

# Introduction to Routing

## Week 9

Module : Computer Networks

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# Routing Tables

- Routing protocols fill routing tables with a variety of route information which varies based on the routing protocol used.
- Routing tables contain the information necessary to forward data packets across connected networks.
- Routers keep track of the following information in their routing tables:
  - Protocol type : Identifies the type of routing protocol that created each entry.
  - Next-hop associations : Tell a router that a destination is either directly connected to the router or that it can be reached through another router called the next-hop on the way to the destination.
  - Routing metric : Different routing protocols use different routing metrics.
  - Outbound interfaces: The interface that the data must be sent out of to reach the final destination.
- Routers communicate with one another to maintain their routing tables through the transmission of routing update messages. Some routing protocols transmit update messages periodically. Other protocols send them only when there are changes in the network topology.

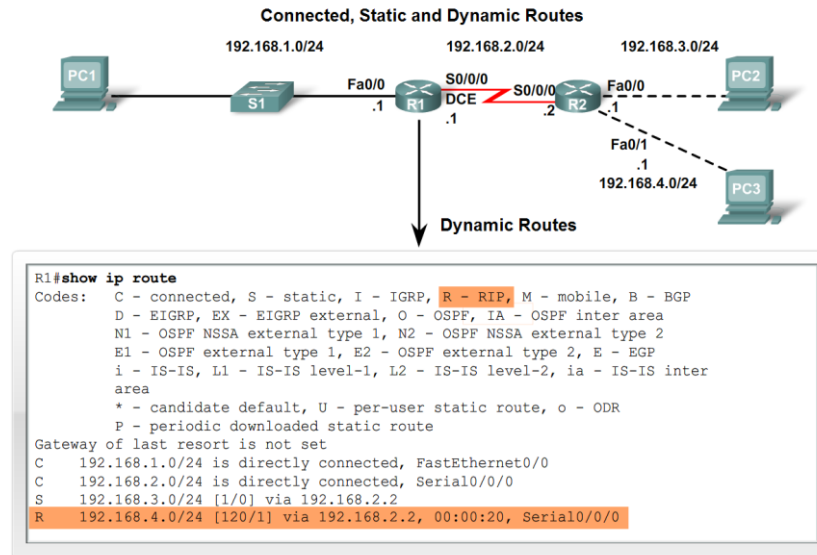
# Routing Table Structure

- Maintaining routing tables

- Dynamic routing protocols are used to share routing information with other router & to maintain and up date their own routing table.

- IP routing protocols. Example of routing protocols include:

- RIP
  - EIGRP
  - OSPF

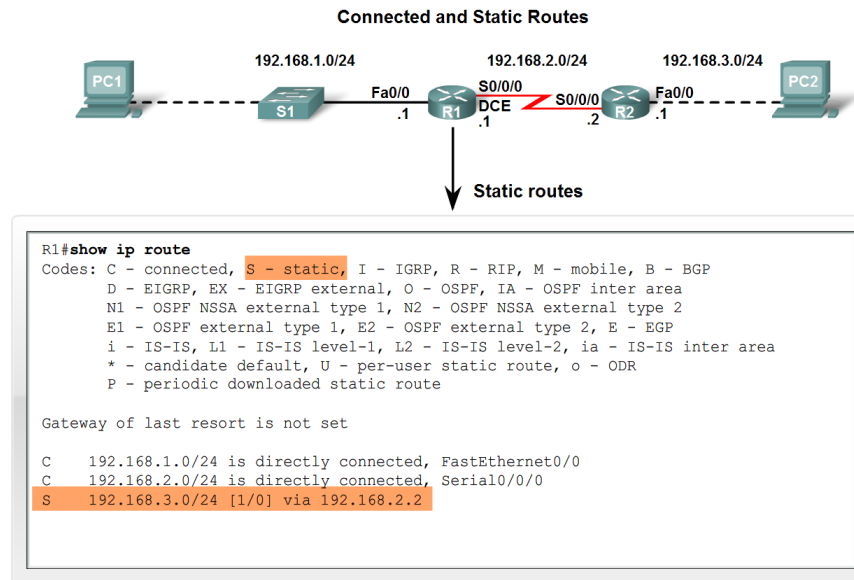


# Routing Table Structure

- Routing Table is stored in ram and contains information about:
  - **Directly connected networks** - this occurs when a device is connected to another router interface
  - **Remotely connected networks** - this is a network that is not directly connected to a particular router
  - **Detailed information** about the networks include source of information, network address & subnet mask, and Ip address of next-hop router
- **Show ip route** command is used to view a routing table

