Basic Network and Routing Concepts

CCNP ROUTE: Implementing IP Routing

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Objectives

- Dynamic routing protocols
- How different traffic types, network types, and overlaying network technologies influence routing
- Differentiating between the various branch connectivity options and describing their impact on routing protocols
- RIP overview

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Dynamic Routing Protocols

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Routing Protocols

- Dynamic routing protocols play an important role in the enterprise networks
- Basic objective is to exchange network reachability information between routers and dynamically adapt to network changes
- Uses routing algorithms to determine the optimal path between different segments in the network, and updating routing tables with the best paths
- Several different routing protocols exist
- Each having different characteristics, advantages and limitations
- Can be described and compared in the regards to where and how they operate
- Three important characteristics that influence routing protocol selection are:
  - Convergence
  - Support for summarization
  - Ability to scale in larger environments

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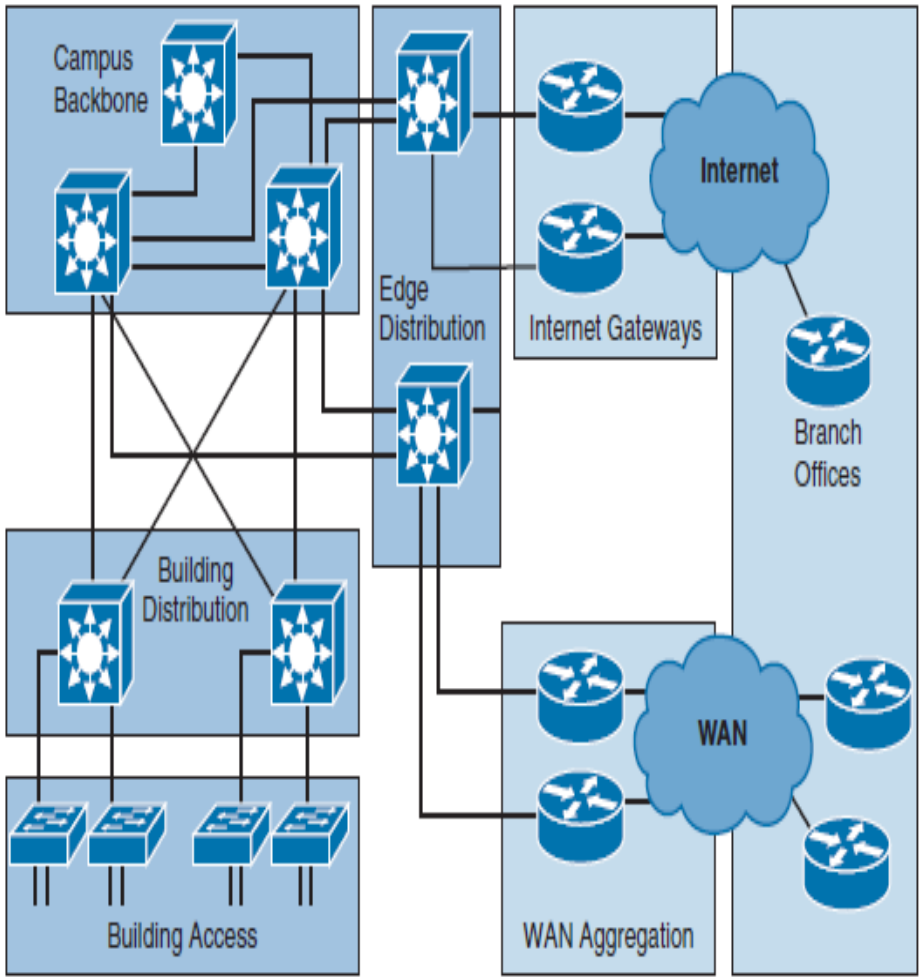
Enterprise network infrastructure



Enterprise Campus

- An enterprise campus provides access to the network communications services and resources to end users and devices.
- It is spread over a single geographic location, spanning a single floor, building, or several buildings in the same locality.
- The campus is commonly designed using a hierarchical model — comprising the core, distribution, and access layers—creating a scalable infrastructure.

