Chapter 3: Branch Connections

Instructor Materials

CCNA Routing and Switching

Connecting Networks v6.0

Chapter 3: Branch Connections

Connecting Networks v6.0 Planning Guide

Chapter 3: Branch Connections

CCNA Routing and Switching

Connecting Networks v6.0

Chapter 3 - Sections & Objectives

- 3.1 Remote Access Connections
  - Select broadband remote access technologies to support business requirements.
    - Compare remote access broadband connection options for small to medium-sized businesses.
    - Select an appropriate broadband connection for a given network requirement.
- 3.2 PPPoE
  - Configure a Cisco router with PPPoE.
    - Explain how PPPoE operates.
    - Implement a basic PPPoE connection on a client router.
- 3.3 VPNs
  - Explain how VPNs secure site-to-site and remote access connectivity.
    - Describe benefits of VPN technology.
    - Describe site-to-site and remote access VPNs.

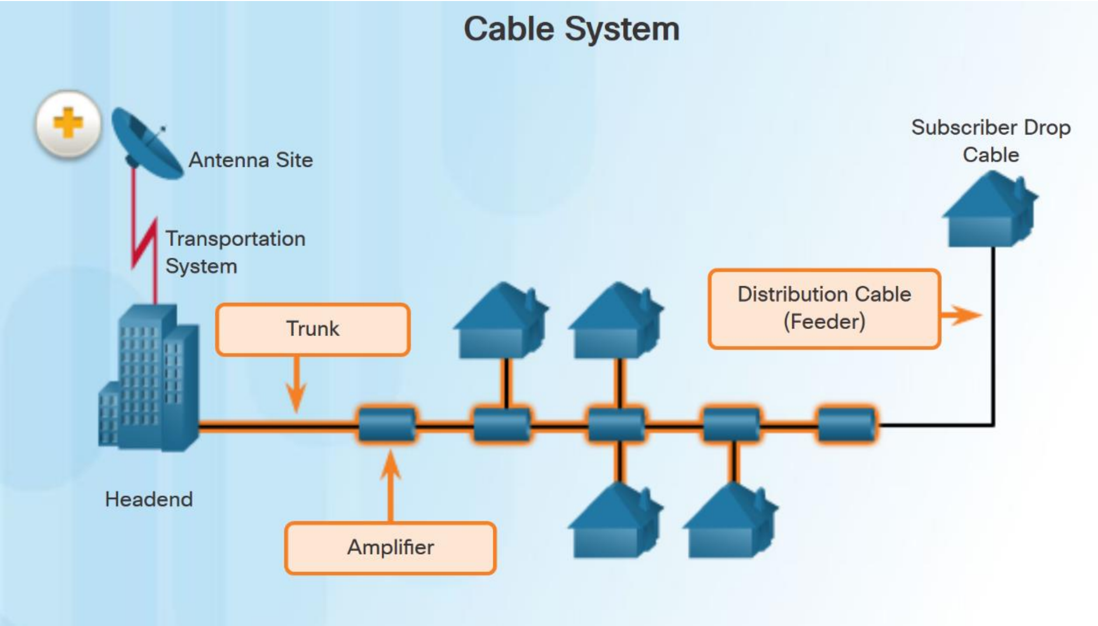
Chapter 3 - Sections & Objectives (Cont.)

- 3.4 GRE
  - Implement a GRE tunnel.
    - Explain the purpose and benefits of GRE tunnels.
    - Troubleshoot a site-to-site GRE tunnel.
- 3.5 eBGP
  - Implement eBGP in a single-homed remote access network.
    - Describe basic BGP features.
    - Explain BGP design considerations.
    - Configure an eBGP branch connection.

3.1 Remote Access Connections

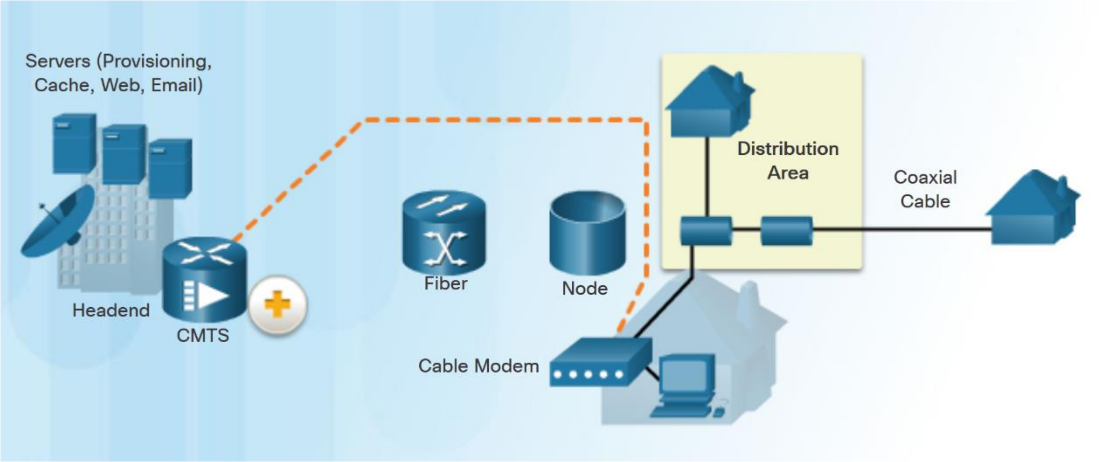
What is a Cable System?

- Cable system uses a coaxial cable that carries radio frequency (RF) signals across the network.
- Cable systems provide high-speed Internet access, digital cable television, and residential telephone service.
- Use hybrid fiber-coaxial (HFC) networks to enable high-speed transmission of data.