# Routing Table Structure

- Adding a connected network to the routing table
  - Router interfaces
    - Each router interface is a member of a **different** network
    - Activated using the *no shutdown* command
    - In order for static and dynamic routes to exist in routing table you must have directly connected networks



# Routing Table Structure

- Static routes in the routing table

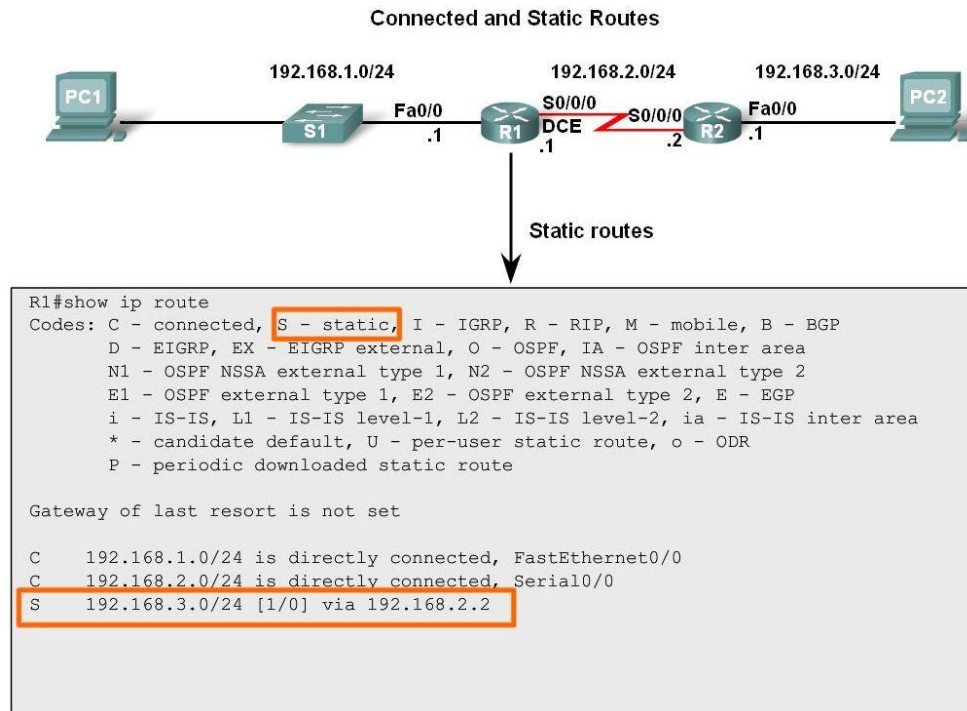
- Includes: network address and subnet mask and IP address of next hop router or exit interface
- Denoted with the code **S** in the routing table
- Routing tables must contain directly connected networks used to connect remote networks before static or dynamic routing can be used

- When to use static routes

- When network only consists of a few routers
- Network is connected to internet only through one ISP

