Introduction to Routing

SDC CNW (CSE 4541)

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References

Glen E. Clarke & Richard Deal

CCT/CCNA

Routing & Switching Exam Guide

McGrawHll

Talk Flow

Introduction

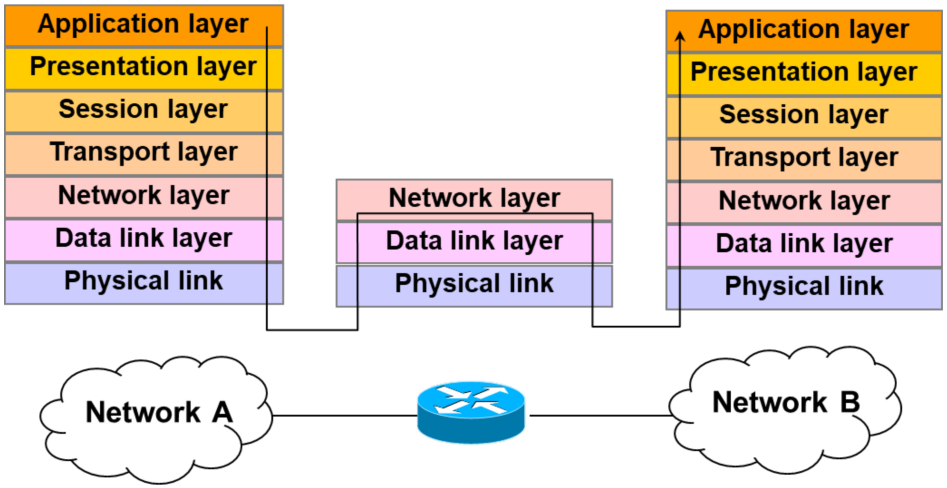


Figure 1

Router

A router is a network device that connects multiple networks together and forwards data packets between them.

Introduction (Cont...)

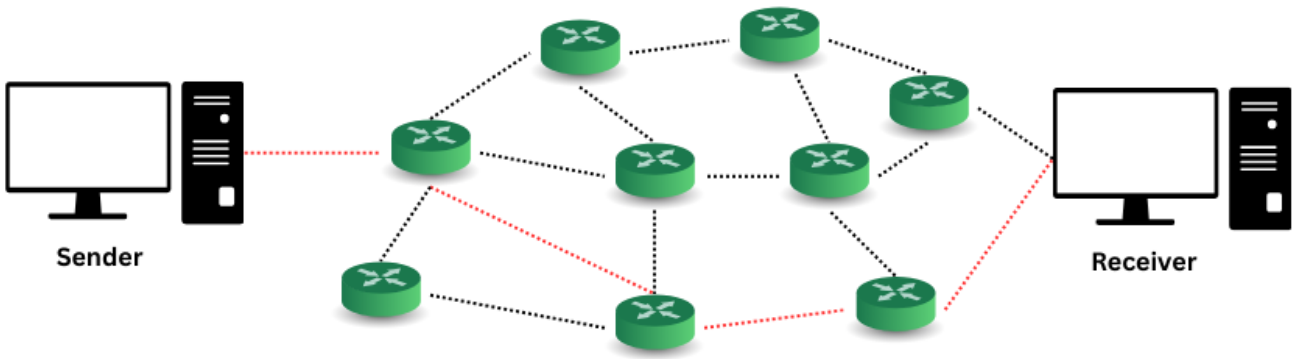


Figure 2

Routing

- Routing is the process of directing data packets from one network device to another based on their destination IP addresses.
- It occurs at the network layer (Layer 3) of the OSI model.
- Routers use routing tables to determine the best path for forwarding packets.
- Routing can be static or dynamic, depending on whether routing entries are manually configured or automatically updated.

Interface Configuration

- An interface in a router refers to a physical or virtual connection point through which the router connects to a network.
- Interfaces can be physical ports, such as Ethernet ports, serial ports, or wireless interfaces, that allow the router to connect to other devices or networks.
- Assign an IP address to the interface using the **ip address** command, followed by the IP address and subnet mask.

