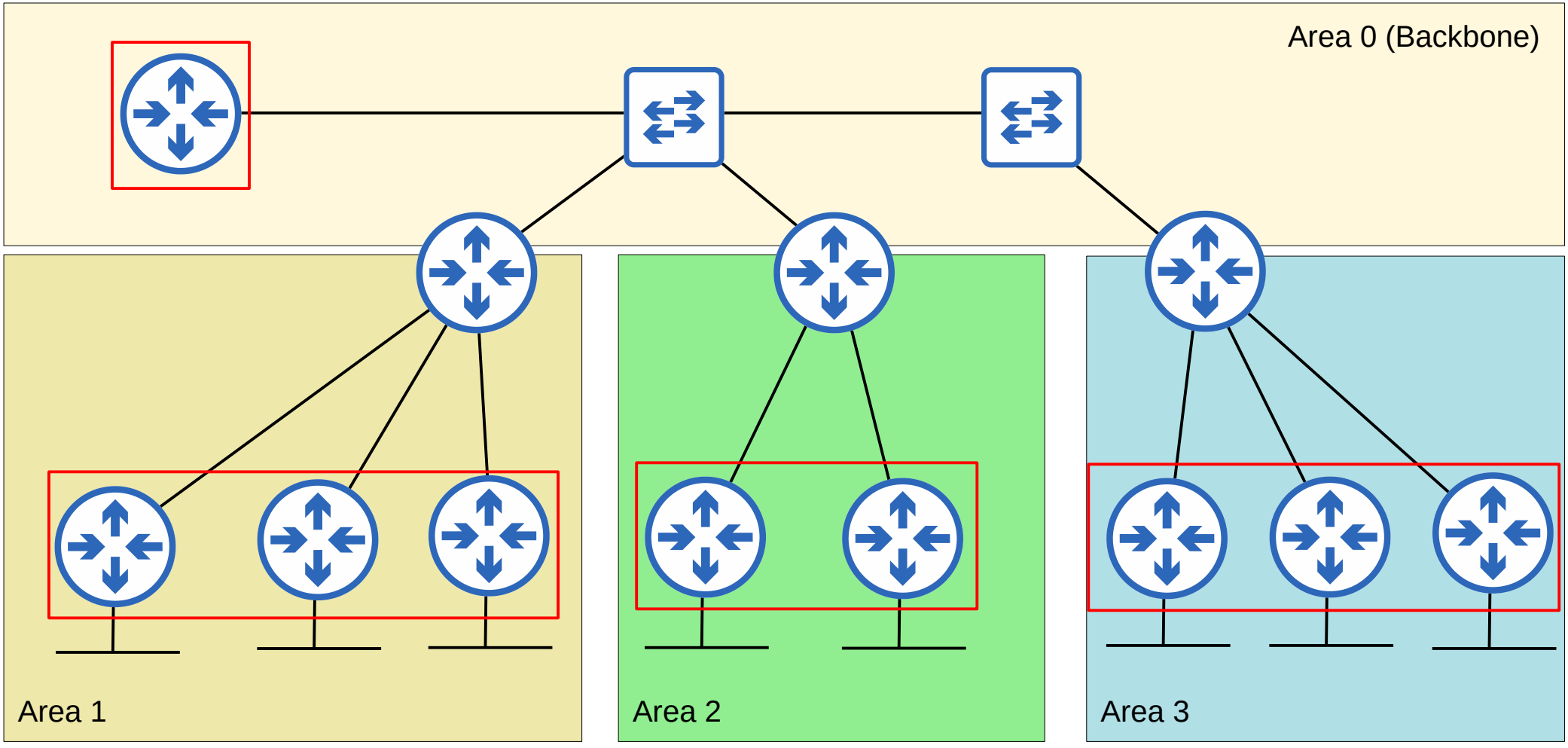


OSPF Areas

- An **area** is a set of routers and links that share the same LSDB.
- The **backbone area** (area 0) is an area that all other areas must connect to.
- Routers with all interfaces in the same area are called **internal routers**.

Jeremy's IT Lab

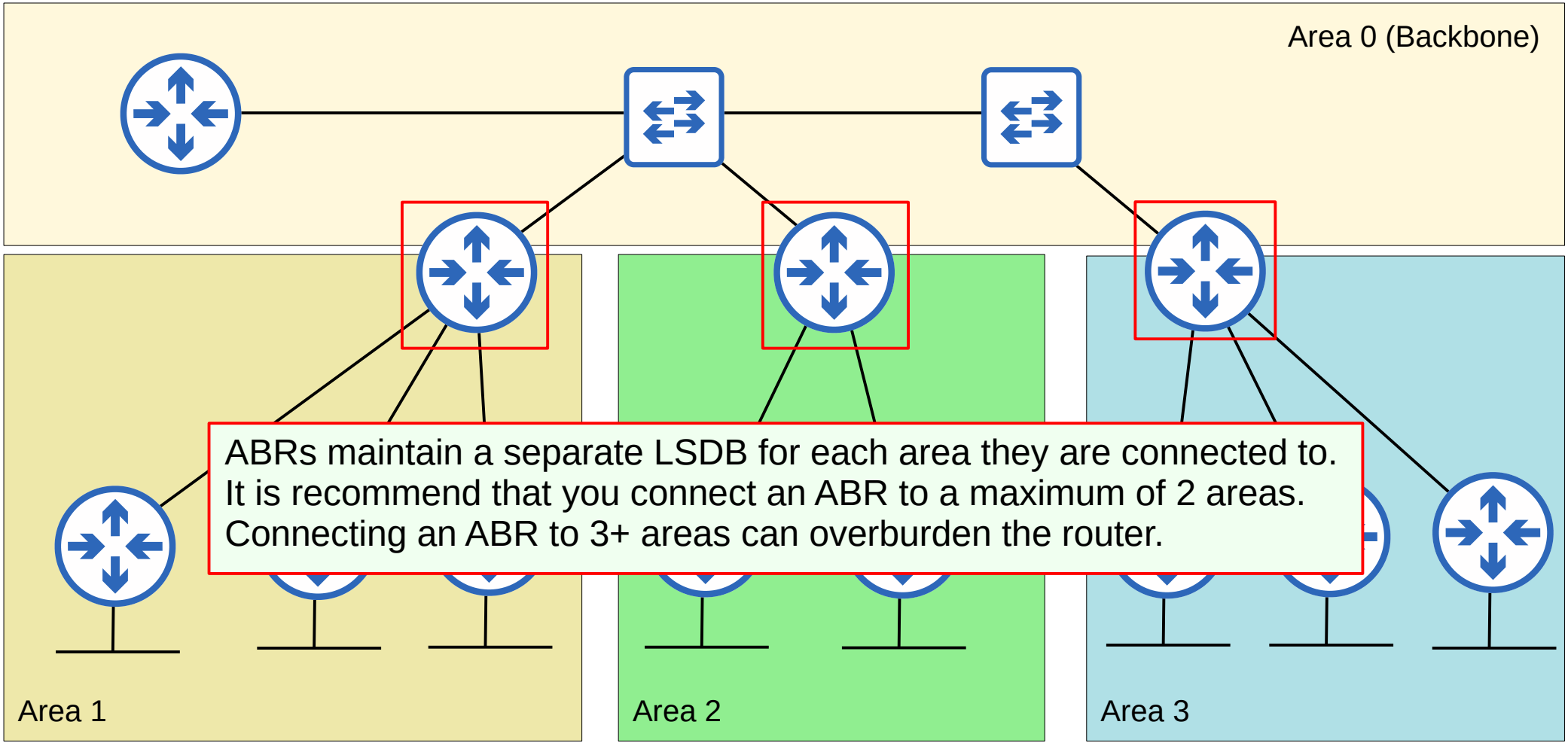
OSPF Areas



OSPF Areas

- An **area** is a set of routers and links that share the same LSDB.
- The **backbone area** (area 0) is an area that all other areas must connect to.
- Routers with all interfaces in the same area are called **internal routers**.
- Routers with interfaces in multiple areas are called **area border routers** (**ABRs**).