Enterprise Edge

- An enterprise edge provides users at geographically disperse remote sites with access to the same network services as users at the main site.
- The network edge aggregates private WAN links that are rented from service providers, and it enables individual users to establish VPN connections.
- In addition, the network edge also provides Internet connectivity for campus and branch users.

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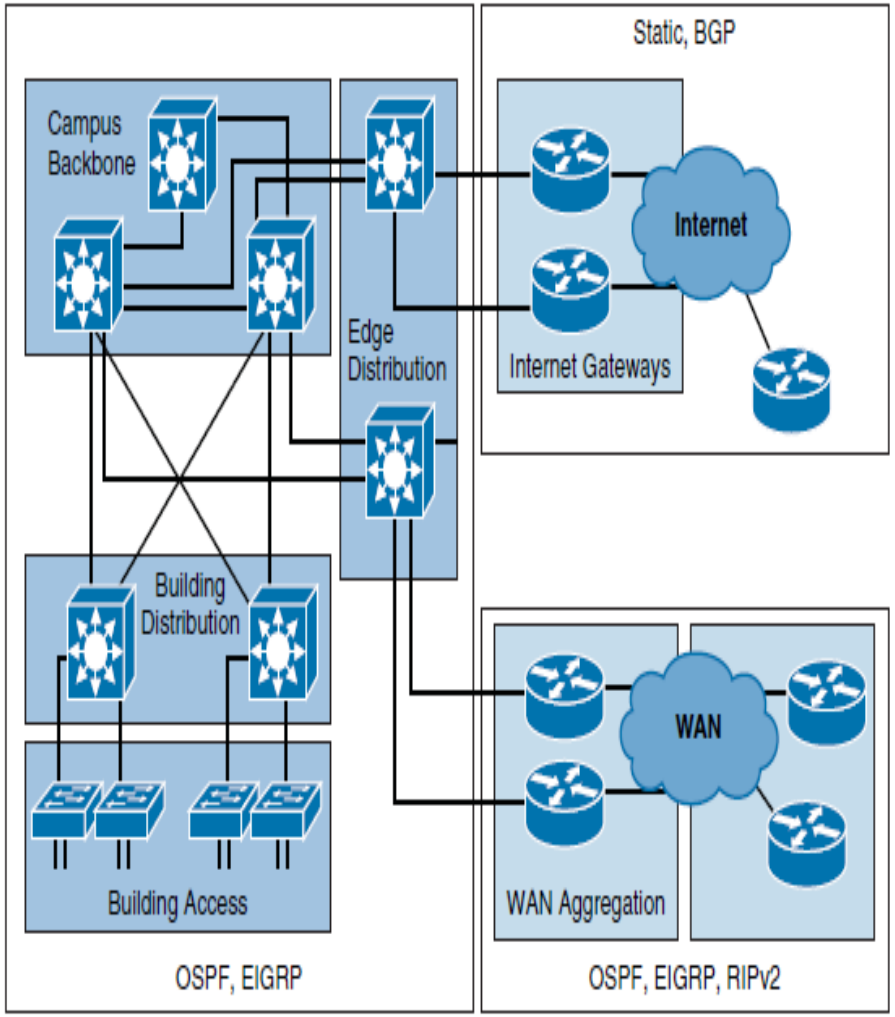
Dynamic Routing Protocols in the Enterprise Network Infrastructure

- It is a best practice that you use one IP routing protocol throughout the enterprise, if possible.
- One common example of when multiple routing protocols are used is when the organization is multihomed.
- The most commonly used protocol to exchange routes with the service provider is Border Gateway Protocol (BGP), whereas within the organization, Open Shortest Path First (OSPF) or Enhanced Interior Gateway Routing Protocol (EIGRP) is typically used.
- In a single-homed infrastructure static routes are commonly used between the customer and the ISP.