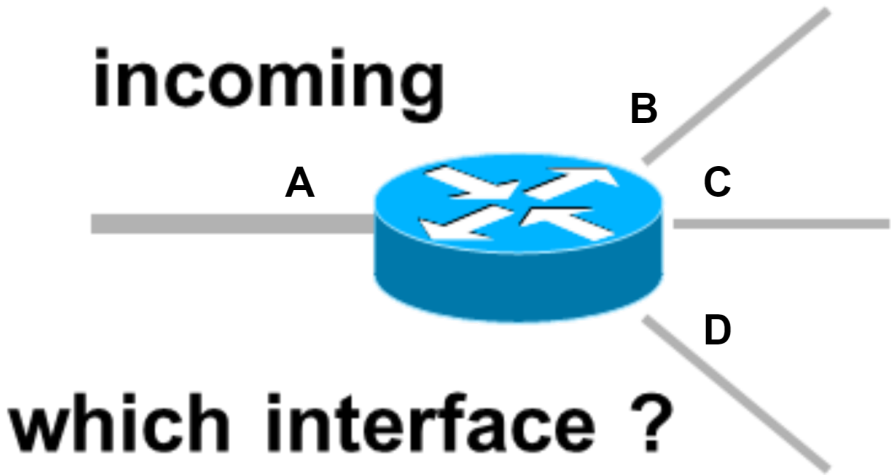
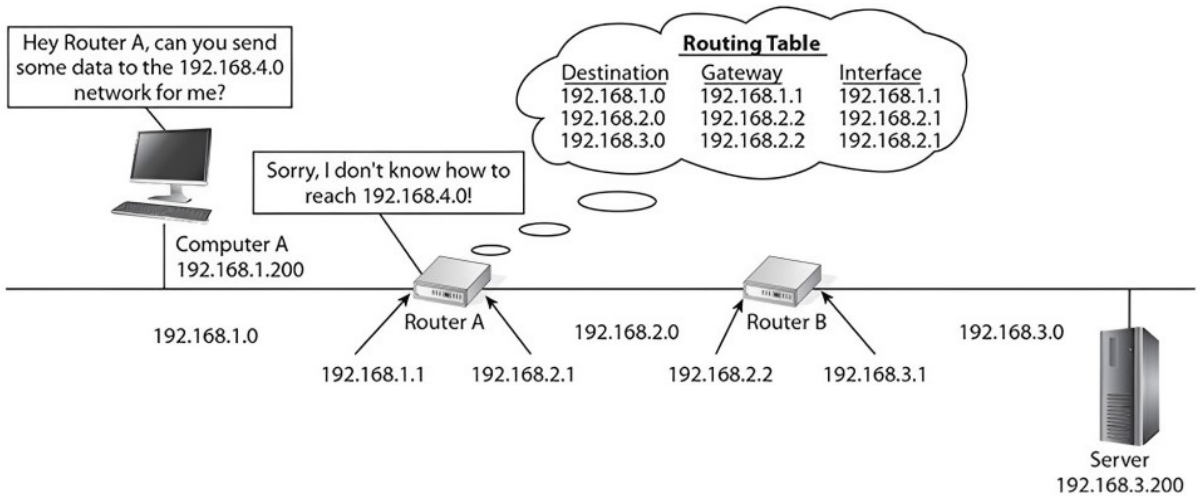


Figure 3

Configuring an Ethernet Interface

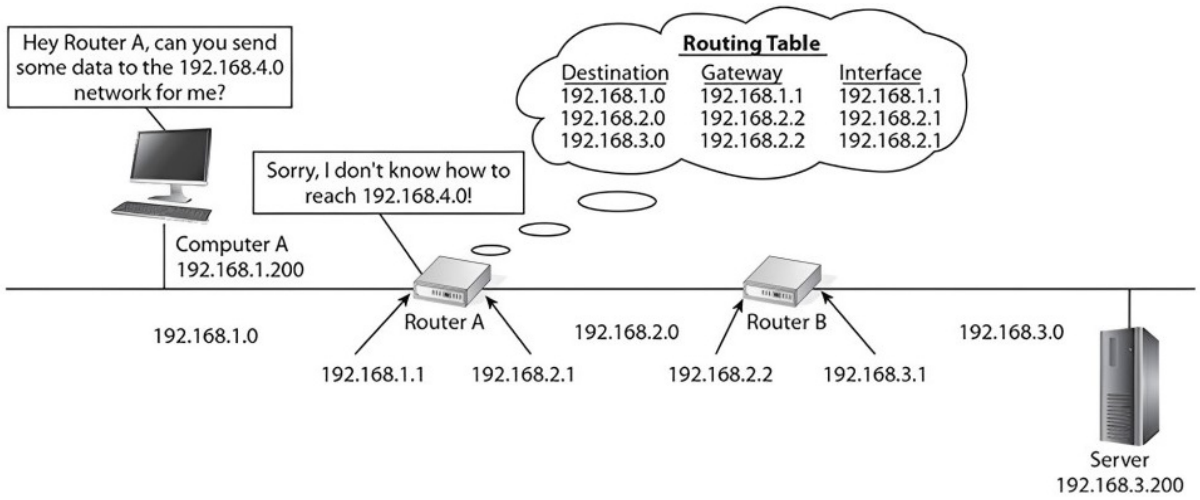


Assume that on Router A, the interface assigned the IP address of 192.168.1.1 is an Ethernet interface (which connects to an Ethernet network 192.168.0.0).