OSPF Areas

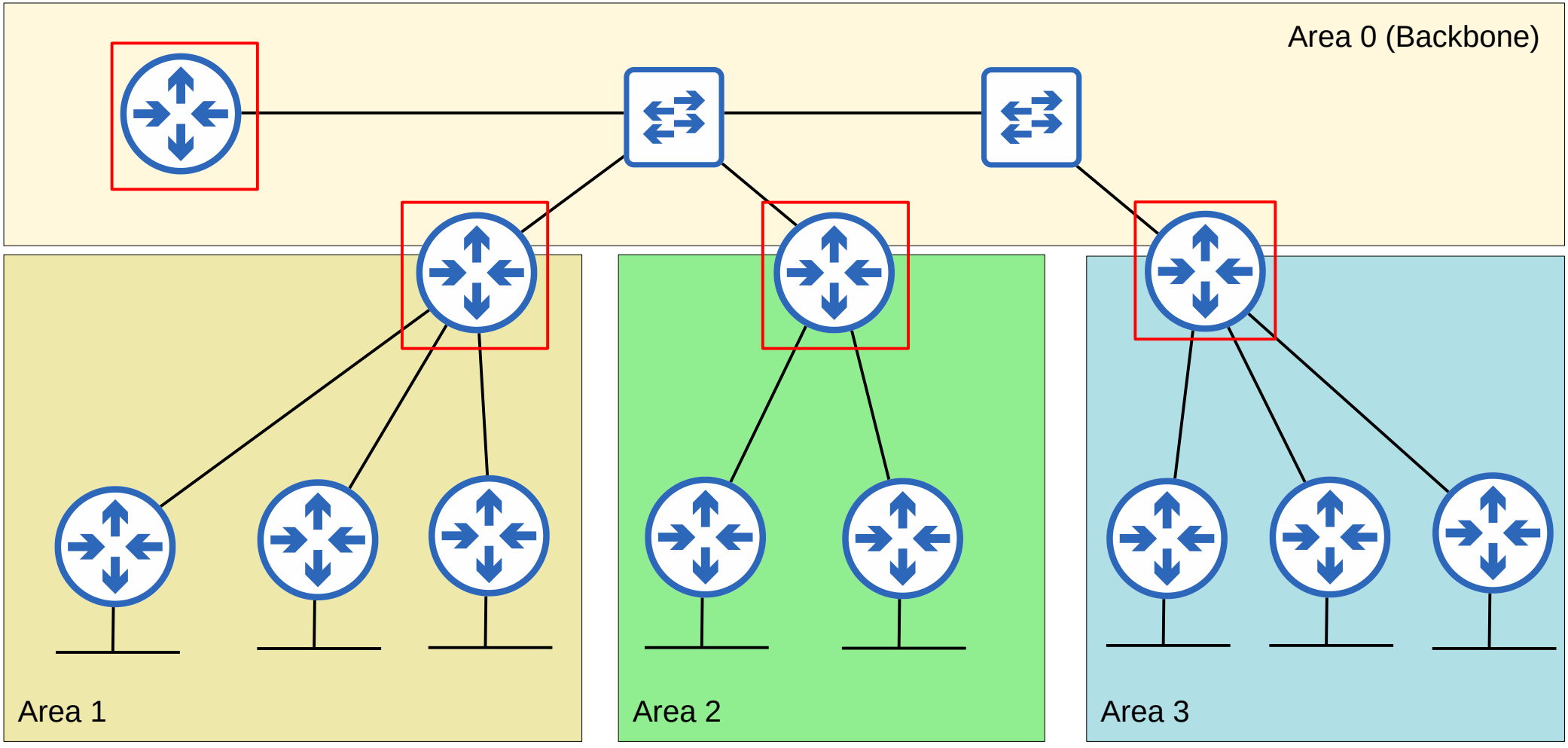

Area 0 (Backbone)
ABRs maintain a separate LSDB for each area they are connected to.
It is recommend that you connect an ABR to a maximum of 2 areas.
Connecting an ABR to 3+ areas can overburden the router.
Area 1
Area 2
Area 3

OSPF Areas

- An **area** is a set of routers and links that share the same LSDB.
- The **backbone area** (area 0) is an area that all other areas must connect to.
- Routers with all interfaces in the same area are called **internal routers**.
- Routers with interfaces in multiple areas are called **area border routers** (**ABRs**).
- Routers connected to the backbone area (area 0) are called **backbone routers**.

Jeremy's IT Lab

OSPF Areas

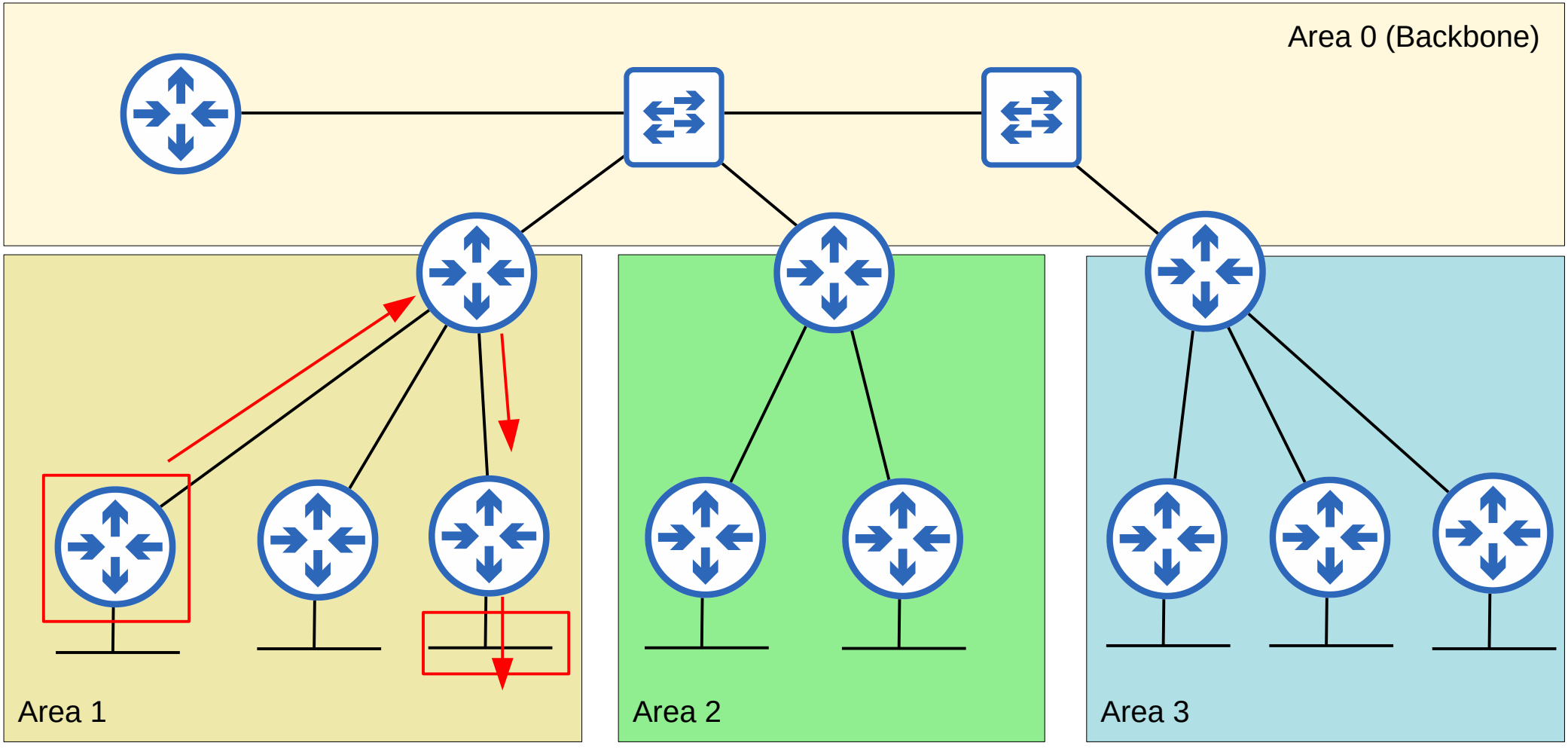


OSPF Areas

- An **area** is a set of routers and links that share the same LSDB.
- The **backbone area** (area 0) is an area that all other areas must connect to.
- Routers with all interfaces in the same area are called **internal routers**.
- Routers with interfaces in multiple areas are called **area border routers** (**ABRs**).
- Routers connected to the backbone area (area 0) are called **backbone routers**.
- An **intra-area route** is a route to a destination inside the same OSPF area.