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Choosing of a Dynamic Routing Protocols

Input requirements :

- Size of network
- Multivendor support
- Knowledge level of specific protocol

Protocol characteristics :

- Type of routing algorithm
- Speed of convergence
- Scalability

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IGP and EGP Routing Protocols

An **Autonomous System** (AS) represents a collection of network devices under a common administrator.

Routing protocols can be divided based on whether they exchange routes within an AS or between different AS's:

Interior Gateway Protocols (IGP)

- Used to exchange routes within an AS
- Support small, medium-sized, and large organizations, but their scalability has its limits.
- Fast convergence
- Basic functionality is not complex to configure.
- The most commonly used IGPs in enterprises are EIGRP and OSPF. IS-IS is also commonly found as ISP IGP.

Exterior Gateway Protocols (EGP)

- Used to exchange routes between different ASs.
- BGP is the EGP that is used today.
- The main function of BGP is to exchange a huge number of routes between different autonomous systems.

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Types of Routing Protocols

	Interior Gateway Protocols				Exterior Gateway Protocols
	Distance Vector		Link-State		Path Vector
IPv4	RIPv2	EIGRP	OSPFv2	IS-IS	BGP-4
IPv6	RIPng	EIGRP for IPv6	OSPFv3	IS-IS for IPv6	MBGP

Distance vector protocols

- The distance vector routing approach determines the direction (vector) and distance (such as link cost or number of hops) to any link in the network. The only information that a router knows about a remote network is the distance or metric to reach this network and which path or interface to use to get there. Distance vector routing protocols do not have an actual map of the network topology.

Link-state protocols

- The link-state approach uses the Shortest Path First (SPF) algorithm to create an abstract of the exact topology of the entire network or at least within its area. A link-state routing protocol is like having a complete map of the network topology. The map is used to determine the best path to a destination.

Path vector protocols

- Path information is used to determine the best paths and to prevent routing loops. Similar to distance vector protocols, path vector protocols do not have an abstract of the network topology. Path vector protocols indicate direction and distance, but also include additional information about the specific path of the destination.

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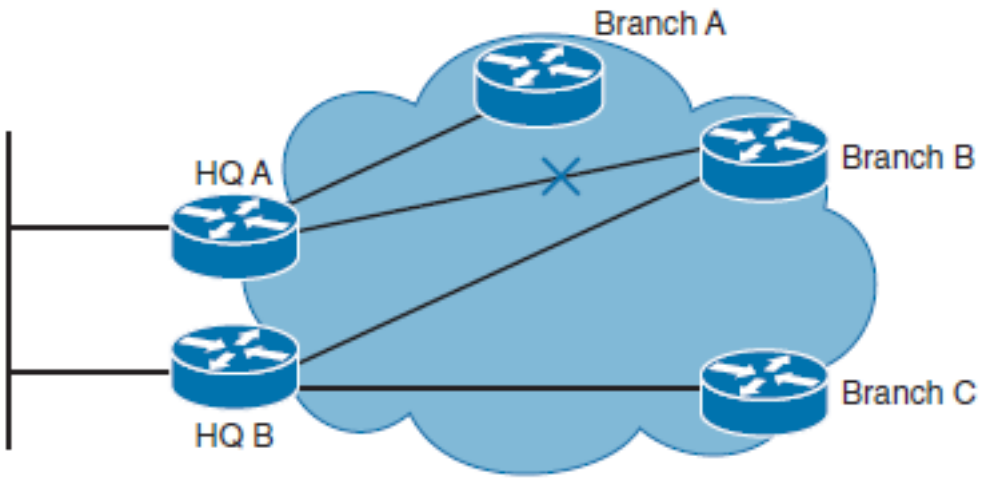
Importance of Convergence

- Convergence is the process of when routers notice a change in the network, exchange information about the change, and perform necessary calculations to re-evaluate the best routes.
- To minimize downtime and quickly respond to network changes, a fast convergence time is desired.