Command

```
RouterA> enable
RouterA# configure terminal
RouterA(config)# interface fastEthernet0/0
RouterA(config-if)# ip address 192.168.1.1 255.255.255.0
RouterA(config-if)# no shutdown
```

Configuring an Serial Interface



Assume that the interface on Router A that is assigned the IP address of 192.168.2.1 is a serial interface. Serial interfaces are used either to connect to your wide area network (WAN) or to serve as a point-to-point link (a direct connection between two routers).

Command

```
RouterA> enable
RouterA# configure terminal
RouterA(config)# interface Serial0/0
RouterA(config-if)# ip address 192.168.2.1 255.255.255.0
RouterA(config-if)# encapsulation hdlc
RouterA(config-if)# no shutdown
```

Configuring the Bandwidth Parameter

- Each interface has a bandwidth value assigned to it. A bandwidth value is used by certain routing protocols, such as OSPF and Enhanced Interior Gateway Routing Protocol (EIGRP), when making routing decisions.
- For LAN-based interfaces, the speed of the interface becomes the bandwidth value, where the bandwidth is measured in kilobits per second (Kbps).
- For serial interfaces, the bandwidth defaults to 1554 Kbps.

Command

```
RouterA> enable
RouterA# configure terminal
RouterA(config)# interface serial [slot_#/port_#]
RouterA(config-if)# bandwidth rate_in_kbps
```

Example

```
RouterA> enable
RouterA# configure terminal
RouterA(config)# interface serial0
RouterA(config-if)# bandwidth 56
```

Routing Table

Once you have assigned the IP addresses to each interface, you will need to ensure that routing is enabled on the router by typing the following commands:

Command

```
RouterA> enable
RouterA# configure terminal
RouterA(config)# ip routing
```

* **Note:** The ip routing command enables routing. To disable routing, you would type no ip routing.

Viewing the Routing Table

Once routing has been enabled, the router will automatically add a route for each of the networks it is directly connected to. To view the routing table and verify that the routes are added, use the following command:

Command

```
RouterA> enable
RouterA# show ip route
```

```
ROUTER-A(config)#do show ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

C    192.168.2.0/24 is directly connected, Serial2/0
S    192.168.3.0/24 [1/0] via 192.168.2.2
C    198.168.1.0/24 is directly connected, FastEthernet0/0
```

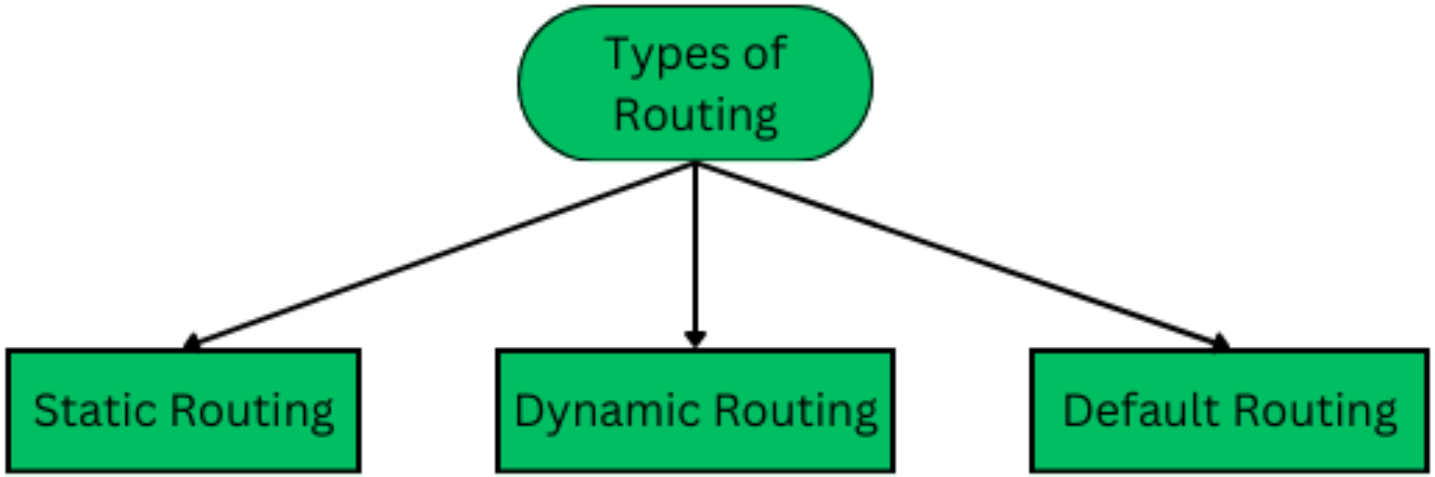
Reach Remote Networks

A router can learn about remote networks in one of two ways:

Manually - Remote networks are manually entered into the route table using static routes.