Jeremy's IT Lab

OSPF Areas

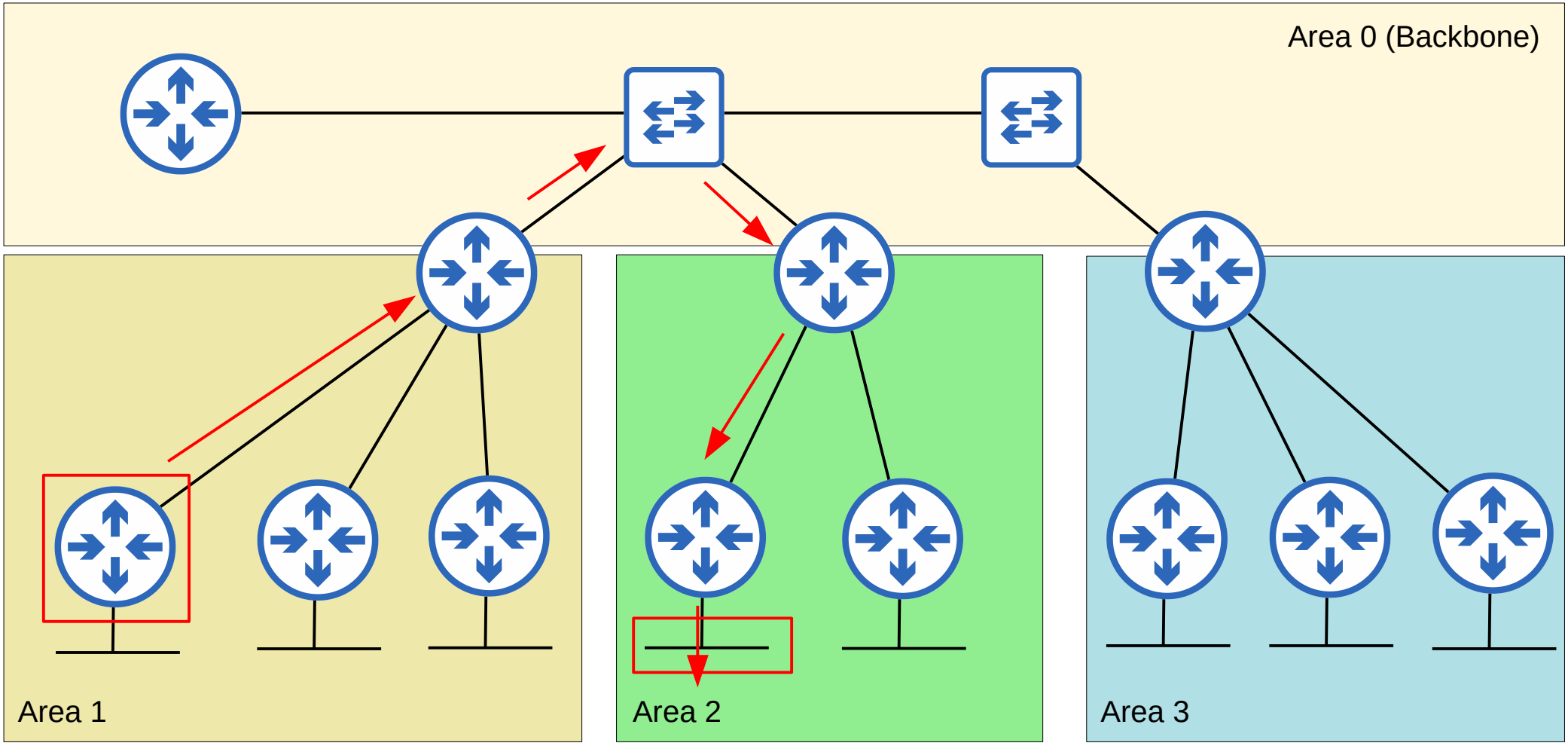


OSPF Areas

- An **area** is a set of routers and links that share the same LSDB.
- The **backbone area** (area 0) is an area that all other areas must connect to.
- Routers with all interfaces in the same area are called **internal routers**.
- Routers with interfaces in multiple areas are called **area border routers** (**ABRs**).
- Routers connected to the backbone area (area 0) are called **backbone routers**.
- An **intra-area route** is a route to a destination inside the same OSPF area.
- An **interarea route** is a route to a destination in a different OSPF area.

Jeremy's IT Lab

OSPF Areas



OSPF Areas

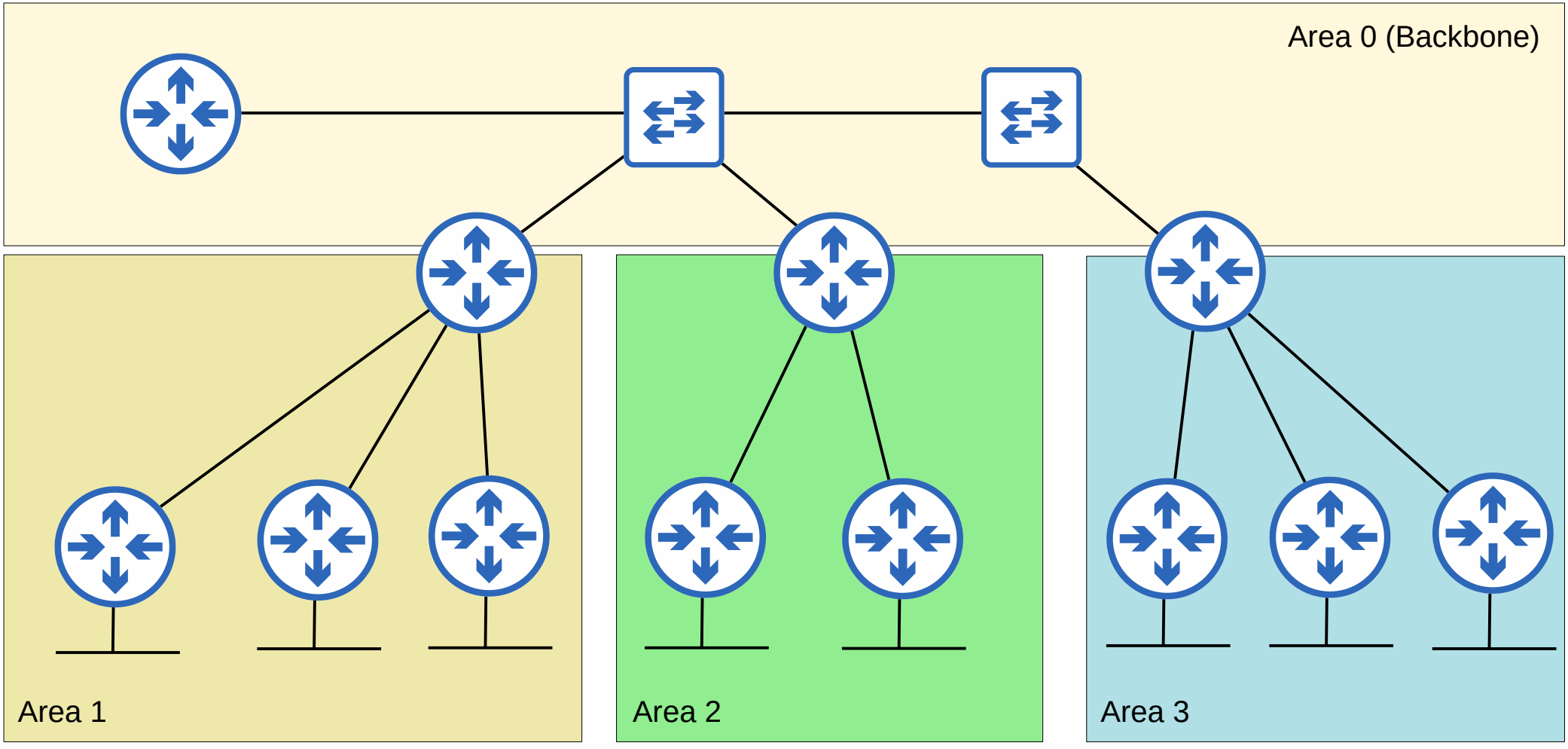
- An **area** is a set of routers and links that share the same LSDB.
- The **backbone area** (area 0) is an area that all other areas must connect to.
- Routers with all interfaces in the same area are called **internal routers**.
- Routers with interfaces in multiple areas are called **area border routers** (**ABRs**).
- Routers connected to the backbone area (area 0) are called **backbone routers**.
- An **intra-area route** is a route to a destination inside the same OSPF area.
- An **interarea route** is a route to a destination in a different OSPF area.

OSPF Areas

- OSPF areas should be *contiguous*.