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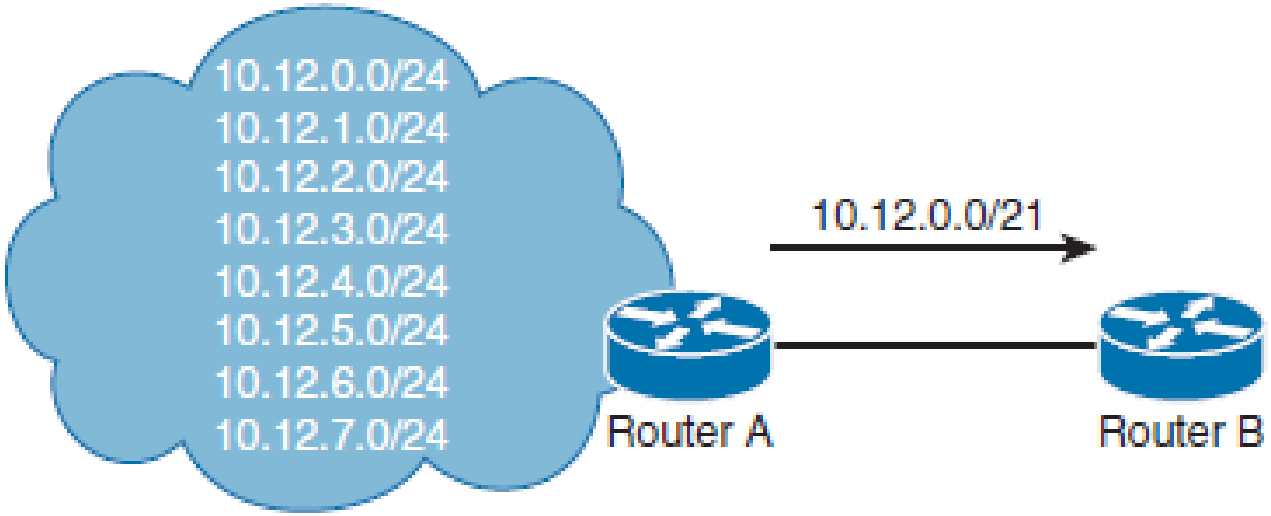
Route Summarization

- Route summarization reduces routing overhead and improve stability and scalability of routing by reducing the amount of routing information that is maintained and exchanged between routers.
- Less frequent and smaller updates, as a result of route summarization, also lower convergence time.



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Routing Protocol Scalability

Scalability factors include:

- Number of routes
- Number of adjacent neighbors
- Number of routers in the network
- Network design
- Frequency of changes
- Available resources (CPU and memory)

- The scalability of the routing protocol and its configuration options to support a larger network can play an important role when evaluating routing protocols against each other.

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Understanding Network Technologies