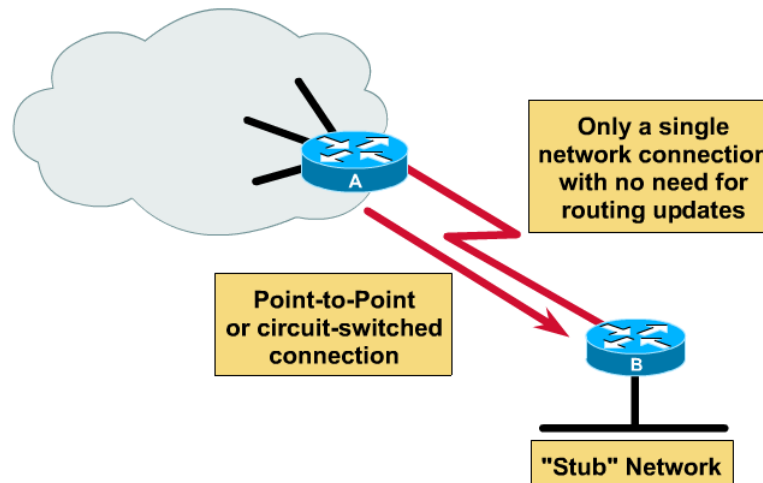
# Routing Table Structure

- Connected and Static routes



# Common uses for Static Routes

## Static Routing Example



### Static routes in the real-world

- Soon we will learn about **dynamic routing protocols** (RIP, etc.), where routers can learn automatically about networks, without the manual configuration of static routes.
- **Does this mean that static routes are never used in the real-world?**
- **No!** Static routes are used in conjunction with dynamic routing protocols.
- It is common to use a static route where using a dynamic routing protocols would have disadvantages or where it just not needed.



# Static Routes with Exit Interfaces

- **IP route command**

- To configure a static route use the following command: **ip route**

- Example:

- Router(config)# ip route network-address subnet-mask {ip-address | exit-interface }

```
Router(config)# ip route network-address subnet-mask  
{ip-address | exit-interface }
```

Parameter	Description
<b>network-address</b>	Destination network address of the remote network to be added to the routing table.
<b>subnet-mask</b>	Subnet mask of the remote network to be added to the routing table. The subnet mask can be modified to summarize a group of networks.
<b>ip-address</b>	Commonly referred to as the next-hop router's IP address.
<b>exit-interface</b>	Outgoing interface that is used to forward packets to the destination network.

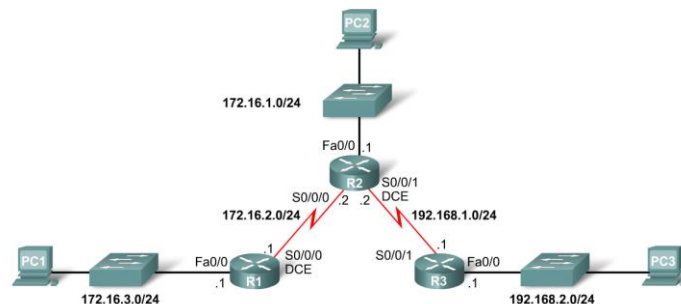
# Static Routes with Exit Interfaces

- Resolving to an Exit Interface

- **Recursive route lookup** - Occurs when the router has to perform multiple lookups in the routing table before forwarding a packet. A static route that forwards all packets to the next-hop IP address goes through the following process (recursive route lookup)

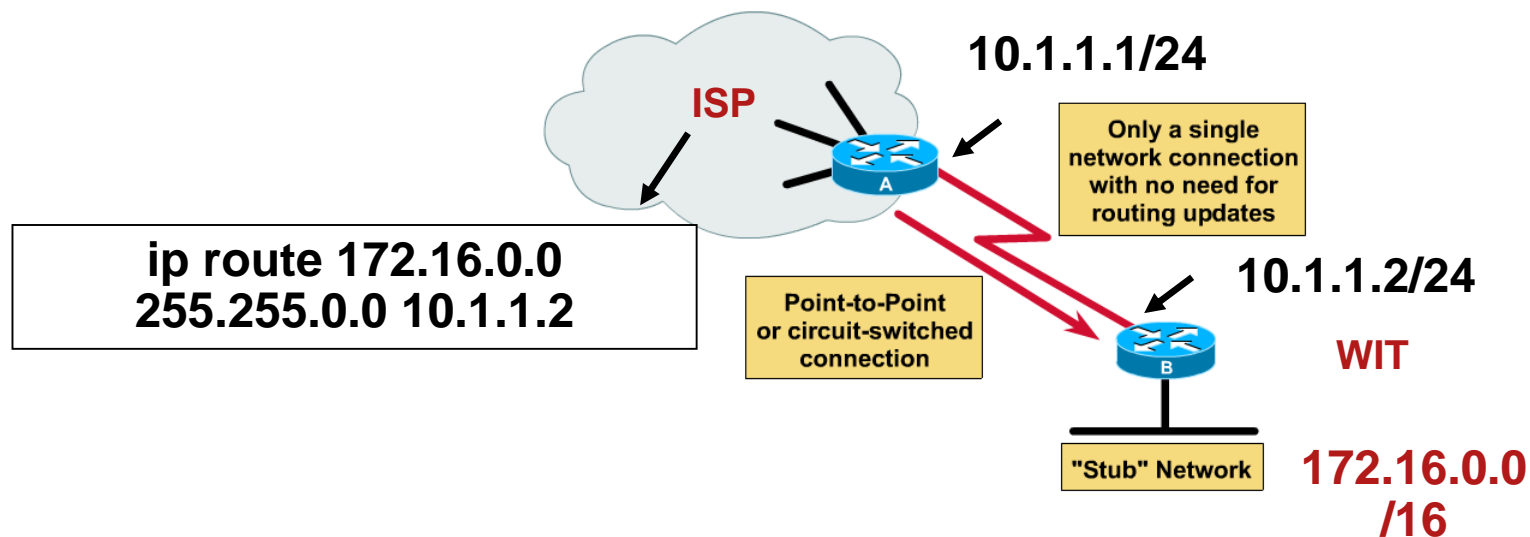
- The router first must match static route's destination IP address with the Next hop address
    - The next hop address is then matched to an exit interface