Dynamically - Remote routes are automatically learned using a dynamic routing protocol.

Types of Routing



Static Routing

- Static routing involves manually configuring routing tables on routers.
- Routes are manually entered, specifying the next-hop router or outgoing interface for each destination network.
- Routes remain unchanged unless manually modified or removed.

Types of Routing (Cont...)

Dynamic Routing

- Dynamic routing uses routing protocols to automatically exchange routing information between routers.
- Routers dynamically update their routing tables based on information received from neighboring routers.
- Routing algorithms calculate the best paths to destination networks.

Default Routing

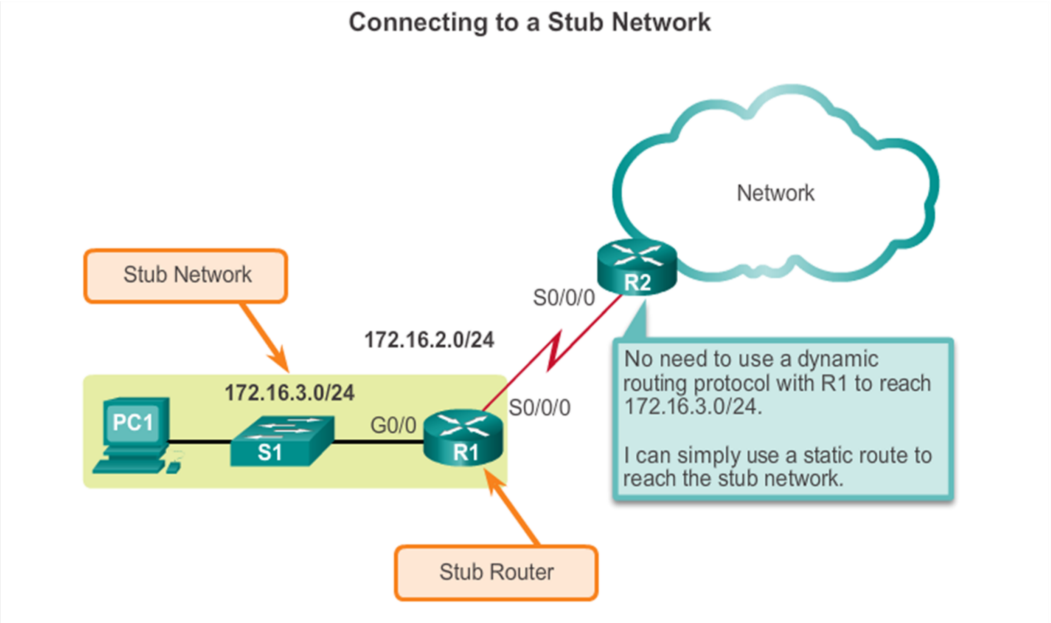
- Default routing forwards packets with unknown destination IP addresses to a specific next-hop router, known as the default gateway.
- It is used when a router does not have a specific route entry for a destination network in its routing table.
- Provides connectivity to networks outside the router's known routes, such as the internet.

Static Routing

Why We Use Static Routing

- Static routing provides some advantages over other routing methods.
- Static routes are not advertised over the network, resulting in better security.
- Static routes use less bandwidth than dynamic routing protocols, no CPU cycles are used to calculate and communicate routes.
- The path a static route uses to send data is known.

Static Routing



When We Use Static Routing

Static routing has three primary uses:

- Providing ease of routing table maintenance in smaller networks that are not expected to grow significantly.
- Routing to and from stub networks. A stub network is a network accessed by a single route, and the router has no other neighbors.
- Using a single default route to represent a path to any network that does not have a more specific match with another route in the routing table. Default routes are used to send traffic to any destination beyond the next upstream router.