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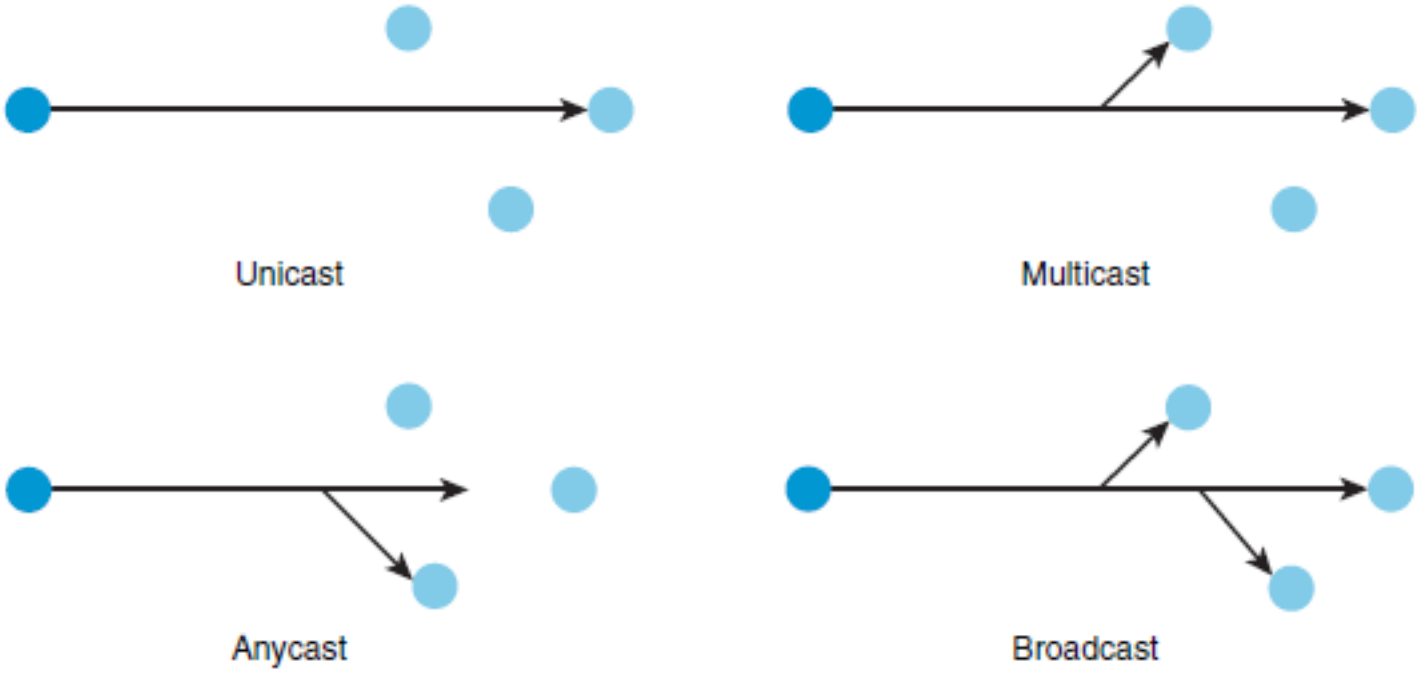
Differentiate Traffic Types



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Differentiate Traffic Types

Unicast

- Unicast addresses are used in a one-to-one context. Unicast traffic is exchanged only between one sender and one receiver.

Multicast

- Multicast addresses identify a group of interfaces across different devices. Traffic that is sent to a multicast address is sent to multiple destinations at the same time.
- IPv4 reserved multicast addresses 224.0.0.0–239.255.255.255.
- IPv6 reserved multicast addresses have the prefix FF00::/8.

Anycast

- An anycast address is assigned to an interface on more than one node. When a packet is sent to an anycast address, it is routed to the nearest interface that has this address. The nearest interface is found according to the measure of distance of the particular routing protocol.

Broadcast

- IPv4 broadcast addresses are used when sending traffic to all devices in the subnet. Local broadcast address 255.255.255.255.
- IPv6 does not use a broadcast address, but uses multicast addresses instead