R1 does a recursive lookup



# Common uses for Static Routes

## Static Routing Example

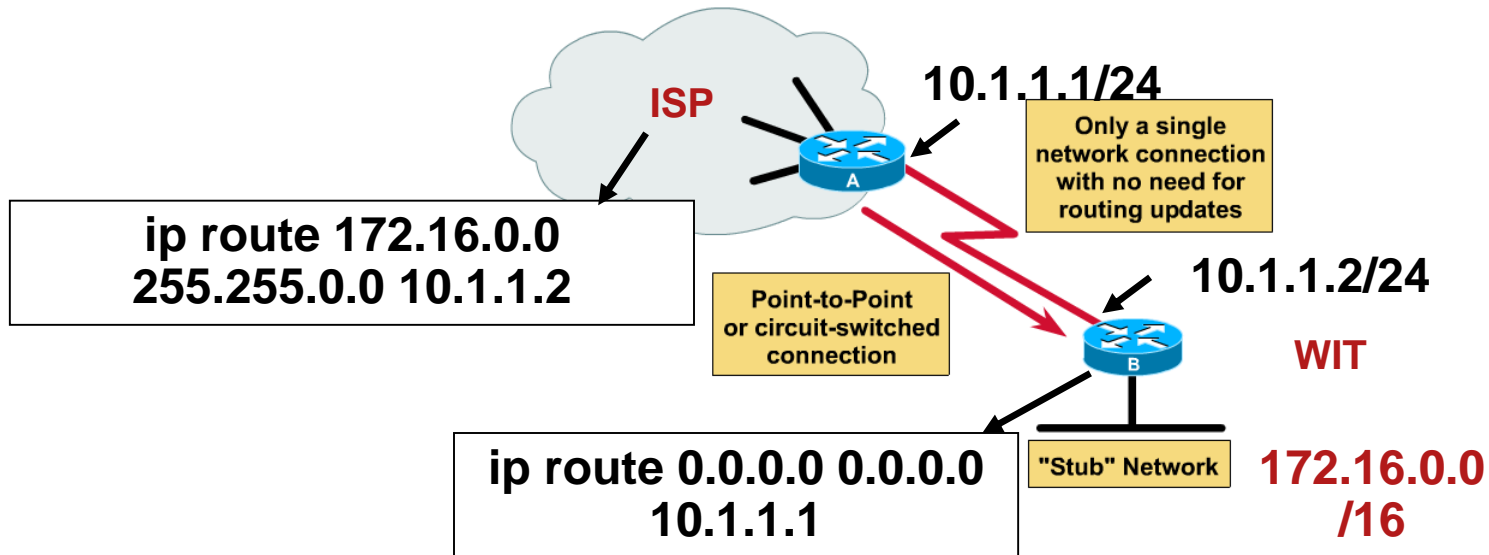


### Static routes in the real-world

- In the example above, there is only one route, link, between WIT's network and the ISP.
- When there is only a single route to a network, this is known as a **stub** network.
- It is very common for the ISP to have a static route pointing to it's customers' networks, in this case WIT.