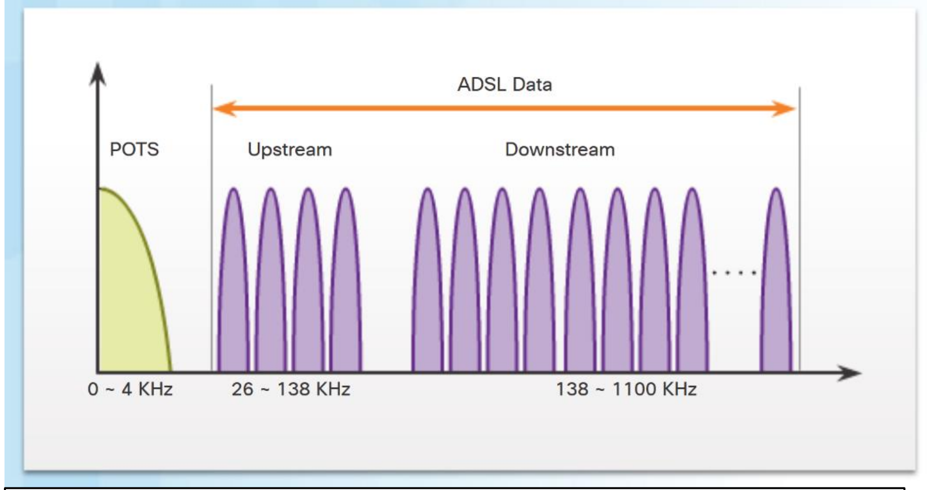
Cable Components

- Two types of equipment are required to send signals upstream and downstream on a cable system:
  - Cable Modem Termination System (CMTS) at the headend of the cable operator. The headend is a router with databases for providing Internet services to cable subscribers.
  - Cable Modem (CM) on the subscriber end.



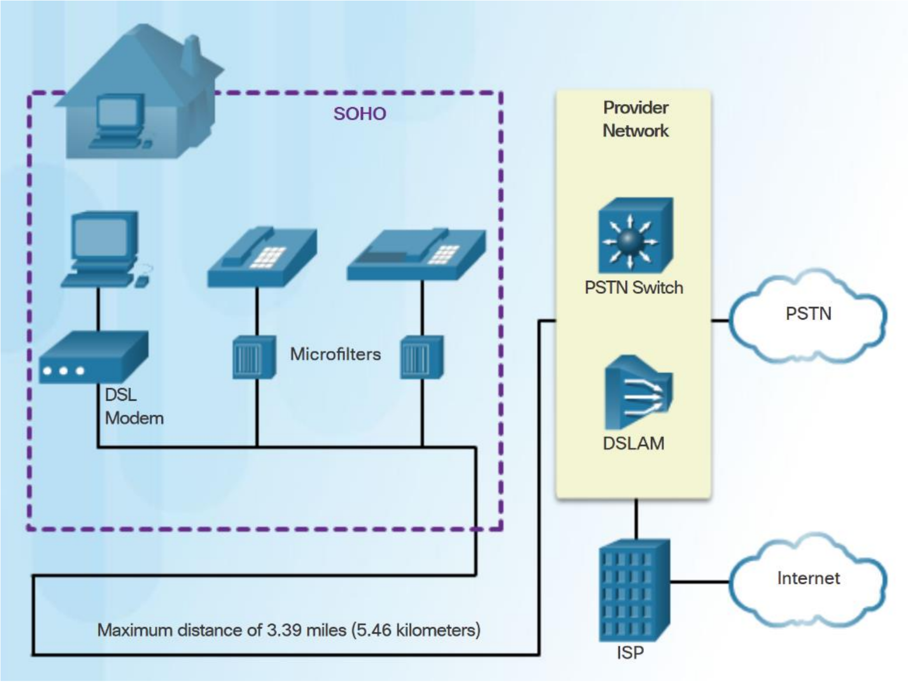
What is DSL?

- Digital Subscriber Line (DSL) is a means of providing high-speed connections over installed copper wires.
- Asymmetric DSL (ADSL) provides higher downstream bandwidth to the user than upload bandwidth.
- Symmetric DSL (SDSL) provides the same capacity in both directions.
- For satisfactory ADSL service, the local loop length must be less than 3.39 miles (5.46 km).



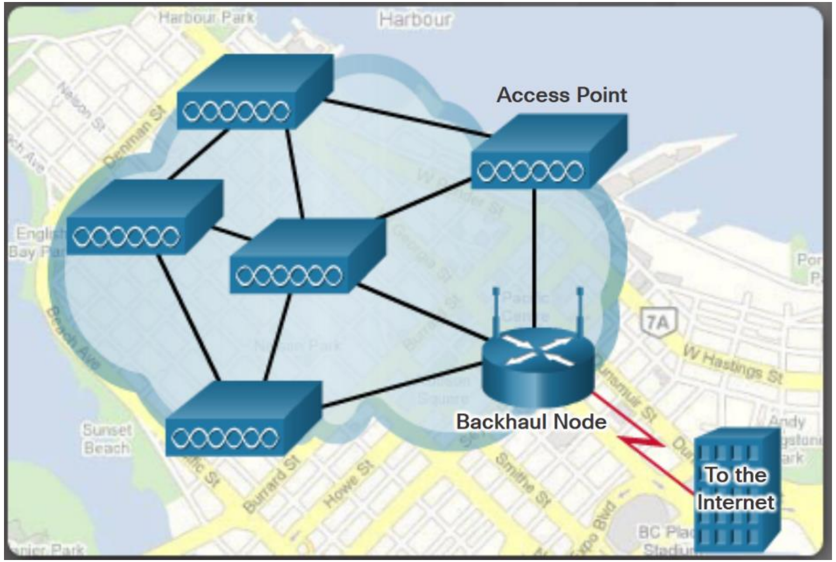
The figure shows a representation of bandwidth space allocation on a copper wire for ADSL. POTS (Plain Old Telephone System) identifies the frequency range used by the voice-grade telephone service. The area labeled ADSL represents the frequency space used by the upstream and downstream DSL signals.

Broadband Connections
DSL Connections



- The DSL connection is set up between the customer premises equipment (CPE) and the DSL access multiplexer (DSLAM) device located at the Central Office (CO).
- Key components in the DSL connection:
  - Transceiver - Usually a modem in a router which connects the computer of the teleworker to the DSL.
  - DSLAM - Located at the CO of the carrier, it combines individual DSL connections from users into one high-capacity link to an ISP.
- Advantage of DSL over cable technology is that DSL is not a shared medium. Each user has a separate direct connection to the DSLAM.