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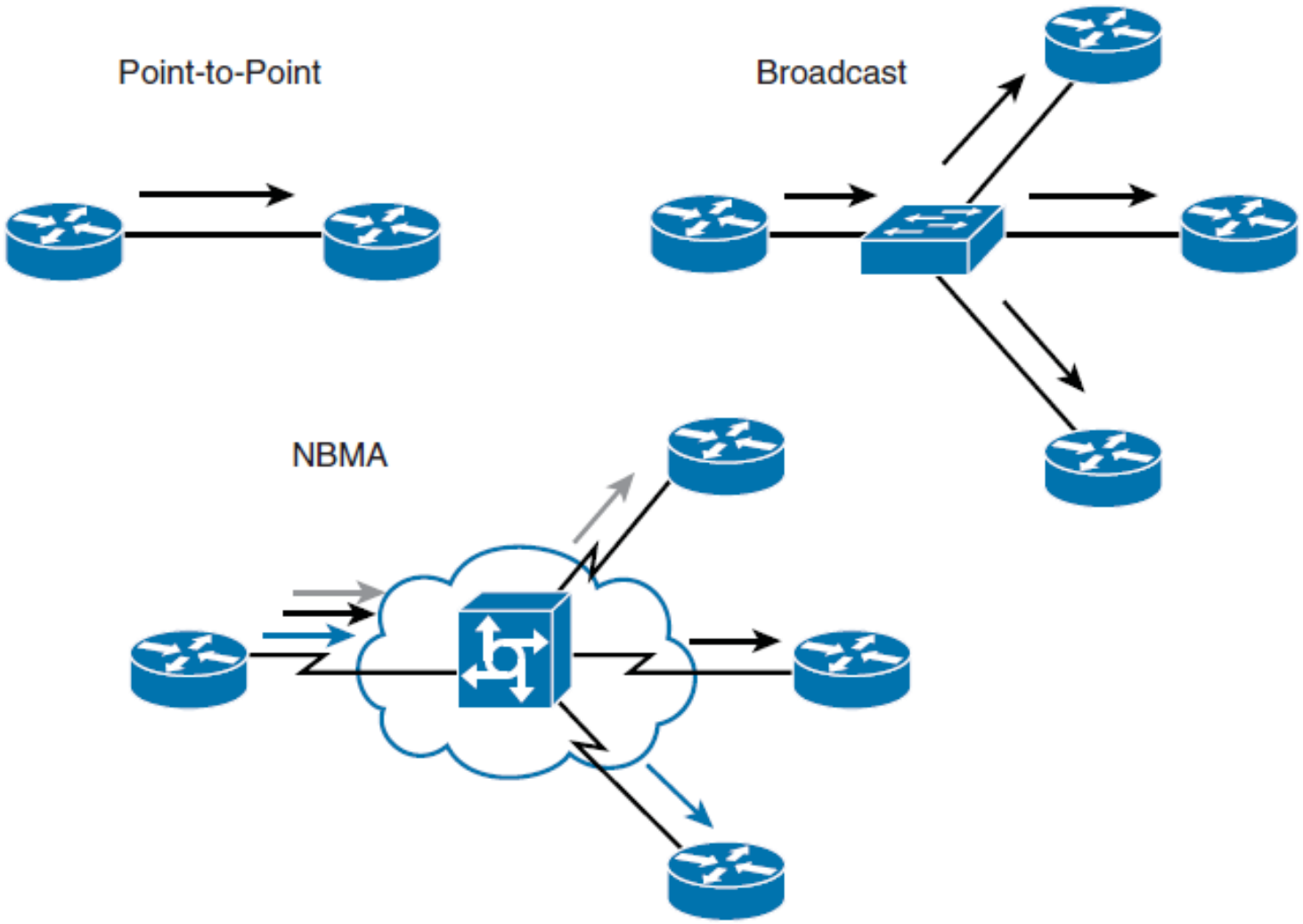
Network Types



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Network Types

Point-to-point network

- A network that connects a single pair of routers.
- A serial link is an example of a point-to-point connection.

Broadcast network

- A network that can connect many routers along with the capability to address a single message to all of the attached routers.
- Ethernet is an example of a broadcast network.

Nonbroadcast Multiaccess (NBMA) network

- A network that can support many routers but does not have broadcast capability.
- The sender needs to create an individual copy of the same packet for each recipient if it wishes to inform all connected routers.
- Frame Relay and Asynchronous Transfer Mode (ATM) are examples of an NBMA network type.

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Connecting Remote Locations

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Principles of Static Routing

A static route can be used in the following circumstances

- When it is undesirable to have dynamic routing updates forwarded across slow bandwidth links, such as a dialup link.
- When the administrator needs total control over the routes used by the router.
- When a backup to a dynamically recognized route is necessary.
- When it is necessary to reach a network accessible by only one path (a stub network).
- When a router connects to its ISP and needs to have only a default route (static route that matches all networks).
- When a router is underpowered and does not have the CPU or memory resources necessary to handle a dynamic routing protocol.