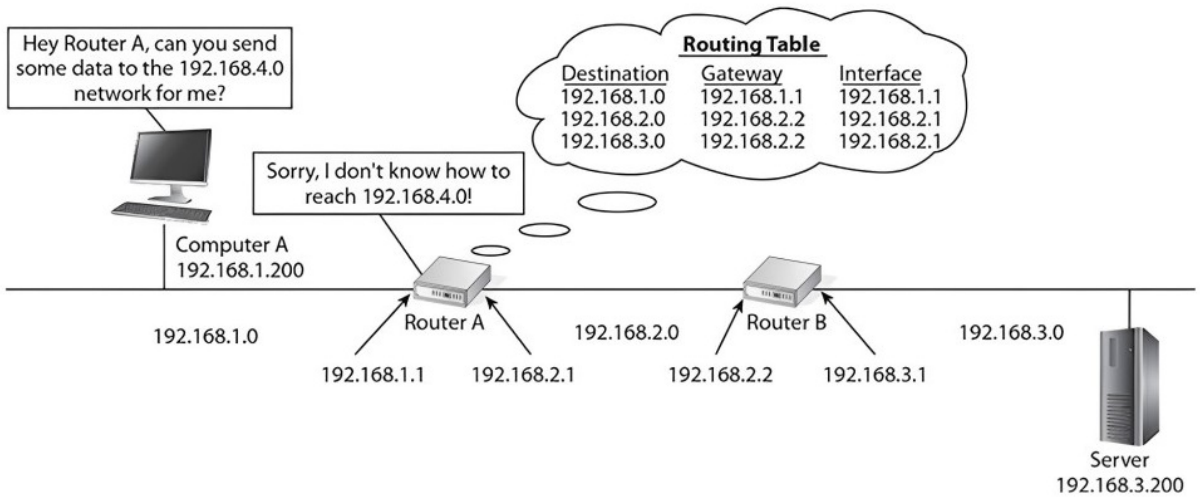
Static Routing

Applications of Static Routing

Static Routes are often used to:

- Connect to a specific network.
- Provide a Gateway of Last Resort for a stub network.
- Reduce the number of routes advertised by summarizing several contiguous networks as one static route.
- Create a backup route in case a primary route link fails.

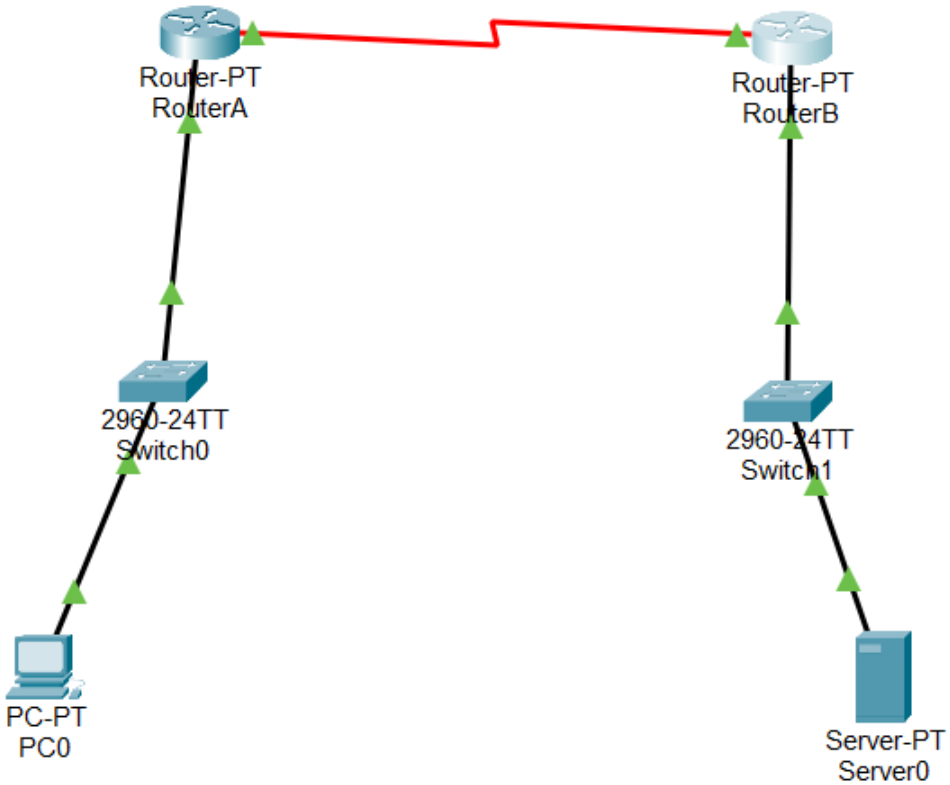
Configuring Static Routing



Command

```
RouterA> enable
RouterA# configure terminal
RouterA(config)# ip route 192.168.3.0 255.255.255.0 192.168.2.2
```