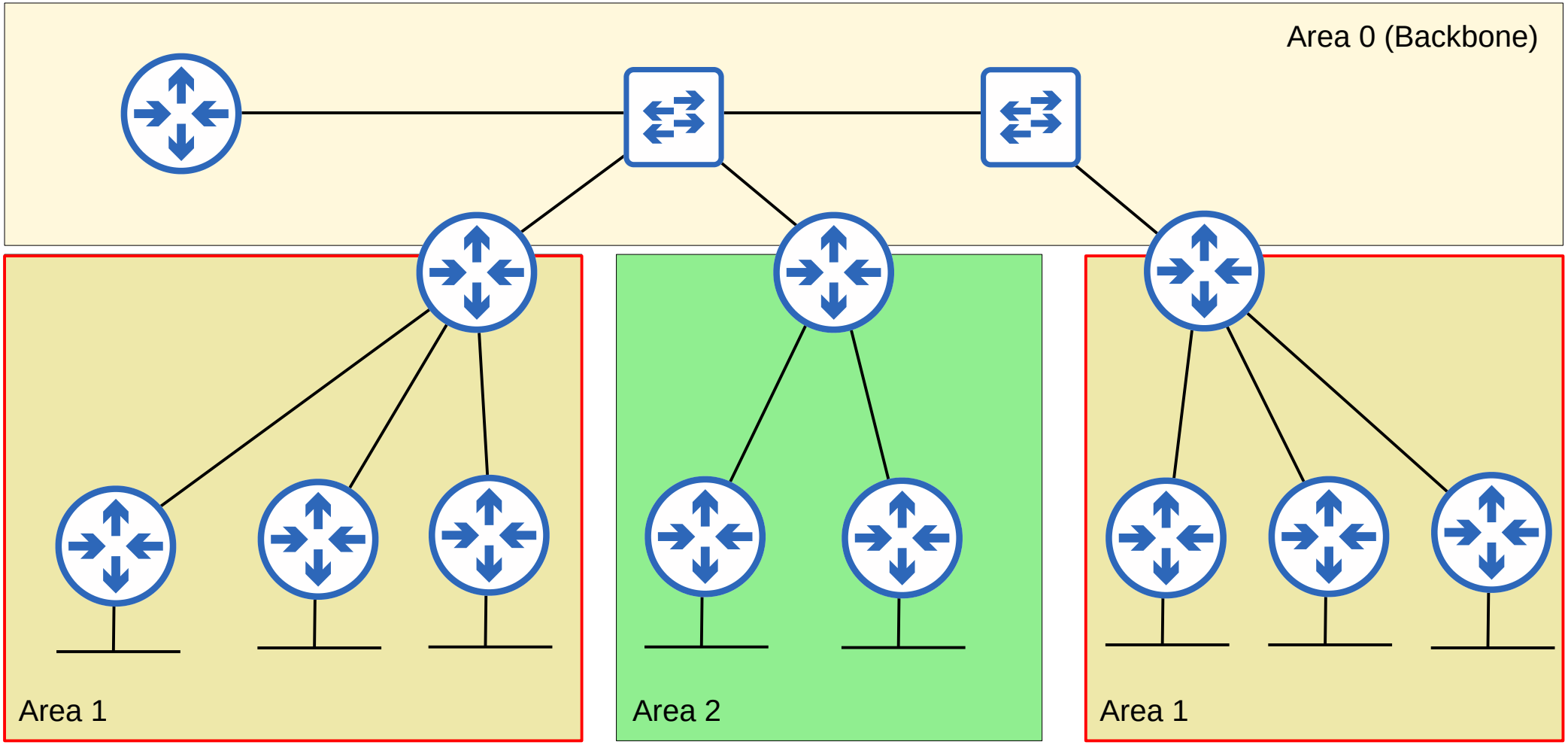
Jeremy's IT Lab

OSPF Areas



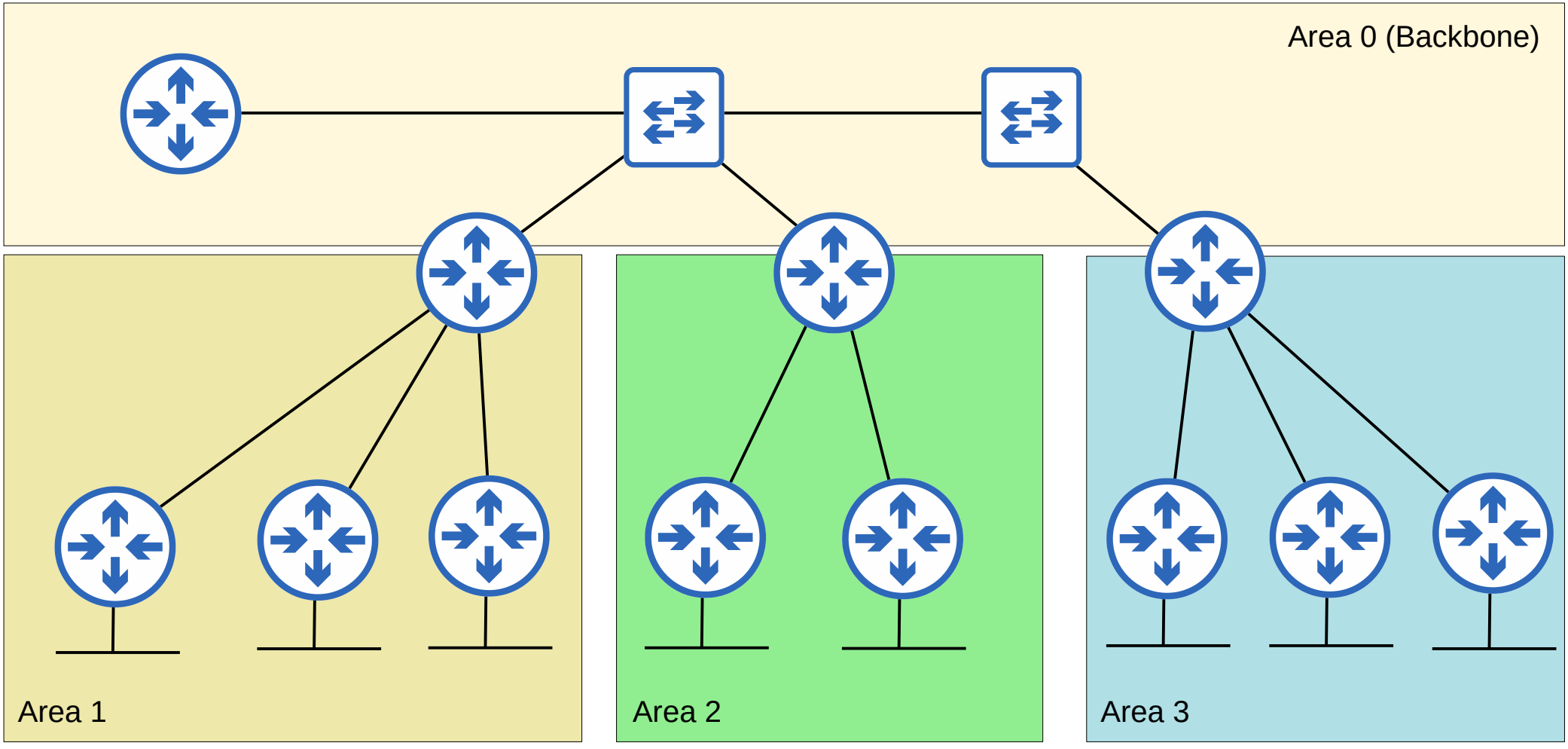
Jeremy's IT Lab

OSPF Areas



Jeremy's IT Lab

OSPF Areas

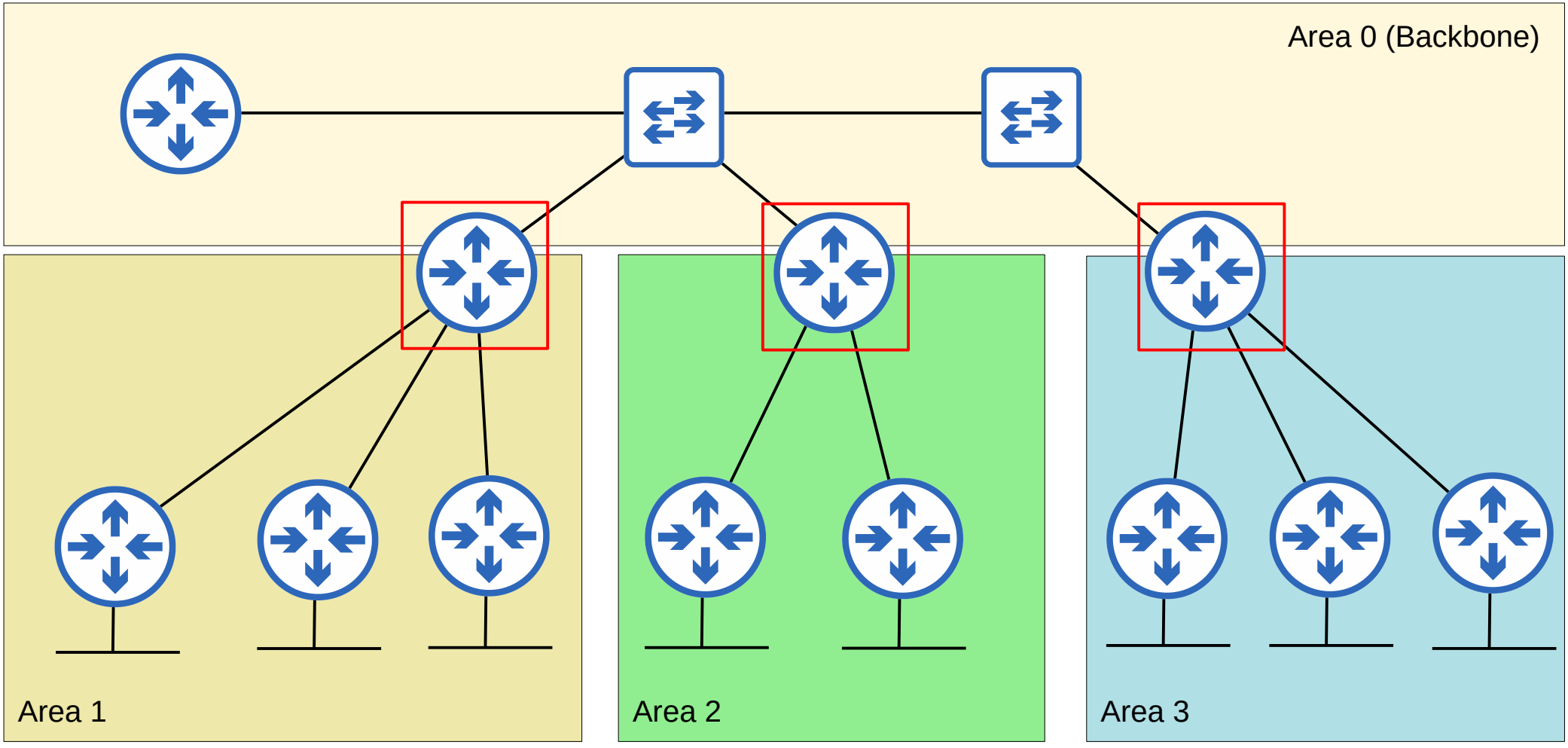


OSPF Areas

- OSPF areas should be *contiguous*.
- All OSPF areas must have at least one ABR connected to the backbone area.