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Configuring an IPv4 Static Route

ip route *prefix mask* { *address* | *interface* [*address*]} [**dhcp**] [*distance*] [**name** *next-hop-name*] [**permanent** | **track** *number*] [**tag** *tag*]

ip route **Command**	**Description**
prefix mask	The IPv4 network and subnet mask for the remote network to be entered into the IPv4 routing table.
address	The IPv4 address of the next hop that can be used to reach the destination network.
interface	The local router outbound interface to be used to reach the destination network.
dhcp	(Optional) Enables a Dynamic Host Configuration Protocol (DHCP) server to assign a static route to a default gateway (option 3).
distance	(Optional) The administrative distance to be assigned to this route. Must 1 or greater.
name *next-hop-name*	(Optional) Applies a name to the specified route.
permanent	(Optional) Specifies that the route will not be removed from the routing table even if the interface associated with the route goes down.
track *number*	(Optional) Associates a track object with this route. Valid values for the number argument range from 1 to 500.
tag *tag*	(Optional) A value that can be used as a match value in route maps.

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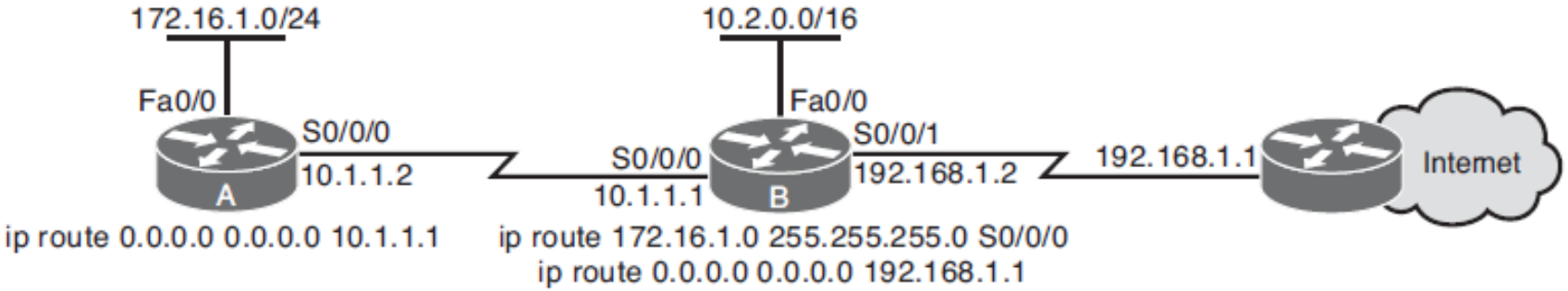
Configuring a Static and Default Route




```
RouterA# show ip route
<Output omitted>
Gateway of last resort is not set
C    172.16.1.0 is directly connected, FastEthernet0/0
C    10.1.1.0 is directly connected, Serial0/0/0
S*   0.0.0.0/0 [1/0] via 10.1.1.1
```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RIP Overview

- RIP is an IGP that is used in smaller networks.
- It is a distance vector routing protocol that uses hop count as a routing metric.
- There are three versions of RIP: RIPv1, RIPv2, and RIPng.
  - RIPv1 and RIPv2 is used in IPv4 networks.
  - RIPng is used in IPv6 networks.
- RIP is a standardized IGP routing protocol that works in a mixed-vendor router environment.