Configuring Static Routing-CPT




```
ROUTER-A>enable
ROUTER-A#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
ROUTER-A(config)#ip route 192.168.3.0 255.255.255.0 192.168.2.2
ROUTER-A(config)#
```

Configuring Static Routing-CPT

Route before addition

```
ROUTER-A>enable
ROUTER-A#show ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, 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

Gateway of last resort is not set

C    192.168.2.0/24 is directly connected, Serial2/0
C    198.168.1.0/24 is directly connected, FastEthernet0/0
```

Route after addition

```
ROUTER-A#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
ROUTER-A(config)#ip route 192.168.3.0 255.255.255.0 192.168.2.2
ROUTER-A(config)#do show ip route
Codes: C - connected, S - static, I - IGRP, 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
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```
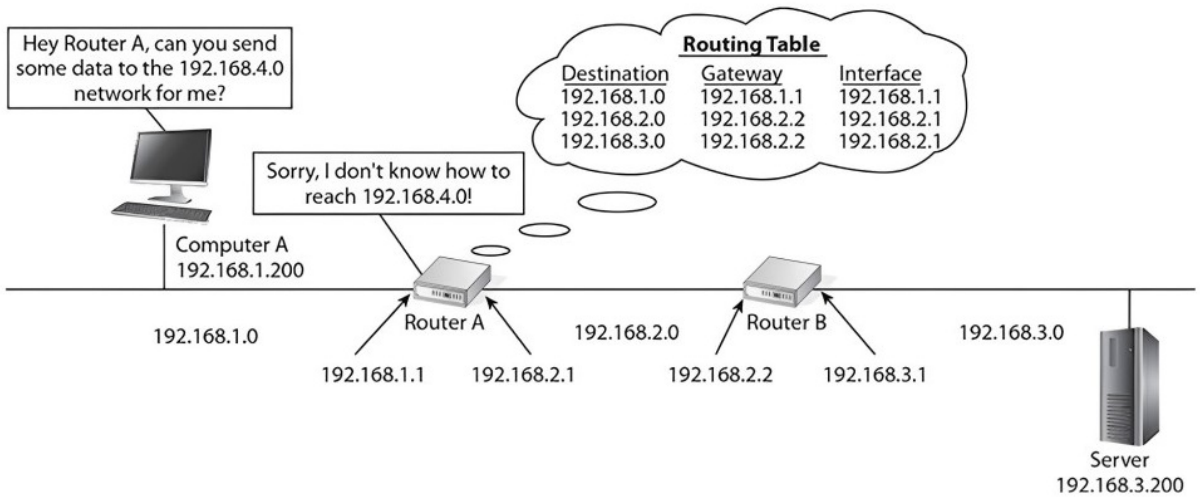

Deleting a Static Route on a Cisco Router



Command

```
Router> enable
Router# configure terminal
Router(config)# no ip route 192.168.3.0 255.255.255.0
```

Deletion of a Static Route-CPT

Route before deletion

```
ROUTER-A(config)#do show ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
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C    192.168.2.0/24 is directly connected, Serial2/0
S    192.168.3.0/24 [1/0] via 192.168.2.2
C    198.168.1.0/24 is directly connected, FastEthernet0/0

ROUTER-A(config)#
```

Route after deletion

```
ROUTER-A(config)#no ip route 192.168.3.0 255.255.255.0
ROUTER-A(config)#do show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
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Gateway of last resort is not set

C    192.168.2.0/24 is directly connected, Serial2/0
C    198.168.1.0/24 is directly connected, FastEthernet0/0