# Common uses for Static Routes

## Default Static Routing Example

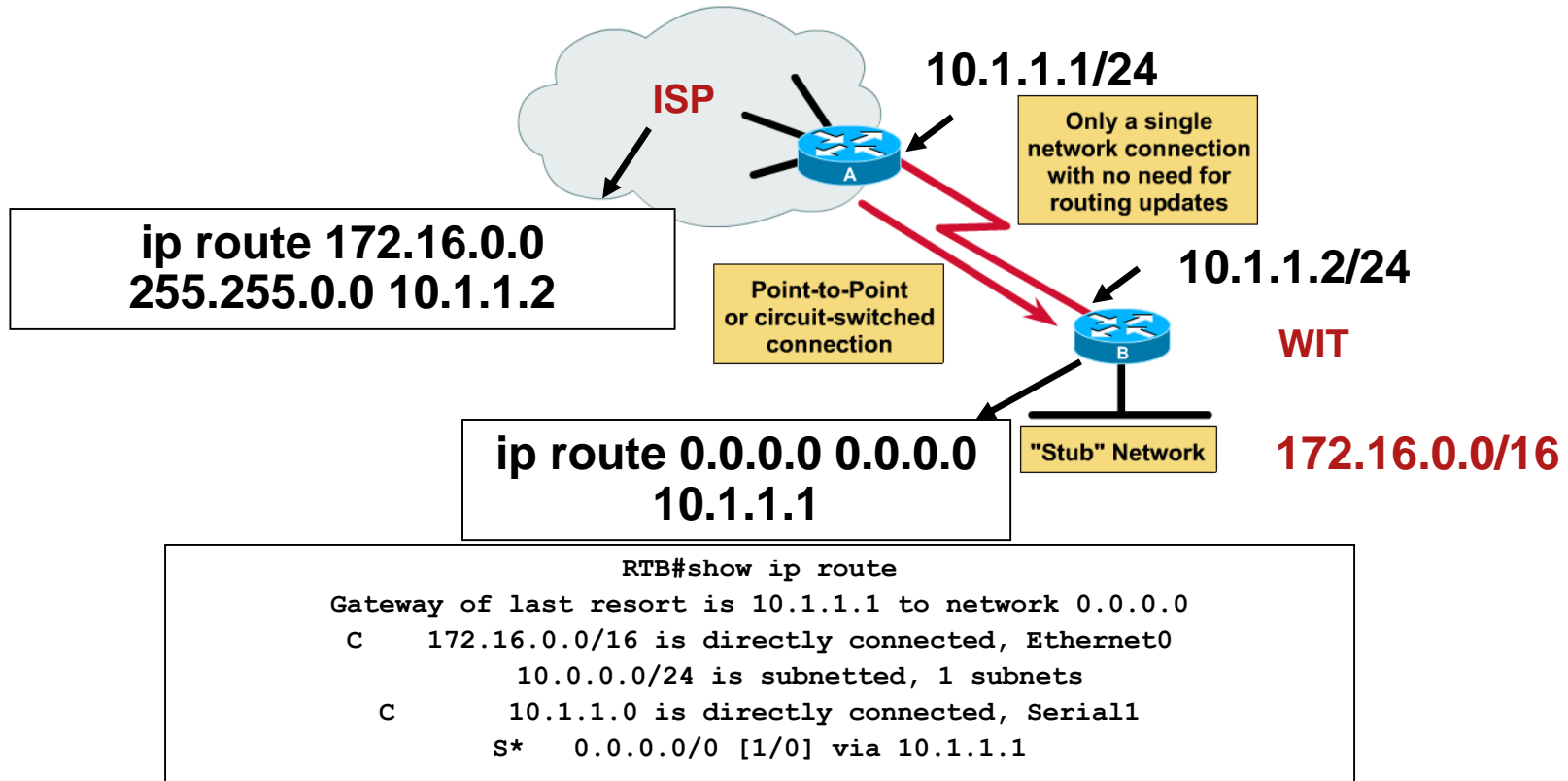


### Static routes in the real-world (continued)

- What about WIT and sending packets to the ISP – packets going to the Internet?
- It is also common for customer networks to use a special kind of static route, known as a **default static route**.
- Now we specify the network and mask as "0.0.0.0 0.0.0.0" (pronounced "quad-zero").
- This tells the router to forward all packets to this next-hop address (or exit interface) that do not have an explicit route in the routing table.