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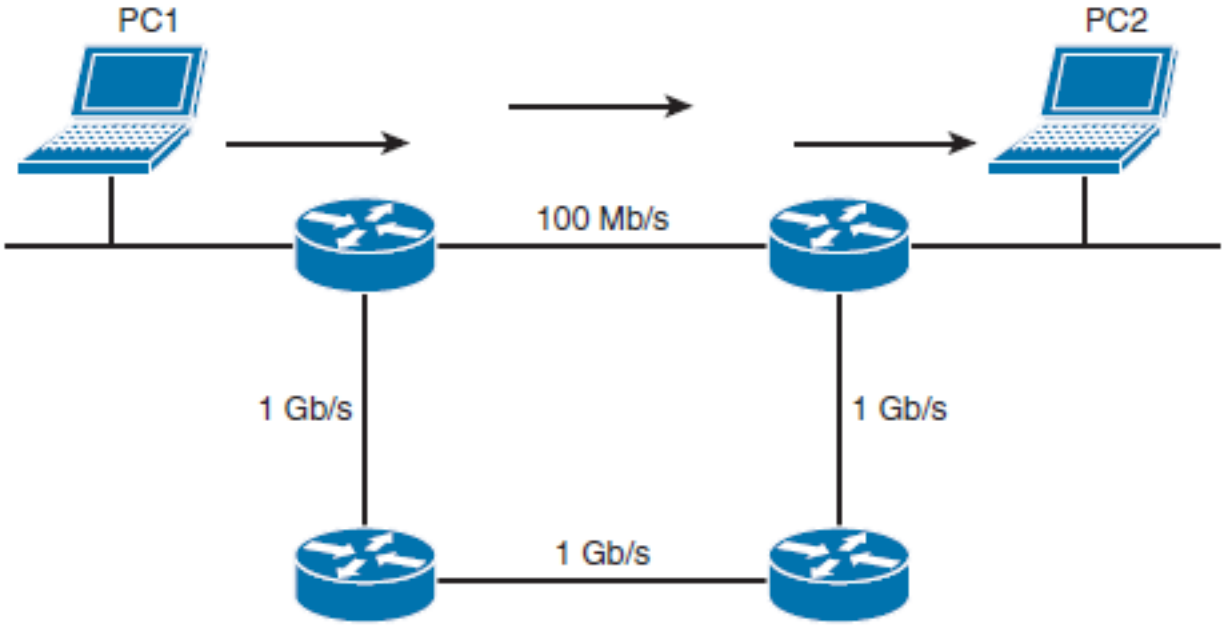
RIP Overview



- RIP uses hop count (the number of routers) as the metric.
- If a device has two paths to the destination network, the path with fewer hops will be chosen as the path to forward traffic.
- If a network is 16 or more hops away, the router considers it unreachable.

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RIP Overview

- As a routing loop-prevention technique, RIP implements split horizon. Split horizon prevents routing information from being sent out the same interface from which it was received.
- Split horizon with poison reverse is a similar technique but sends the update with a metric of 16, which is considered unreachable by RIP.
- RIP is also capable of load balancing traffic over equal-cost paths.
  - The default is four equal-cost paths.
  - If the maximum number of paths is set to one, load balancing is disabled.

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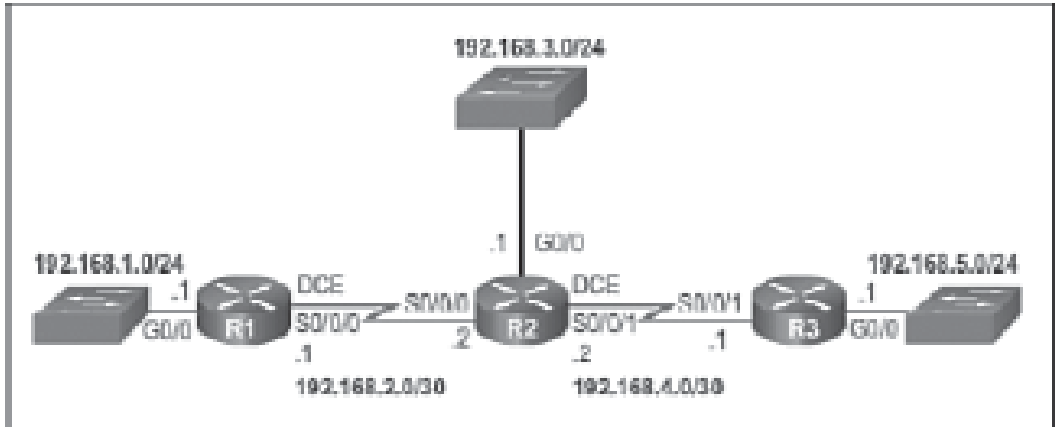
RIPv2 Configuration




```
R1(config)# router rip
R1(config-router)# network 192.168.1.0
R1(config-router)# network 192.168.2.0
R1(config-router)# version 2
R1(config-router)#
```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