Wireless Connection



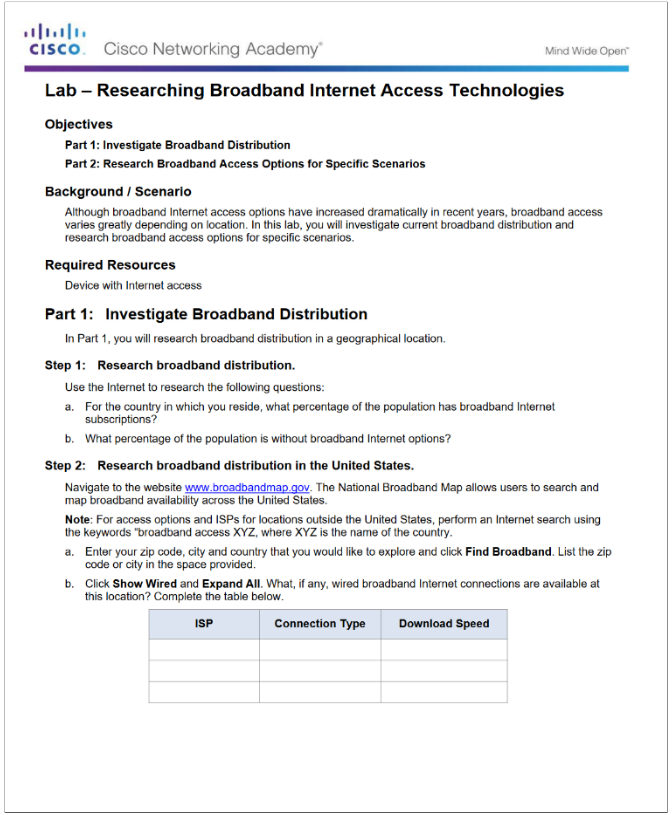
- Three main broadband wireless technologies:
  - **Municipal Wi-Fi** - Most municipal wireless networks use a mesh of interconnected access points as shown in figure.
  - **Cellular/mobile** - Mobile phones use radio waves to communicate through nearby cell towers. Cellular speeds continue to increase. LTE Category 10 supports up to 450 Mb/s download and 100 Mb/s upload.
  - **Satellite Internet** - Used in locations where land-based Internet access is not available. Primary installation requirement is for the antenna to have a clear view toward the equator.

Note: WiMAX has largely been replaced by LTE for mobile access, and cable or DSL for fixed access.

Comparing Broadband Solutions

- Factors to consider in selecting a broadband solution:
  - **Cable -** Bandwidth shared by many users, slow data rates during high-usage hours.
  - **DSL** - Limited bandwidth that is distance sensitive (in relation to the ISP’s central office).
  - **Fiber-to-the-Home** - Requires fiber installation directly to the home.
  - **Cellular/Mobile** - Coverage is often an issue.
  - **Wi-Fi Mesh** - Most municipalities do not have a mesh network deployed.
  - **Satellite** - Expensive, limited capacity per subscriber

Lab - Researching Broadband Internet Access Technologies



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Lab – Researching Broadband Internet Access Technologies

Objectives

Part 1: Investigate Broadband Distribution

Part 2: Research Broadband Access Options for Specific Scenarios

Background / Scenario

Although broadband Internet access options have increased dramatically in recent years, broadband access varies greatly depending on location. In this lab, you will investigate current broadband distribution and research broadband access options for specific scenarios.

Required Resources

Device with Internet access

Part 1: Investigate Broadband Distribution

In Part 1, you will research broadband distribution in a geographical location.

Step 1: Research broadband distribution.

Use the Internet to research the following questions:

a. For the country in which you reside, what percentage of the population has broadband Internet subscriptions?

b. What percentage of the population is without broadband Internet options?

Step 2: Research broadband distribution in the United States.

Navigate to the website www.broadbandmap.gov. The National Broadband Map allows users to search and map broadband availability across the United States.

Note: For access options and ISPs for locations outside the United States, perform an Internet search using the keywords "broadband access XYZ, where XYZ is the name of the country.

a. Enter your zip code, city and country that you would like to explore and click **Find Broadband**. List the zip code or city in the space provided.

b. Click **Show Wired** and **Expand All**. What, if any, wired broadband Internet connections are available at this location? Complete the table below.

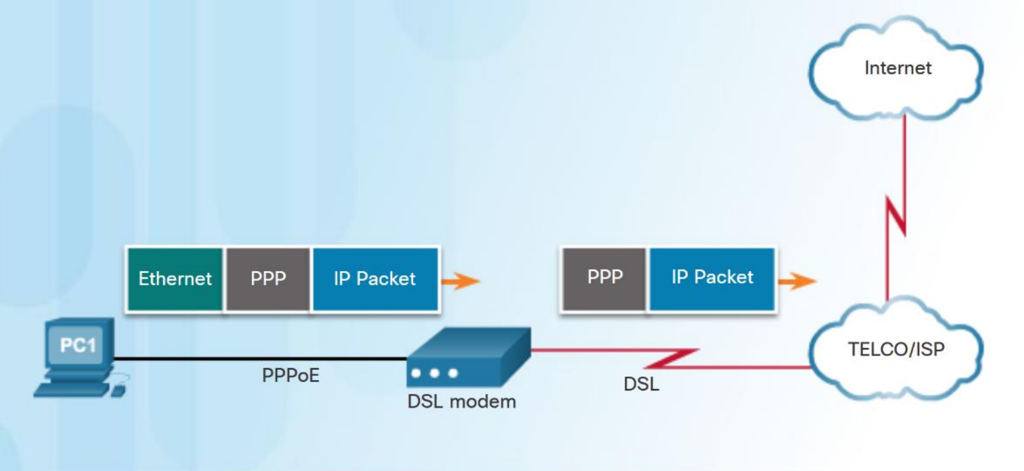
ISP	Connection Type	Download Speed

3.2 PPPoE

PPPoE Motivation

- PPP can be used on all serial links including those links created with dial-up analog and ISDN modems.
- ISPs often use PPP as the data link protocol over broadband connections.
  - ISPs can use PPP to assign each customer one public IPv4 address.
  - PPP supports CHAP authentication.
- Ethernet links do not natively support PPP.
  - PPP over Ethernet (PPPoE) provides a solution to this problem.