ROUTER-A(config)#
```

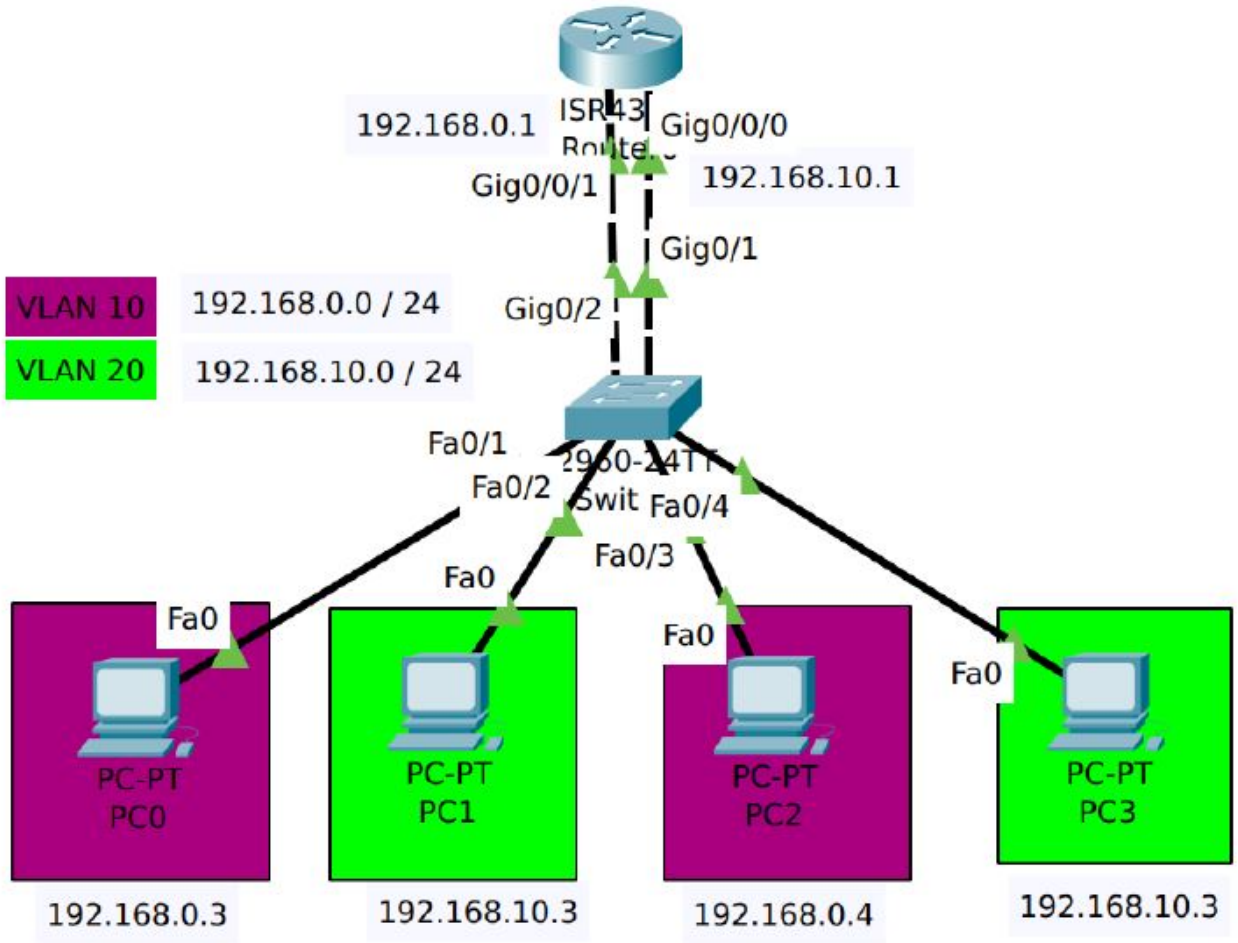
Inter VLAN communication

- ☞ Hosts in a VLAN live in their own broadcast domain and can communicate freely. VLANs create network partitioning and traffic separation at layer 2 of the OSI.
- ☞ By default devices within different VLANs can not communicate due to separate broadcast domain. However, inter VLAN communication can be achieved by including layer 3 devices such as router, layer 3 switch.

Types of inter VLAN communication

- **Legacy Inter-VLAN Routing:** This is a legacy solution. It does not scale well.
- **Router-on-a-Stick (RoaS):** This is an acceptable solution for a small- to medium-sized network.
- **Layer 3 switch using switched virtual interfaces (SVIs):** This is the most scalable solution for medium to large organizations.

Legacy Inter-VLAN Routing



For each VLAN there will be dedicated access port from layer 3 device (router) to layer 2 device (switch).

Legacy Inter-VLAN Routing (Configuration)

Create VLAN & assign to interfaces

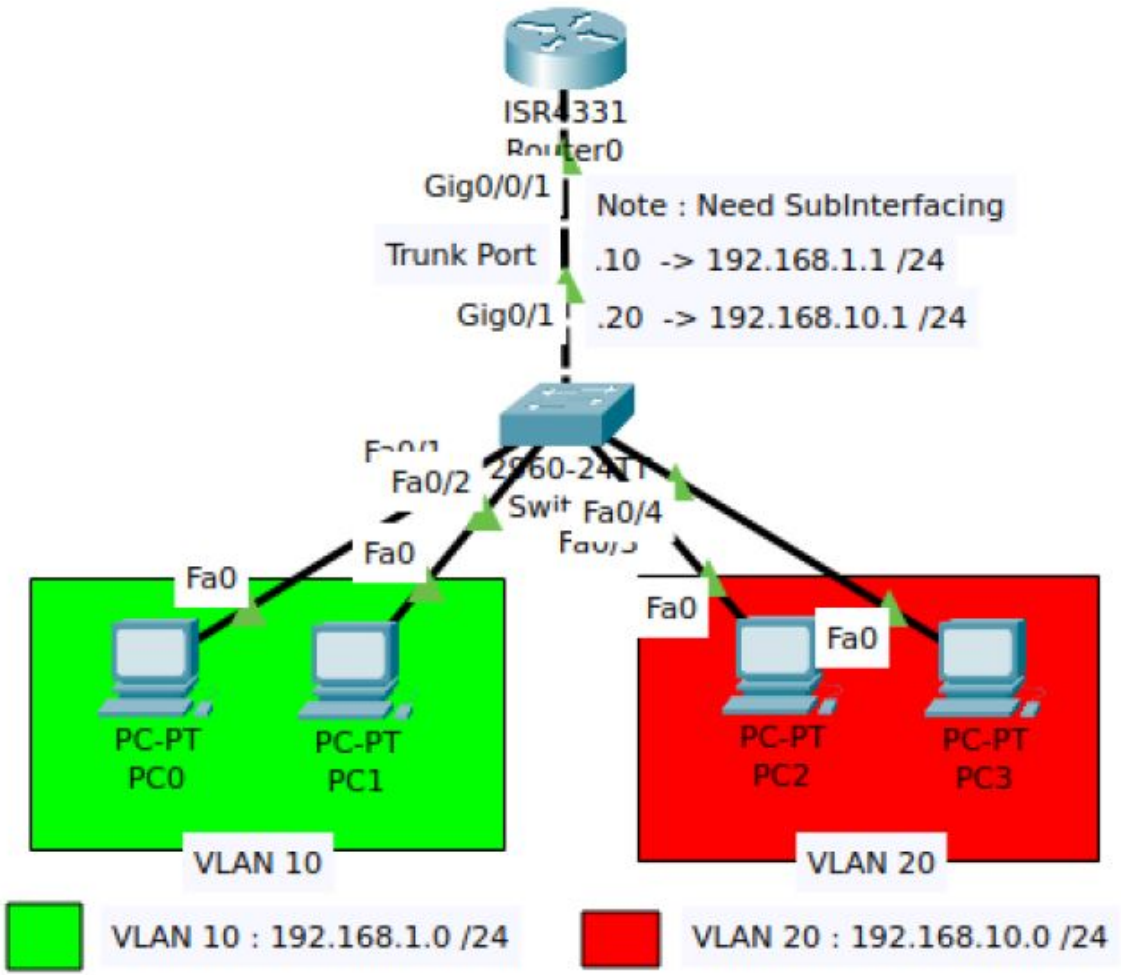
```
SW(config)#int range f0/1, f0/3, gig0/1
SW(config-if-range)#switchport mode access
SW(config-if-range)#switchport access vlan 10
```

Assign Default Gateway to router interfaces