# Common uses for Static Routes

## Default Static Routing Example

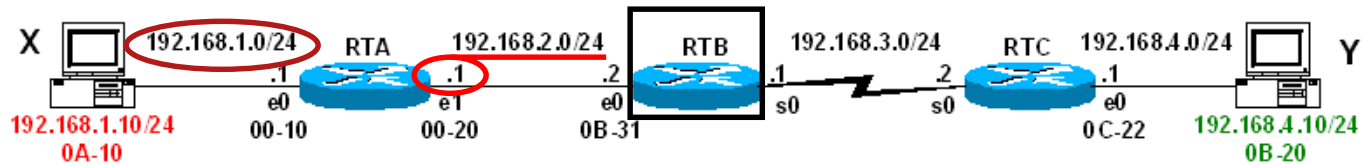


- Any packets not matching the routes 172.16.0.0/16 or 10.1.1.0/24 are sent to the router 10.1.1.1 – where it is now their “problem.”

# Summary and Default Route

- **Summarizing routes** reduces the size of the routing table.
- **Route summarization** is the process of combining a number of static routes into a single static route.

# Static Route Examples



- A router must learn about non-directly connected networks.
- To do this with static routes, Cisco IOS (Internetwork Operating System)

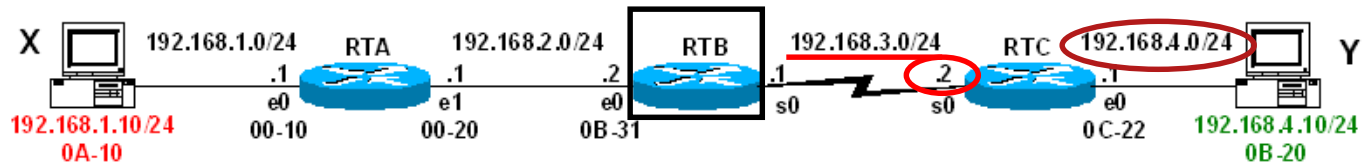
```
RTB(config)# ip route network-address mask next-hop-ip-address
```

To reach hosts like Host X in the 192.168.1.0/24 network:

```
RTB(config)# ip route 192.168.1.0 255.255.255.0 192.168.2.1
```

What would be the static route to reach hosts like Host Y in the 192.168.4.0/24 network?

# Static Route Examples



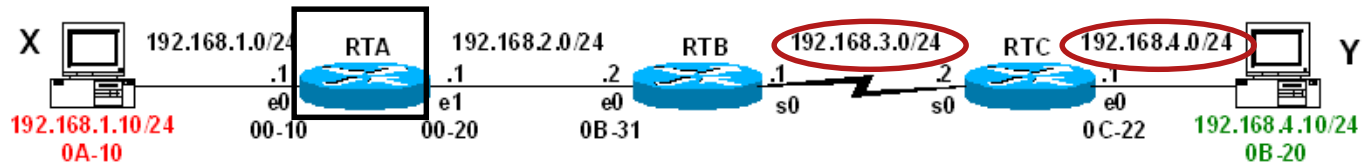
```
RTB(config)# ip route network-address mask next-hop-ip-address
```

To reach hosts like Host Y in the 192.168.4.0/24 network:

```
RTB(config)# ip route 192.168.4.0 255.255.255.0 192.168.3.2
```



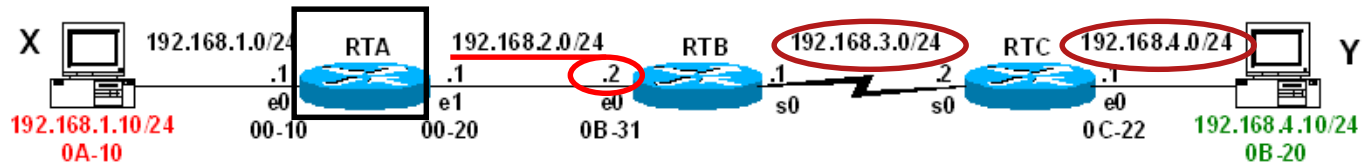
# Static Route Examples



What would be the static routes for RTA to reach 192.168.3.0/24 and 192.168.4.0/24 networks?

```
RTA(config)# ip route network-address mask next-hop-ip-address
```