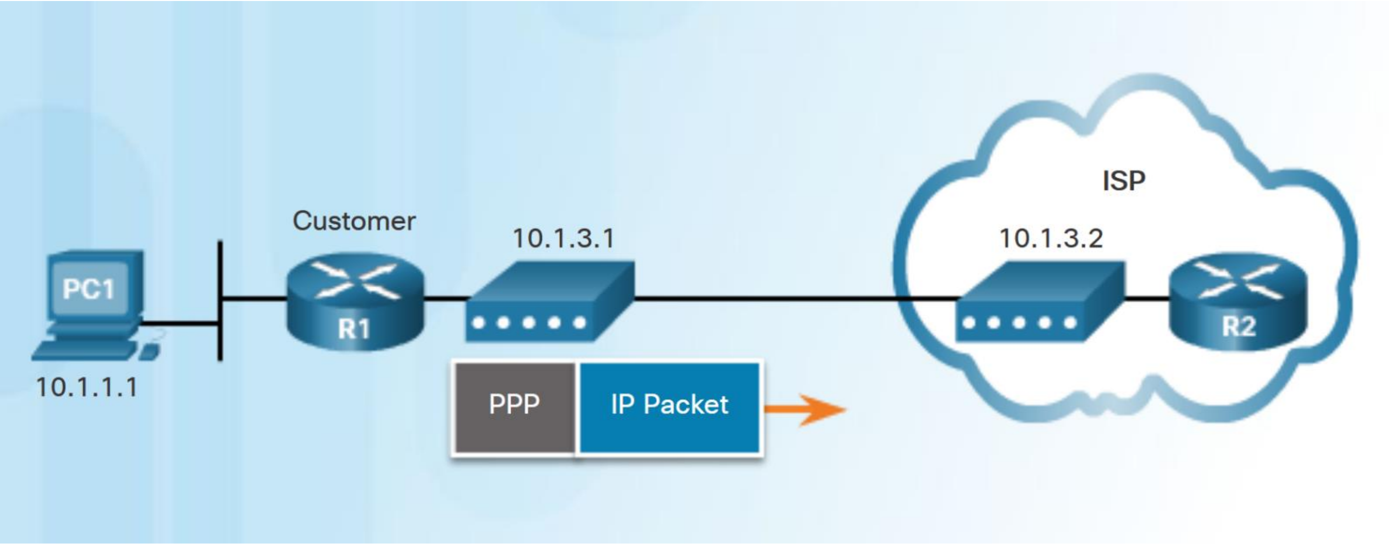
PPP Frames Over An Ethernet Connection



PC1 connects directly to a DSL modem. In a legacy dialup scenario, PC1 reaches the Internet through the TELCO/ISP cloud by using a modem.

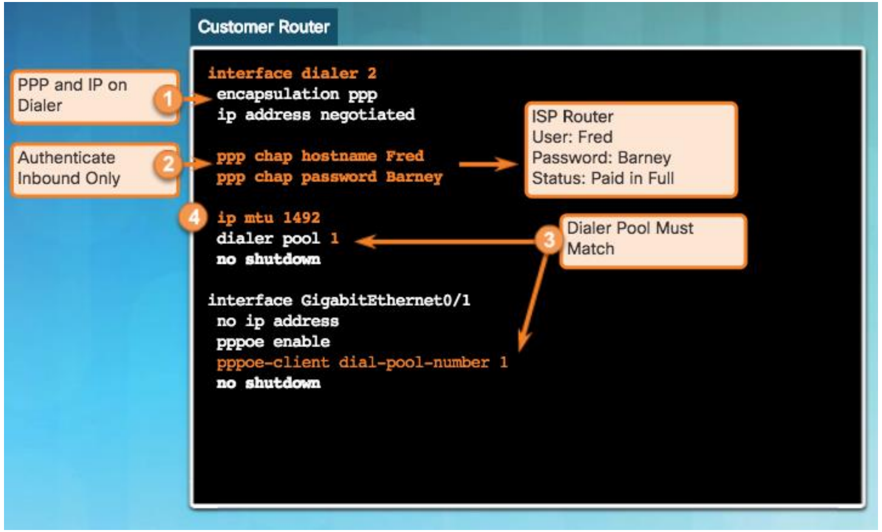
PPPoE Concepts

- PPPoE creates a PPP tunnel over an Ethernet connection.
- This allows PPP frames to be sent across the Ethernet cable to the ISP from the customer’s router.



Implement PPPoE

PPPoE Configuration



- To create the PPP tunnel a dialer interface is configured.
  - Use **interface dialer** *number* command
- The PPP CHAP is then configured. Use **ppp chap hostname** *name* and **ppp chap password** *password.*
- The physical Ethernet interface connected to the DSL modem is enabled with the command **pppoe enable** interface configuration command.
- Dialer interface is linked to the Ethernet interface with the **dialer pool** and **pppoe-client** interface configuration commands.
- The MTU should be set to 1492 to accommodate PPPoE headers.

PPPoE Verification

```
R1# show ip interface brief
Interface                  IP-Address      OK? Method Status                Protocol
Embedded-Service-Engine0/0 unassigned      YES unset  administratively down down
GigabitEthernet0/0         unassigned      YES unset  administratively down down
GigabitEthernet0/1         unassigned      YES unset  up                    up
Serial0/0/0                unassigned      YES unset  administratively down down
Serial0/0/1                unassigned      YES unset  administratively down down
Dialer2                    10.1.3.1        YES IPCP   up                    up
Virtual-Access1            unassigned      YES unset  up                    up
Virtual-Access2            unassigned      YES unset  up                    up
R1#
```

```
R1# show interface dialer 2
Dialer2 is up, line protocol is up (spoofing)
  Hardware is Unknown
  Internet address is 10.1.3.1/32
  MTU 1492 bytes, BW 56 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation PPP, LCP Closed, loopback not set
  Keepalive set (10 sec)
  DTR is pulsed for 1 seconds on reset

 <output omitted>
```

- Use the following commands to verify PPPoE:
  - **show ip interface brief -** verify the IPv4 address automatically assigned.
  - **show interface dialer -** verifies the MTU and PPP encapsulation.
  - **show ip route**
  - **show pppoe session -** displays information about currently active PPPoE sessions.

```
R1# show pppoe session
     1 client session

Uniq ID  PPPoE  RemMAC          Port                    VT  VA         State
           SID  LocMAC                                      VA-st      Type
    N/A      1  30f7.0da3.1641  Gi0/1                   Di2 Vi2        UP
                30f7.0da3.0da1                              UP
R1#
```

PPPoE Troubleshooting

- The following are possible causes of problems with PPPoE:
  - Failure in the PPP negotiation process
  - Failure in the PPP authentication process
  - Failure to adjust the TCP maximum segment size