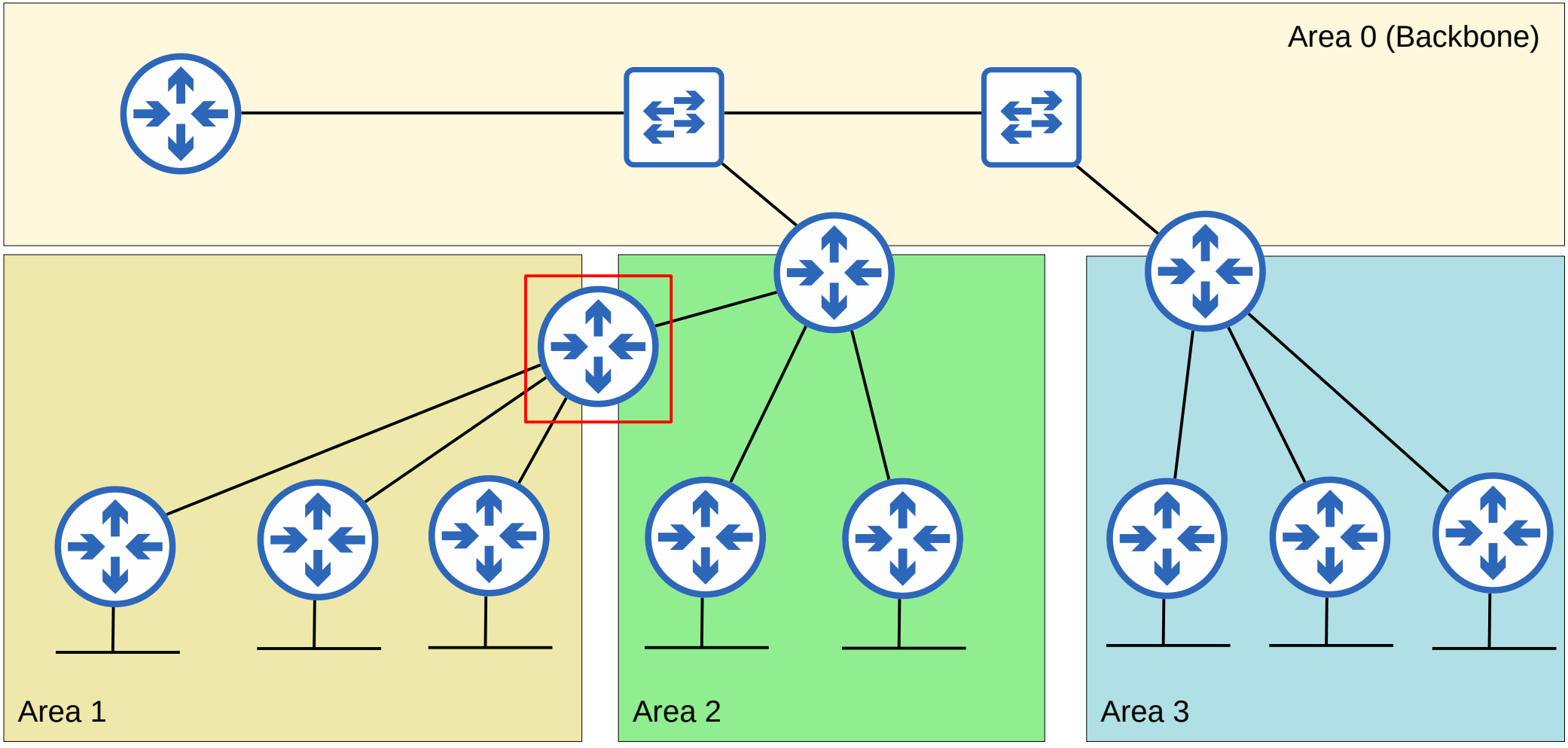
Jeremy's IT Lab

OSPF Areas



Jeremy's IT Lab

OSPF Areas

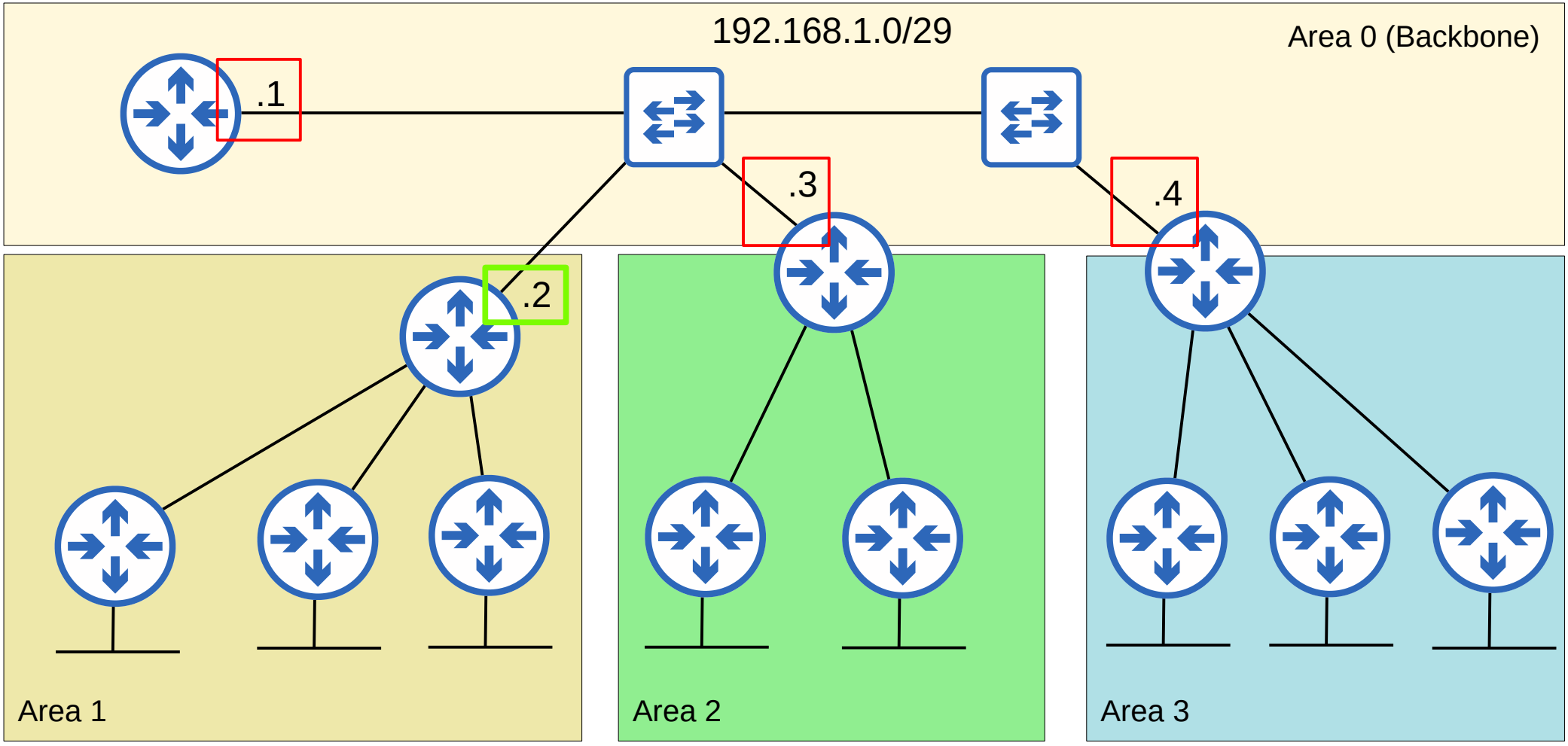


OSPF Areas

- OSPF areas should be *contiguous*.
- All OSPF areas must have at least one ABR connected to the backbone area.
- OSPF interfaces in the same subnet must be in the same area.