# Static Route Examples



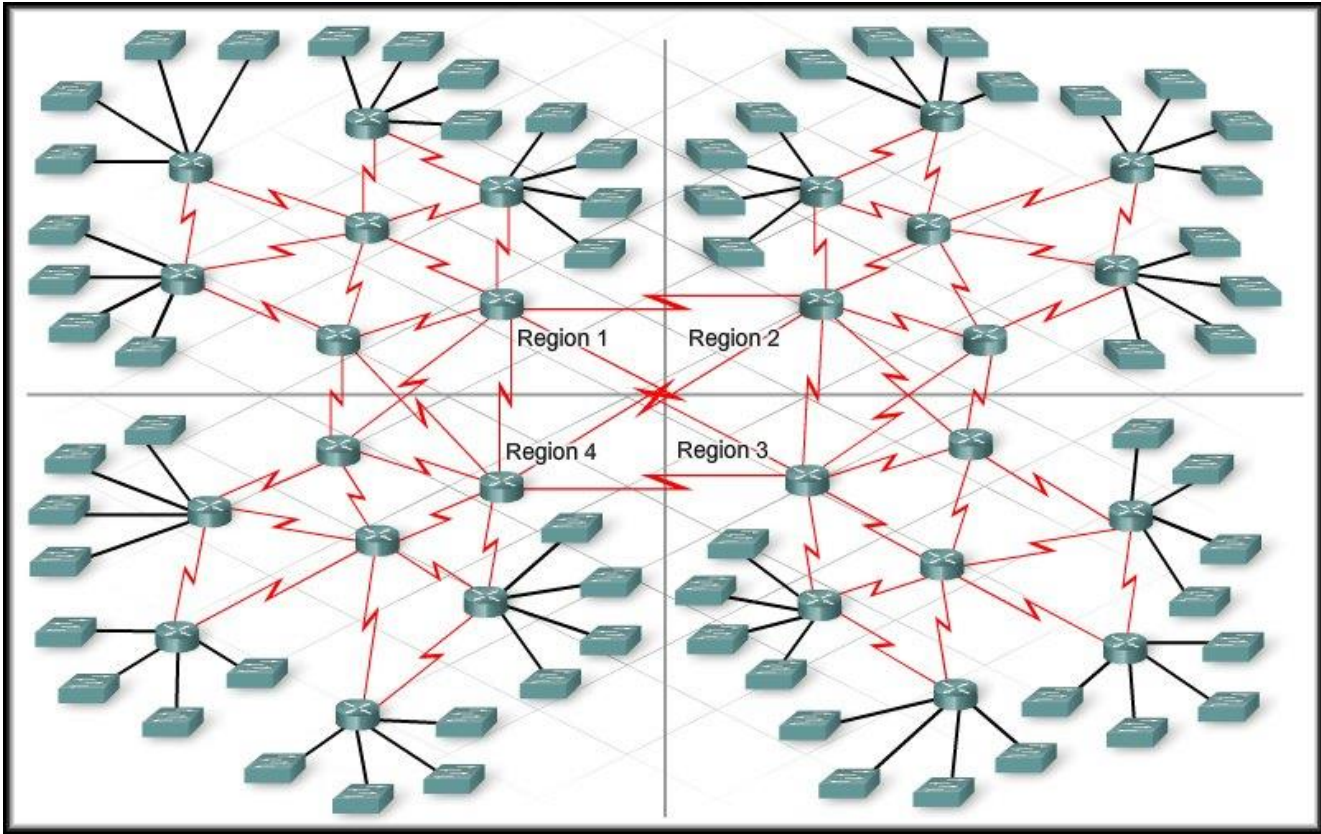
```
RTB(config)# ip route network-address mask next-hop-ip-address
```

The static routes for RTA to reach 192.168.3.0/24 and 192.168.4.0/24 networks:

```
RTA(config)# ip route 192.168.3.0 255.255.255.0 192.168.2.2
```

```
RTA(config)# ip route 192.168.4.0 255.255.255.0 192.168.2.2
```

# Static Routes?



# Summary

- Routing tables contain the following information
  - Directly connected networks
  - Remotely connected networks
  - Network addresses and subnet masks
  - IP address of next hop address
- How to configure Static Routes