PPPoE Negotiation

- Use the debug ppp negotiation command to verify PPP negotiation.
- Four possible points of failure in PPP negotiation:
  - No response from the remote device.
  - Link Control Protocol (LCP) not open.
  - Authentication failure.
  - IP Control Protocol (IPCP) failure.

```
R1# debug ppp negotiation
*Sep 20 19:05:05.239: Vi2 PPP: Phase is AUTHENTICATING, by the peer
*Sep 20 19:05:05.239: Vi2 LCP: State is Open
 <output omitted>
*Sep 20 19:05:05.247: Vi2 CHAP: Using hostname from interface CHAP
*Sep 20 19:05:05.247: Vi2 CHAP: Using password from interface CHAP
*Sep 20 19:05:05.247: Vi2 CHAP: O RESPONSE id 1 len 26 from "Fred"
*Sep 20 19:05:05.255: Vi2 CHAP: I SUCCESS id 1 len 4

*Sep 20 19:05:05.259: Vi2 IPCP:    Address 10.1.3.2 (0x03060A010302)
*Sep 20 19:05:05.259: Vi2 IPCP: Event[Receive ConfAck] State[ACKsent to Open]
*Sep 20 19:05:05.271: Vi2 IPCP: State is Open
*Sep 20 19:05:05.271: Di2 IPCP: Install negotiated IP interface address 10.1.3.2
*Sep 20 19:05:05.271: Di2 Added to neighbor route AVL tree: topoid 0, address 10.1.3.2
*Sep 20 19:05:05.271: Di2 IPCP: Install route to 10.1.3.2
R1# undebug all
```

PPPoE Authentication

- Verify that the CHAP username and password are correct using **debug ppp negotiation** command.

```
R1# debug ppp negotiation
*Sep 20 19:05:05.239: Vi2 PPP: Phase is AUTHENTICATING, by the peer
*Sep 20 19:05:05.239: Vi2 LCP: State is Open
 <output omitted>
*Sep 20 19:05:05.247: Vi2 CHAP: Using hostname from interface CHAP
*Sep 20 19:05:05.247: Vi2 CHAP: Using password from interface CHAP
*Sep 20 19:05:05.247: Vi2 CHAP: O RESPONSE id 1 len 26 from "Fred"
*Sep 20 19:05:05.255: Vi2 CHAP: I SUCCESS id 1 len 4
 <output omitted>
*Sep 20 19:05:05.259: Vi2 IPCP:    Address 10.1.3.2 (0x03060A010302)
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*Sep 20 19:05:05.271: Di2 IPCP: Install route to 10.1.3.2
R1# undebug all
```
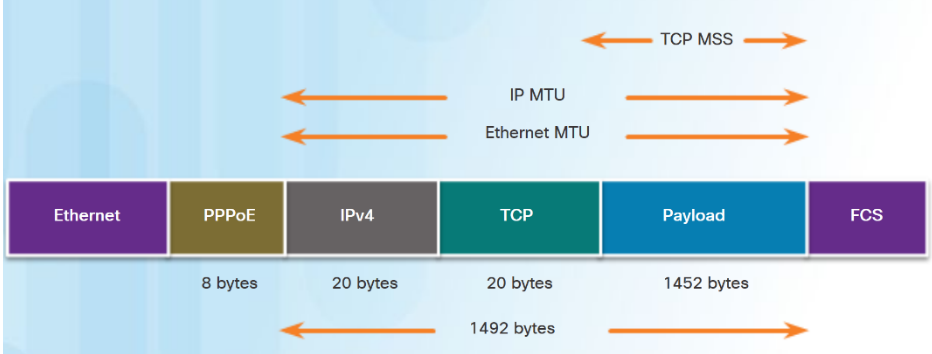

PPPoE MTU Size

- PPPoE supports an MTU of only 1492 bytes in order to accommodate the additional 8-byte PPPoE header.
- Use **show running-config** command to verify PPPoE MTU.
- The **ip tcp adjust-mss** *max-segment-size* interface command prevents TCP sessions from being dropped by adjusting the MSS value during the TCP 3-way handshake.

Adjusted maximum segment size with PPPoE Header




```
R1# show running-config | section interface Dialer2
interface Dialer2
 mtu 1492
 ip address negotiated
 encapsulation ppp

 <output omitted>
```

```
R1(config)# interface g0/0
R1(config-if)# ip tcp adjust-mss 1452
```


Lab - Configuring a Router as a PPPoE Client for DSL Connectivity

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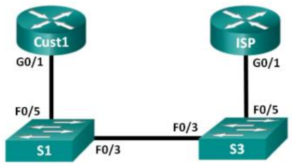
Lab – Configuring a Router as a PPPoE Client for DSL Connectivity

Topology



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
Cust1	G0/1	Learned via PPP	Learned via PPP	Learned via PPP
ISP	G0/1	N/A	N/A	N/A

Objectives

Part 1: Build the Network

Part 2: Configure the ISP Router

Part 3: Configure the Cust1 Router

Background / Scenario

ISPs often use Point-to-Point Protocol over Ethernet (PPPoE) on DSL links to their customers. PPP supports the assignment of IP address information to a device at the remote end of a PPP link. More importantly, PPP supports CHAP authentication. ISPs can check accounting records to see if a customer's bill has been paid, before letting them connect to the Internet.

In this lab, you will configure both the client and ISP side of the connection to set up PPPoE. Typically, you would only configure the client end.

Note: The routers used with CCNA hands-on labs are Cisco 1941 Integrated Services Routers (ISRs) with Cisco IOS Release 15.2(4)M3 (universalk9 image). The switches used are Cisco Catalyst 2960s with Cisco IOS Release 15.0(2) (lanbasek9 image). Other routers, switches, and Cisco IOS versions can be used. Depending on the model and Cisco IOS version, the commands available and output produced might vary from what is shown in the labs. Refer to the Router Interface Summary Table at the end of this lab for the correct interface identifiers.

Note: Ensure that the routers and switches have been erased and have no startup configurations. If you are unsure, contact your instructor.

Implement PPPoE

Lab - Troubleshoot PPPoE

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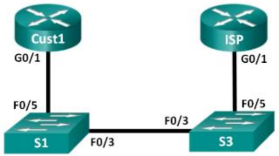
Lab – Troubleshoot PPPoE

Topology



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
Cust1	G0/1	Learned via PPP	Learned via PPP	Learned via PPP
ISP	G0/1	N/A	N/A	N/A

Objectives

Part 1: Build the Network

Part 2: Troubleshoot PPPoE on Cust1

Background / Scenario

ISPs sometimes use Point-to-Point Protocol over Ethernet (PPPoE) on DSL links to their customers. PPP supports the assignment of IP address information to a device at the remote end of a PPP link. More importantly, PPP supports CHAP authentication. ISPs can check accounting records to see if a customer's bill has been paid, before letting them connect to the Internet.