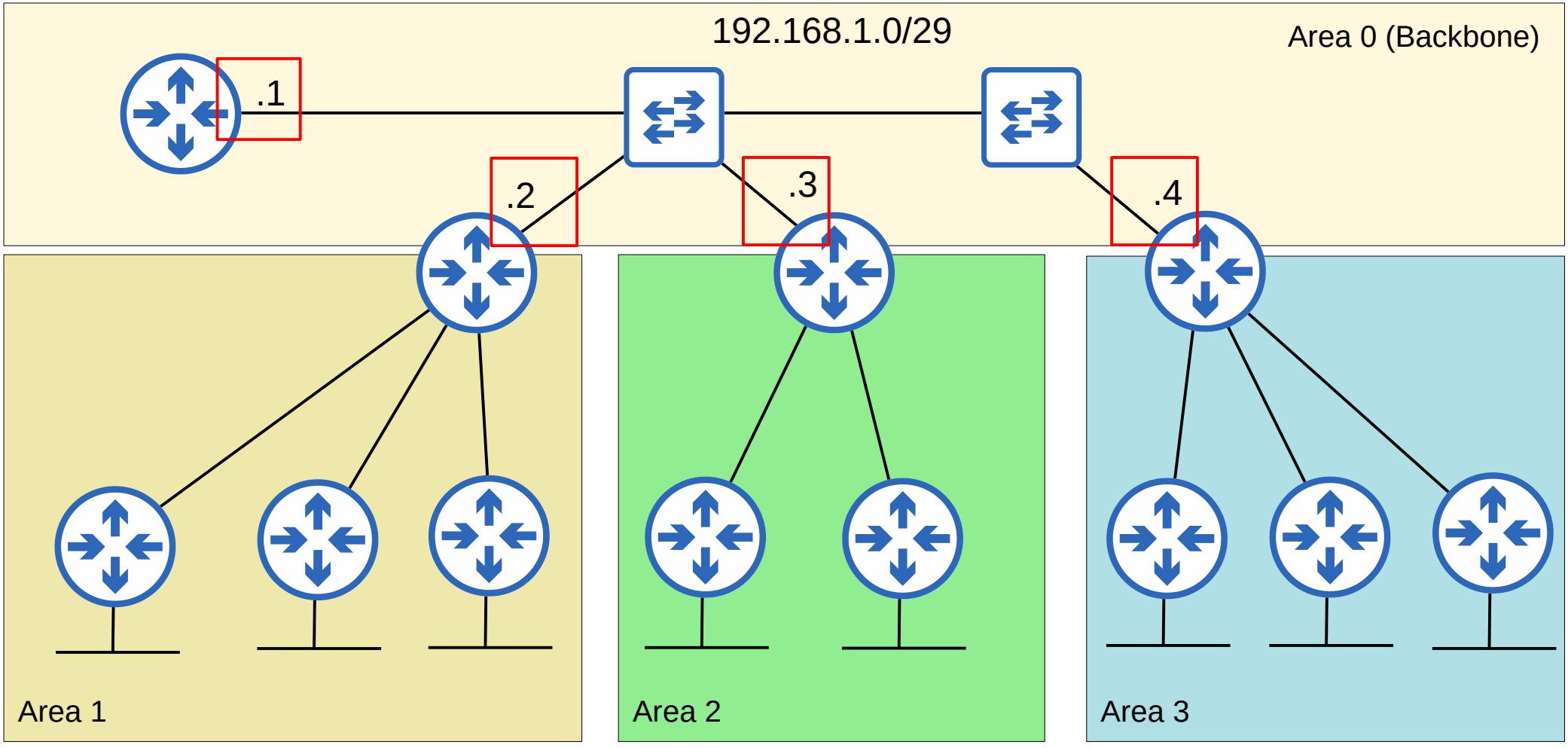
Jeremy's IT Lab

OSPF Areas



Jeremy's IT Lab

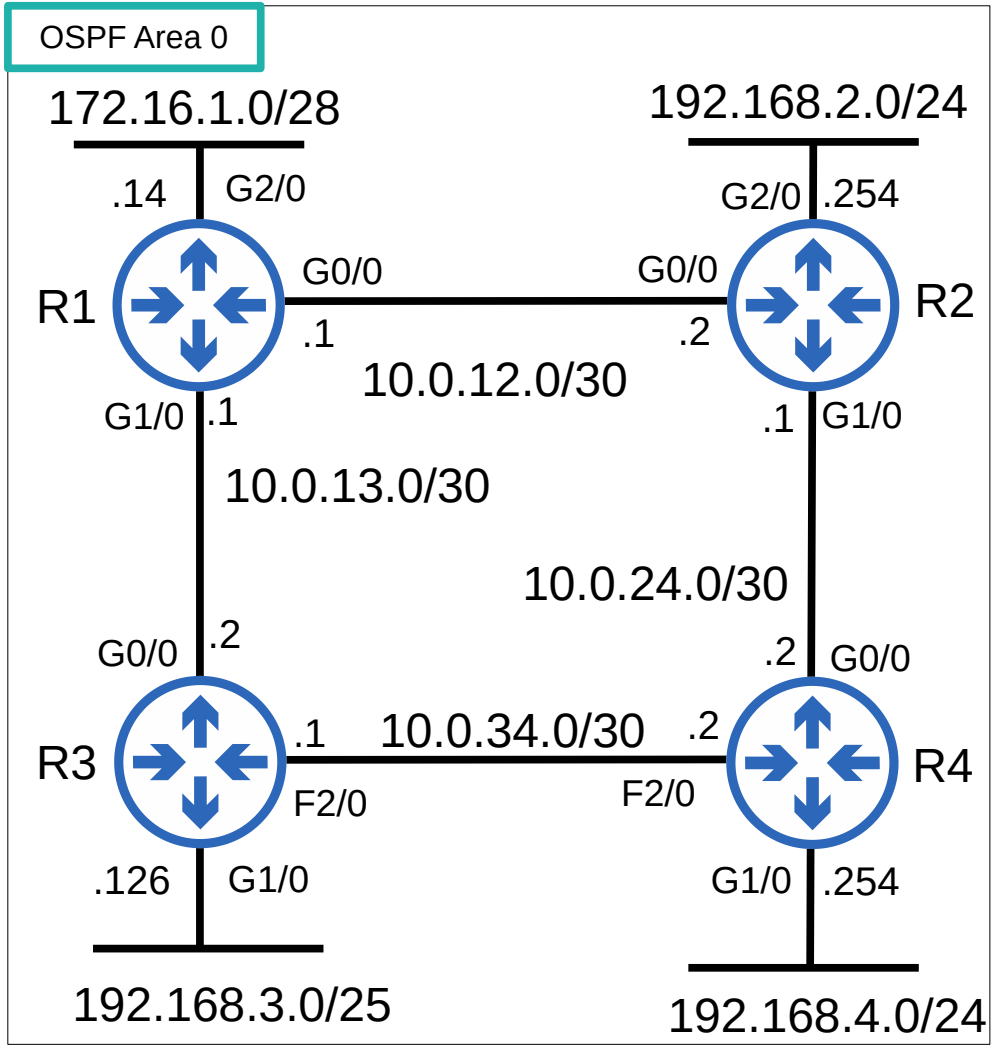
OSPF Areas



OSPF Areas

- OSPF areas should be *contiguous*.
- All OSPF areas must have at least one ABR connected to the backbone area.
- OSPF interfaces in the same subnet must be in the same area.

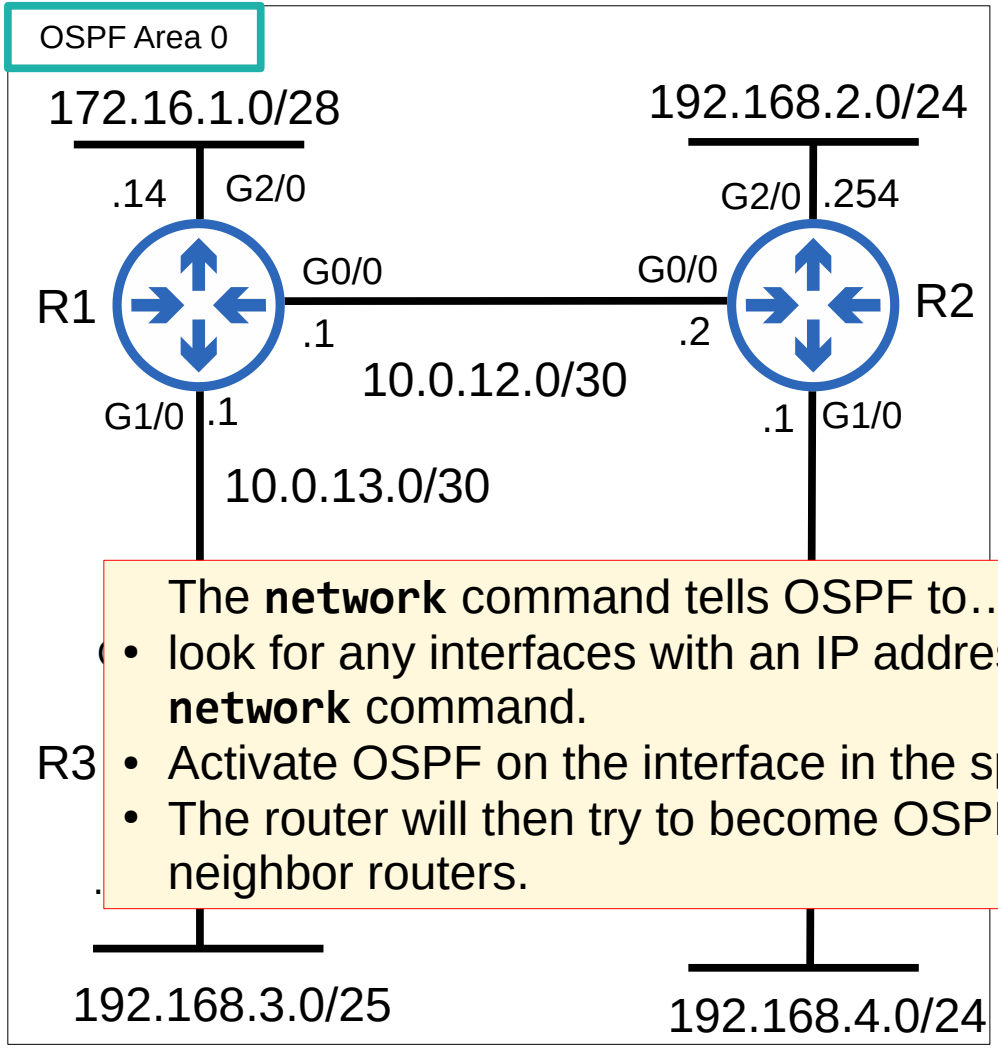
Basic OSPF Configuration




```
R1(config)#router ospf ?
  <1-65535>  Process ID

R1(config)#router ospf 1
R1(config-router)#network 10.0.12.0 0.0.0.3
% Incomplete command.

R1(config-router)#network 10.0.12.0 0.0.0.3 area 0
R1(config-router)#network 10.0.13.0 0.0.0.3 area 0
R1(config-router)#network 172.16.1.0 0.0.0.15 area 0
R1(config-router)#
```

- The OSPF *process ID* is **locally significant**. Routers with different process IDs can become OSPF neighbors.
- The OSPF **`network`** command requires you to specify the **`area`**.
- For the CCNA, you only need to configure single-area OSPF (area 0)