```
R(config)#int gigabitEthernet 0/0/0
R(config-if)#ip address 192.168.0.1 255.255.255.0
R(config-if)#no sh
```

*Configure the other interfaces

Router-on-a-Stick (RoaS)



- There will be only one link between switch (layer 2) and router (layer 3) for all VLANs as trunk port

Sub-interface

Sub interface

- A subinterface is a virtual interface (L3 interface) created by dividing one physical interface (layer 3 device) into multiple (max 4094) logical interfaces.
- If we have one Router with one physical interface, but needed to have the router connected to two IP networks to route traffic between two routers, we can create two sub interfaces within the physical interface, assign each sub interface an IP address within each subnet and then route the data between two subnets.

Example

interface gig 0/0/0 => Physical Interface
interface gig 0/0/0.10 => Logical/sub Interface
interface gig 0/0/0.20 => Logical/sub Interface

Router-on-a-Stick (RoaS) (Configuration))

1. Create VLAN & assign to interfaces

Set Gig0/1 of SW to trunk port

```
SW(config)#int range gig 0/1
SW(config-if-range)#switchport mode trunk
```

Assign Default Gateway to router interfaces

```
R(config)#int gigabitEthernet 0/0/0.10
R(config-subif)#encapsulation dot1Q 10
R(config-if)#ip address 192.168.1.1 255.255.255.0
R(config-if)#no sh
```

Note: 10 indicates VLAN ID 10

*Configure the other interfaces