In this lab, you will troubleshoot the Cust1 router for PPPoE configuration problems.

Note: The routers used with CCNA hands-on labs are Cisco 1941 Integrated Services Routers (ISRs) with Cisco IOS Release 15.2(4)M3 (universalk9 image). The switches used are Cisco Catalyst 2960s with Cisco IOS Release 15.0(2) (lanbasek9 image). Other routers, switches, and Cisco IOS versions can be used. Depending on the model and Cisco IOS version, the commands available and output produced might vary from what is shown in the labs. Refer to the Router Interface Summary Table at the end of this lab for the correct interface identifiers.

Note: Ensure that the routers and switches have been erased and have no startup configurations. If you are unsure, contact your instructor.

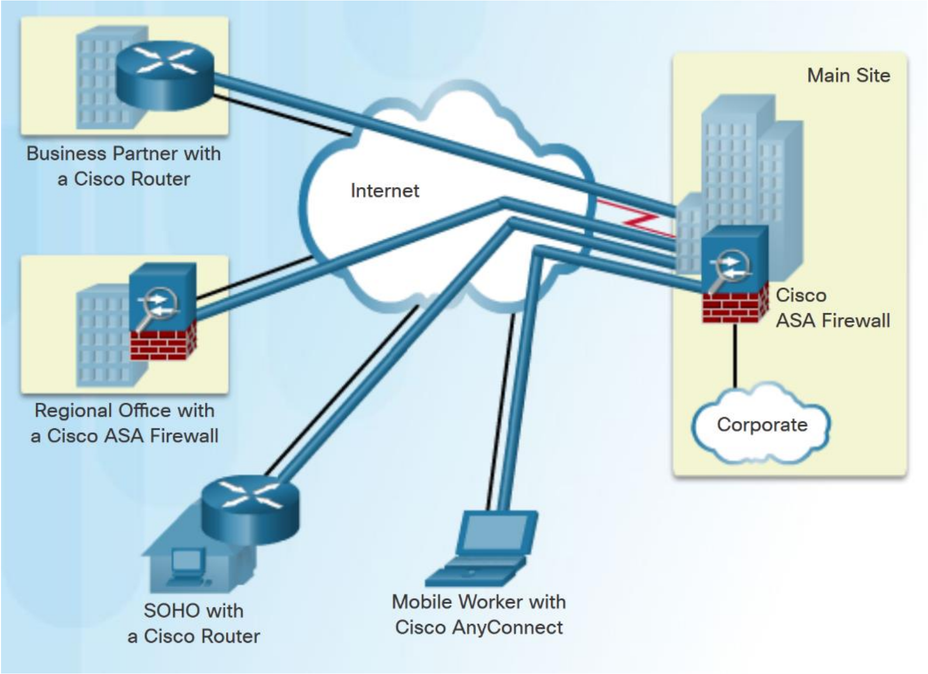
Required Resources

- 2 Routers (Cisco 1941 with Cisco IOS Release 15.2(4)M3 universal image or comparable)
- 2 Switches (Cisco 2960 with Cisco IOS Release 15.0(2) lanbasek9 image or comparable)
- Console cables to configure the Cisco IOS devices via the console ports

3.3 VPNs

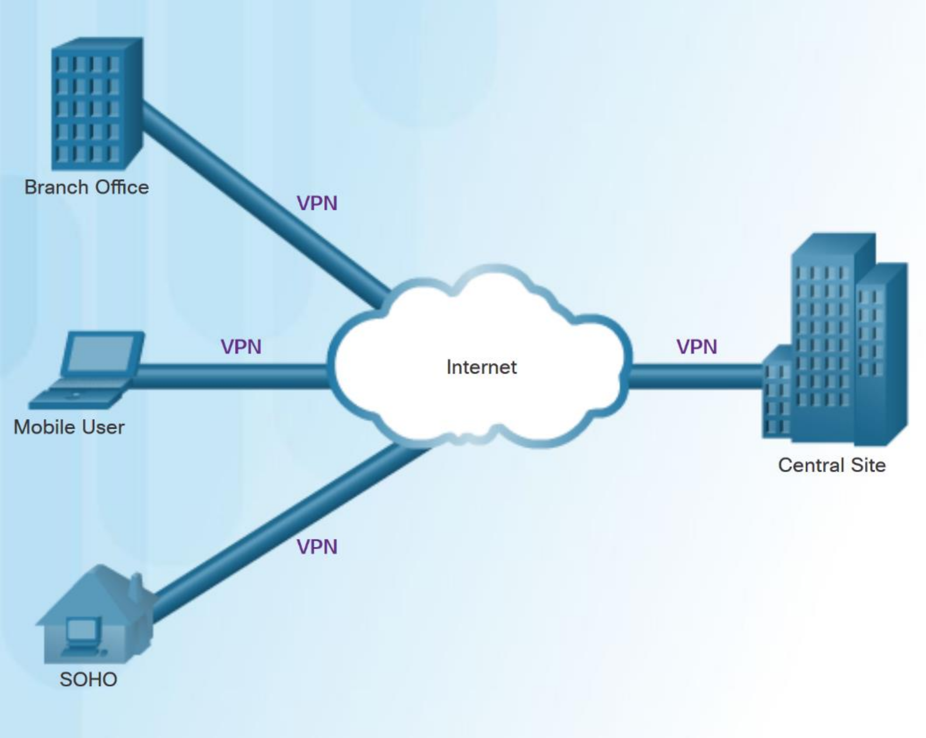
Introducing VPNs

- A VPN is a private network created via tunneling over a public network, usually the Internet.
- A secure implementation of VPN with encryption, such as IPsec VPNs, is what is usually meant by virtual private networking.
- To implement VPNs, a VPN gateway is necessary - could be a router, a firewall, or a Cisco Adaptive Security Appliance (ASA).