Basic OSPF Configuration



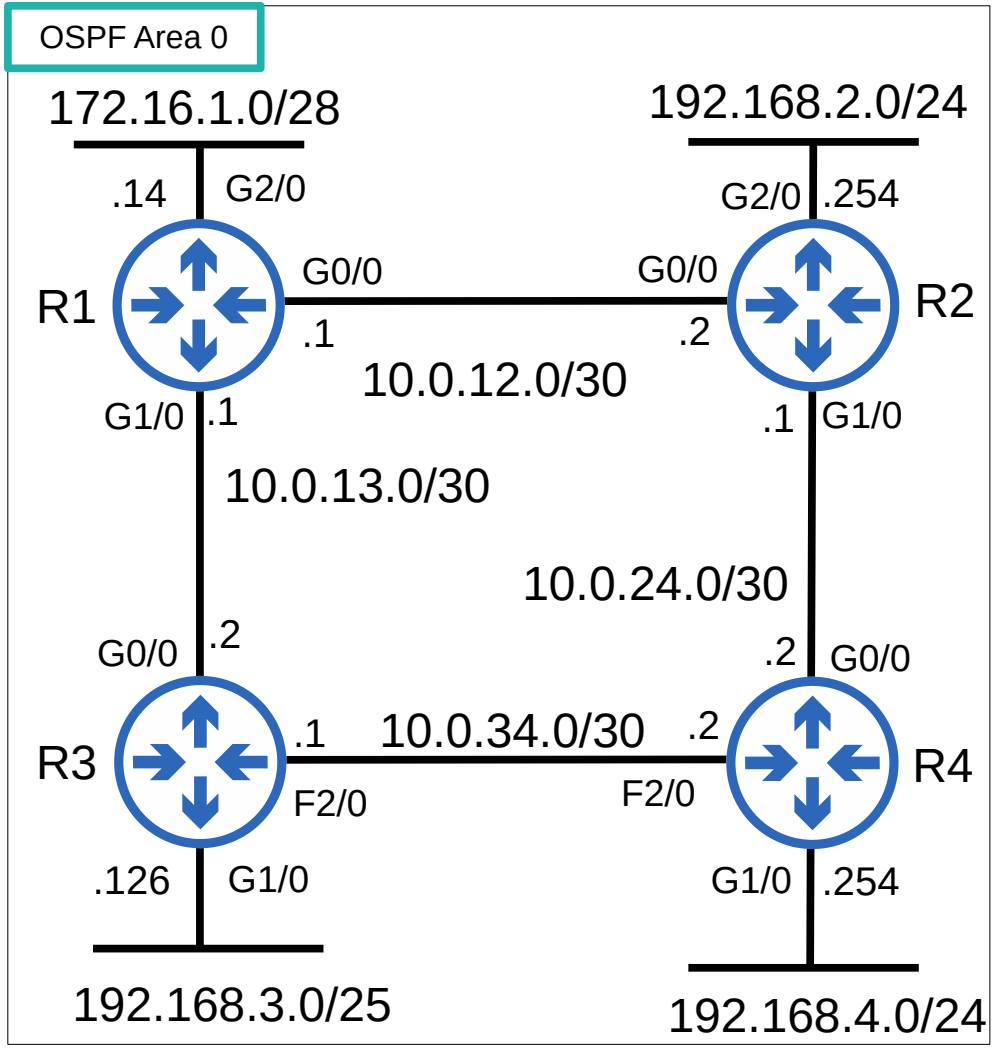

```
R1(config)#router ospf ?
  <1-65535>  Process ID

R1(config)#router ospf 1
R1(config-router)#network 10.0.12.0 0.0.0.3
% Incomplete command.

R1(config-router)#network 10.0.12.0 0.0.0.3 area 0
R1(config-router)#network 10.0.13.0 0.0.0.3 area 0
R1(config-router)#network 172.16.1.0 0.0.0.15 area 0
R1(config-router)#
```

The **network** command tells OSPF to…

- look for any interfaces with an IP address contained in the range specified in the **network** command.
- Activate OSPF on the interface in the specified **area**.
- The router will then try to become OSPF neighbors with other OSPF-activated neighbor routers.

- The OSPF process ID is **locally significant**.
- For the CCNA, you only need to configure single-area OSPF (area 0)

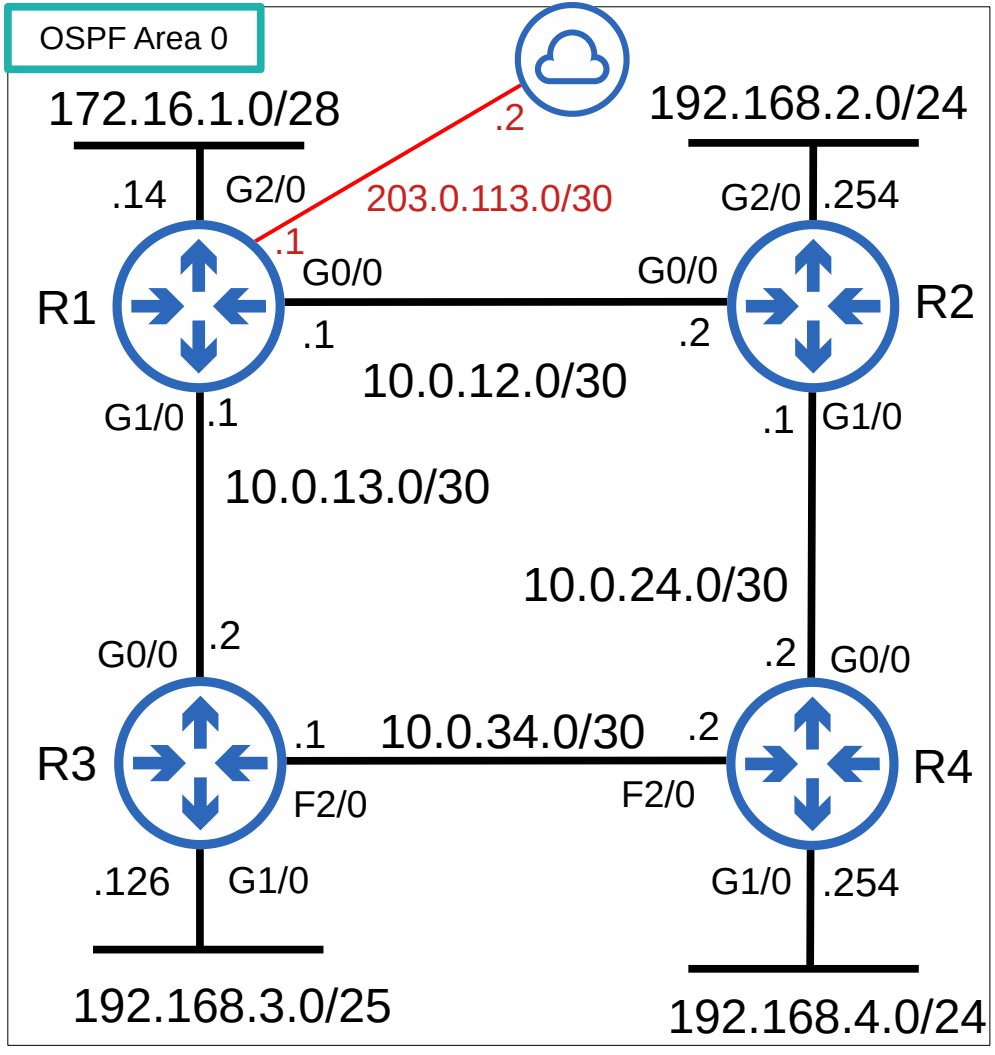
The passive-interface command




```
R1(config-router)#passive-interface g2/0
```

- You already know this command from RIP and EIGRP.
- The **passive-interface** command tells the router to stop sending OSPF 'hello' messages out of the interface.
- However, the router will continue to send LSAs informing it's neighbors about the subnet configured on the interface.
- You should always use this command on interfaces which don't have any OSPF neighbors.