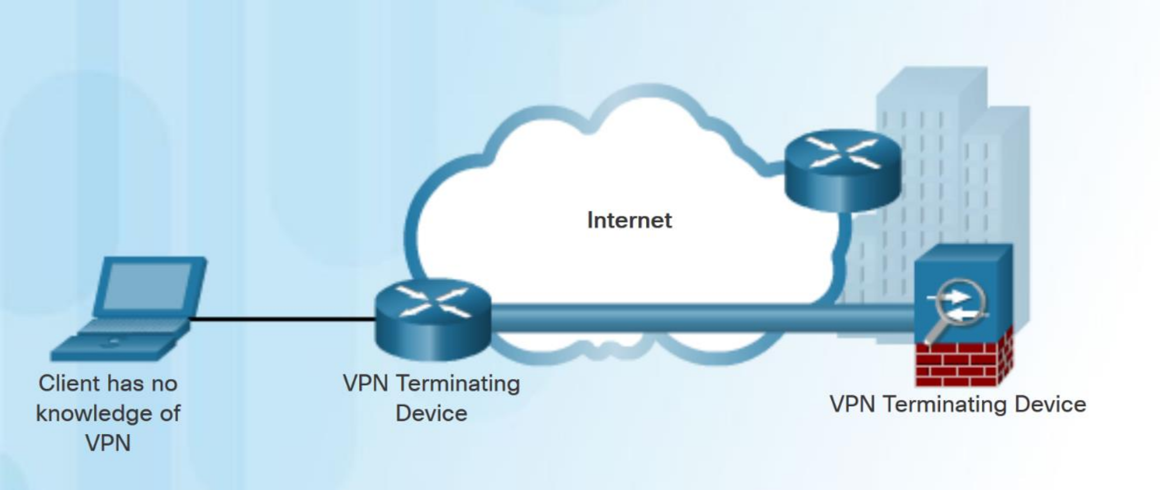
Benefits of VPNs

- The benefits of a VPN include the following:
  - **Cost savings** - VPNs enable organizations to use cost-effective, high-bandwidth technologies, such as DSL to connect remote offices and remote users to the main site.
  - **Scalability** - Organizations are able to add large amounts of capacity without adding significant infrastructure.
  - **Compatibility with broadband technology** - Allow mobile workers and telecommuters to take advantage of high-speed, broadband connectivity.
  - **Security** - VPNs can use advanced encryption and authentication protocols.



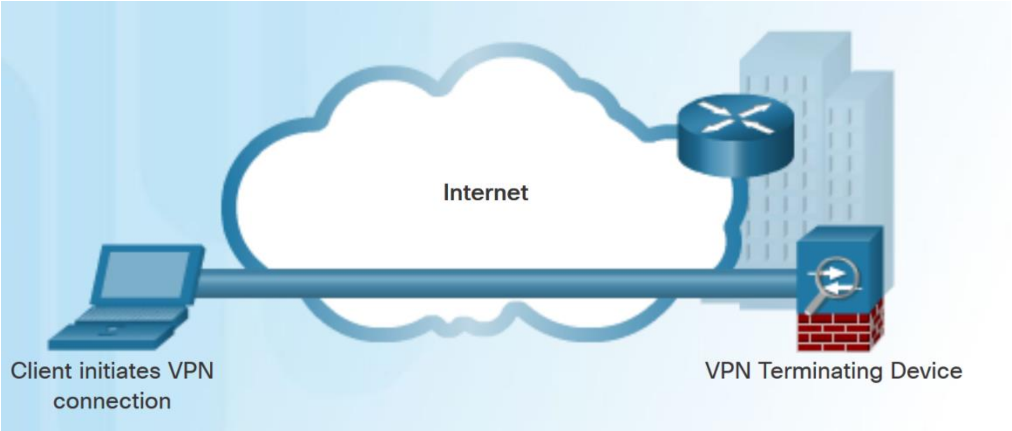
Site-to-Site VPNs

- Site-to-site VPNs connect entire networks to each other, for example, connecting a branch office network to a company headquarters network.
- In a site-to-site VPN, end hosts send and receive normal TCP/IP traffic through a VPN “gateway”.
- The VPN gateway is responsible for encapsulating and encrypting outbound traffic.



Remote Access VPNs

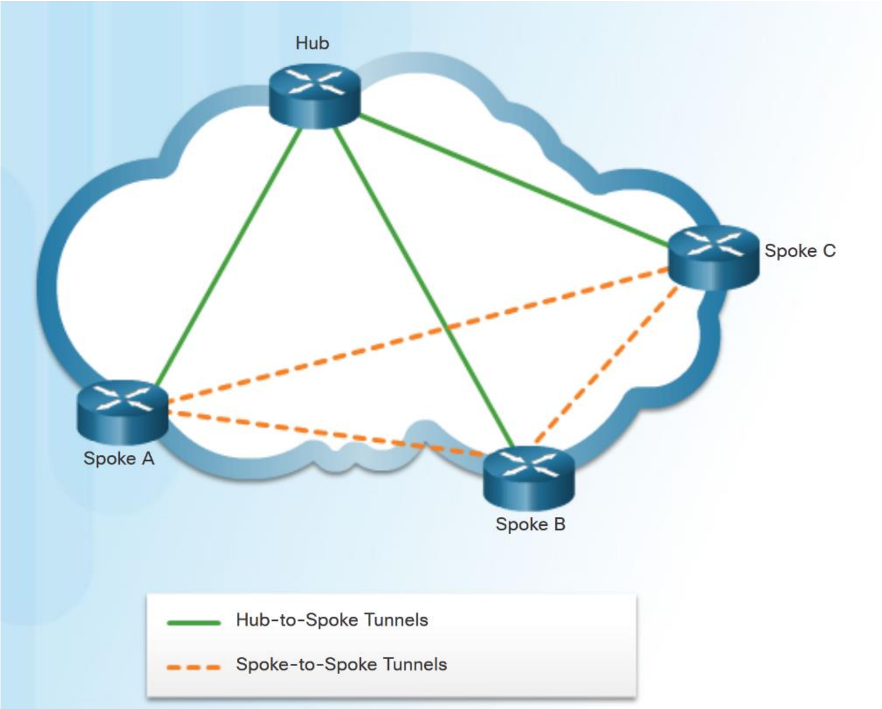
- A remote-access VPN supports the needs of telecommuters, mobile users, and extranet traffic.
- Allows for dynamically changing information, and can be enabled and disabled.
- Used to connect individual hosts that must access their company network securely over the Internet.
- VPN client software may need to be installed on the mobile user's end device.