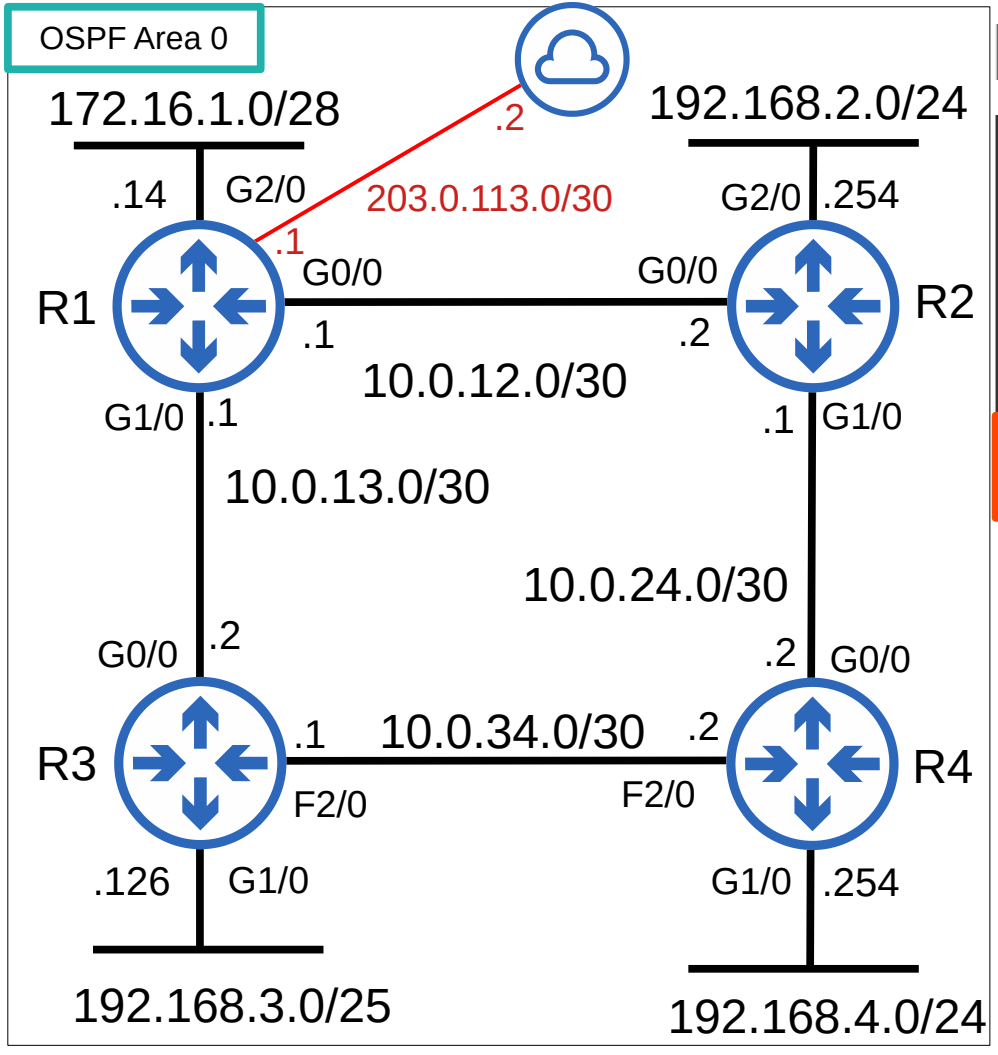
Advertise a default route into OSPF




```
R1(config)#ip route 0.0.0.0 0.0.0.0 203.0.113.2
```

```
Gateway of last resort is 203.0.113.2 to network 0.0.0.0

S*    0.0.0.0/0 [1/0] via 203.0.113.2
      2.0.0.0/32 is subnetted, 1 subnets
O        2.2.2.2 [110/2] via 10.0.12.2, 01:22:21, GigabitEthernet0/0
      3.0.0.0/32 is subnetted, 1 subnets
O        3.3.3.3 [110/2] via 10.0.13.2, 01:22:11, GigabitEthernet1/0
      4.0.0.0/32 is subnetted, 1 subnets
O        4.4.4.4 [110/3] via 10.0.13.2, 00:00:06, GigabitEthernet1/0
                 [110/3] via 10.0.12.2, 00:00:06, GigabitEthernet0/0
      10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C        10.0.12.0/30 is directly connected, GigabitEthernet0/0
L        10.0.12.1/32 is directly connected, GigabitEthernet0/0
C        10.0.13.0/30 is directly connected, GigabitEthernet1/0
L        10.0.13.1/32 is directly connected, GigabitEthernet1/0
O        10.0.24.0/30 [110/2] via 10.0.12.2, 01:22:21, GigabitEthernet0/0
O        10.0.34.0/30 [110/2] via 10.0.13.2, 01:22:11, GigabitEthernet1/0
      172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C        172.16.1.0/28 is directly connected, GigabitEthernet2/0
L        172.16.1.14/32 is directly connected, GigabitEthernet2/0
O     192.168.2.0/24 [110/2] via 10.0.12.2, 01:22:21, GigabitEthernet0/0
      192.168.3.0/25 is subnetted, 1 subnets
O        192.168.3.0 [110/2] via 10.0.13.2, 01:22:11, GigabitEthernet1/0
O     192.168.4.0/24 [110/3] via 10.0.13.2, 01:22:11, GigabitEthernet1/0
                     [110/3] via 10.0.12.2, 01:22:21, GigabitEthernet0/0
      203.0.113.0/24 is variably subnetted, 2 subnets, 2 masks
C        203.0.113.0/30 is directly connected, GigabitEthernet3/0
L        203.0.113.1/32 is directly connected, GigabitEthernet3/0
```

Advertise a default route into OSPF




```
R1(config-router)#default-information originate
```

```
R2#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is 10.0.12.1 to network 0.0.0.0

O*E2  0.0.0.0/0 [110/1] via 10.0.12.1, 00:01:38, GigabitEthernet0/0
```

show ip protocols

```
R1#show ip protocols
*** IP Routing is NSF aware ***

Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 172.16.1.14
  It is an autonomous system boundary router
 Redistributing External Routes from,
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    10.0.12.0 0.0.0.3 area 0
    10.0.13.0 0.0.0.3 area 0
    172.16.1.0 0.0.0.15 area 0
  Passive Interface(s):
    GigabitEthernet2/0
  Routing Information Sources:
    Gateway         Distance      Last Update
    4.4.4.4              110      00:00:08
    2.2.2.2              110      00:01:07
    3.3.3.3              110      00:01:07
    192.168.4.254        110      00:02:29
  Distance: (default is 110)
```

Router ID order of priority:

1) Manual configuration
2) Highest IP address on a loopback interface
3) Highest IP address on a physical interface

```
R1(config-router)#router-id ?
  A.B.C.D  OSPF router-id in IP address format

R1(config-router)#router-id 1.1.1.1
% OSPF: Reload or use "clear ip ospf process" command, for this to take effect
```

```
R1#clear ip ospf process
Reset ALL OSPF processes? [no]: yes
R1#show ip protocols
*** IP Routing is NSF aware ***

Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 1.1.1.1
```

show ip protocols

```
R1#sh ip protocols
*** IP Routing is NSF aware ***

Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 1.1.1.1
  It is an autonomous system boundary router
  Redistributing External Routes from,
  Number of areas in this router is 1. 1 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    10.0.12.0 0.0.0.3 area 0
    10.0.13.0 0.0.0.3 area 0
    172.16.1.0 0.0.0.15 area 0
  Passive Interface(s):
    GigabitEthernet2/0
  Routing Information Sources:
    Gateway         Distance      Last Update
    2.2.2.2              110      00:01:40
    3.3.3.3              110      00:01:40
    4.4.4.4              110      00:01:40
  Distance: (default is 110)
```

- An **autonomous system boundary router** (ASBR) is an OSPF router that connects the OSPF network to an external network.
- R1 is connected to the Internet. By using the **default-information originate** command, R1 becomes an ASBR.

```
R1(config-router)#maximum-paths ?
  <1-32>  Number of paths

R1(config-router)#maximum-paths 8
```

```
R1(config-router)#distance ?
  <1-255>  Administrative distance

R1(config-router)#distance 85
```

Things we covered

- Basic OSPF Operations (introduction)
- OSPF Areas
- Basic OSPF Configuration

Quiz 1

Which of the following statements about OSPF are **not true**? (select two)

a) In multi-area OSPF networks, all non-backbone areas must have an ABR connected to area 0.

b) Single-area OSPF must use area 0.

c) Two OSPF routers with different process IDs can become OSPF neighbors.

d) The OSPF area must be specified in the **`network`** command.

e) An ASBR connects the internal OSPF network to networks outside of the OSPF domain.

f) The OSPF process ID must match the area number.

Quiz 2

You want to activate OSPF on R1's G0/1 and G0/2 interfaces with a single command.
G0/1 IP: `10.0.12.1/28`
G0/2 IP: `10.0.13.1/26`

Which of the following commands should you use on R1?

a) `R1(config-router)# network 10.0.12.0 0.0.0.255 area 0`

b) `R1(config-router)# network 10.0.12.0 0.0.0.254 area 0`

c) `R1(config-router)# network 10.0.12.0 0.0.1.255 area 0`

d) `R1(config-router)# network 10.0.8.0 0.0.3.255 area 0`

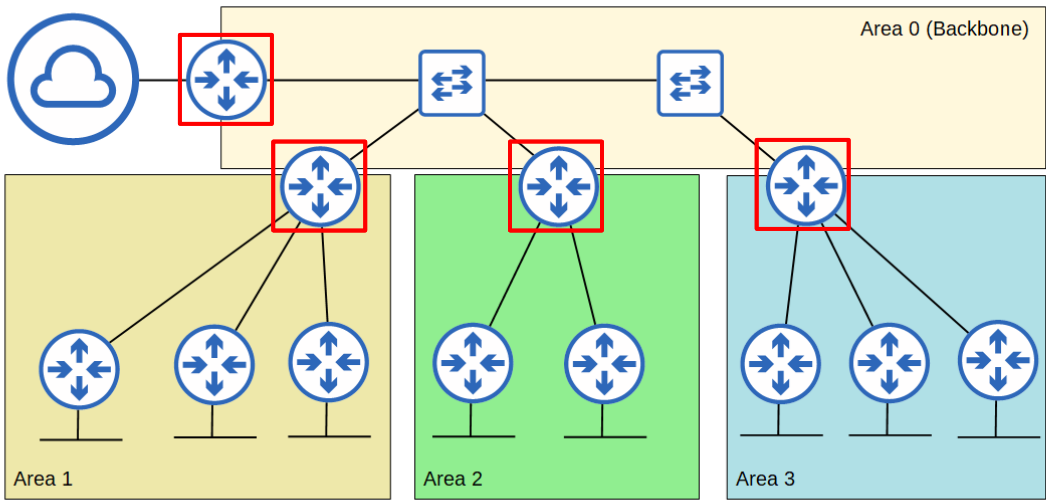
Quiz 3

Answer the following questions about the OSPF network below:

1) How many backbone routers are there? 4

2) How many ABRs are there? 3

3) How many ASBRs are there? 1



Quiz 4

Which of the following commands will make R1 an OSPF ASBR?

a)
```
R1(config-router)# network 10.0.0.0 0.0.0.255 area 0
R1(config-router)# network 10.0.1.0 0.0.0.255 area 1
```

b)
```
R1(config)# ip route 0.0.0.0 0.0.0.0 203.0.113.2
R1(config)# router ospf 1
R1(config-router)# default-information originate
```

c)
```
R1(config-router)# network 0.0.0.0 255.255.255.255 area 0
```

d)
```
R1(config-router)# default-route originate
```

Quiz 5

Which command can be used to manually configure the OSPF router ID?

a)
```
R1(config-router)# router-id 1.1.1.1
```

b)
```
R1(config-router)# ospf router-id 1.1.1.1
```

c)
```
R1(config)# interface loopback0
R1(config-if)# ip address 1.1.1.1 255.255.255.255
```

d)
```
R1(config-router)# ospf router id 1.1.1.1
```