Types of VPNs

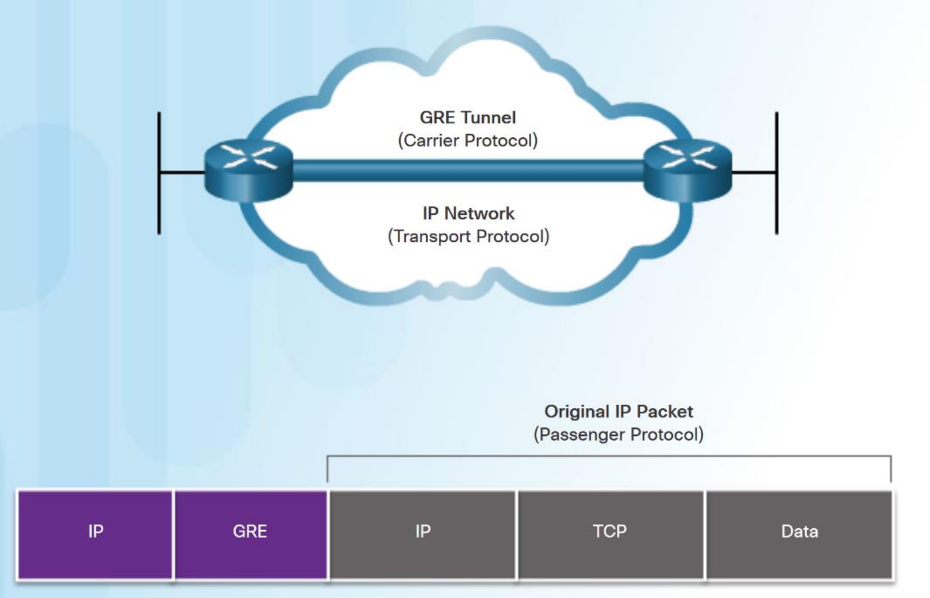
DMVPN

- Dynamic Multipoint VPN (DMVPN) is a Cisco software solution for building multiple VPNs.
- DMVPN is built using the following technologies:
  - **Next Hop Resolution Protocol (NHRP)** - NHRP creates a distributed mapping database of public IP addresses for all tunnel spokes.
  - **Multipoint Generic Routing Encapsulation (mGRE) tunnels** - An mGRE tunnel interface allows a single GRE interface to support multiple IPsec tunnels.
  - **IP Security (IPsec) encryption -** provides secure transport of private information over public networks.



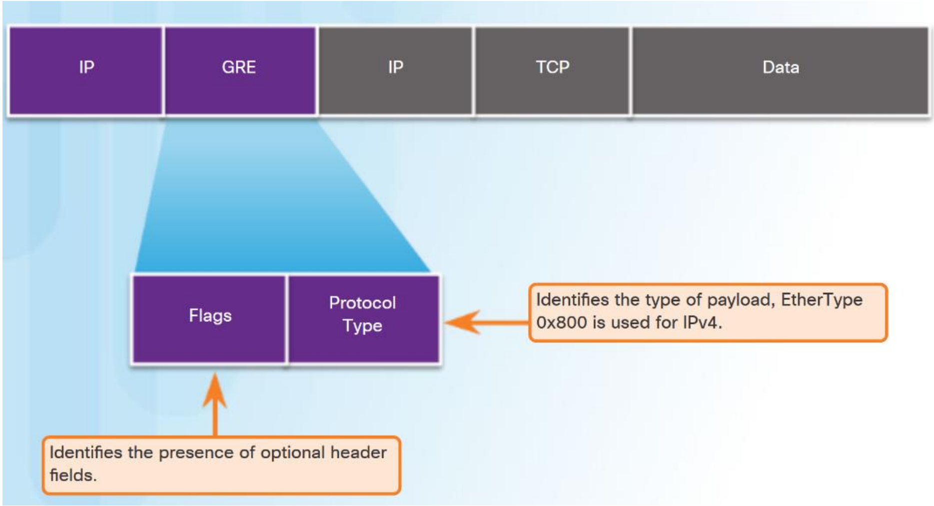
3.4 GRE

GRE Introduction



- Generic Routing Encapsulation (GRE) is a non-secure, site-to-site VPN tunneling protocol.
- Developed by Cisco.
- GRE manages the transportation of multiprotocol and IP multicast traffic between two or more sites
- A tunnel interface supports a header for each of the following:
  - An encapsulated protocol - or passenger protocol, such as IPv4, IPv6.
  - An encapsulation protocol - or carrier protocol, such as GRE.
  - A transport delivery protocol, such as IP.

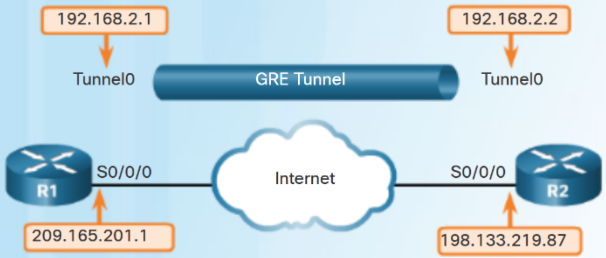
GRE Characteristics



- GRE is defined as an IETF standard (RFC 2784).
- In the outer IP header, 47 is used in the protocol field.
- GRE encapsulation uses a protocol type field in the GRE header to support the encapsulation of any OSI Layer 3 protocol.
- GRE is stateless.
- GRE does not include any strong security mechanisms.
- GRE header, together with the tunneling IP header, creates at least 24 bytes of additional overhead for tunneled packets.

Configure GRE

GRE Tunnel Configuration



R1 Configuration

```
R1(config)# interface Tunnel0
R1(config-if)# tunnel mode gre ip
R1(config-if)# ip address 192.168.2.1 255.255.255.0
R1(config-if)# tunnel source 209.165.201.1
R1(config-if)# tunnel destination 198.133.219.87
R1(config-if)# router ospf 1
R1(config-router)# network 192.168.2.0 0.0.0.255 area 0
```

```
R2(config)# interface Tunnel0
R2(config-if)# tunnel mode gre ip
R2(config-if)# ip address 192.168.2.2 255.255.255.0
R2(config-if)# tunnel source 198.133.219.87
R2(config-if)# tunnel destination 209.165.201.1
R2(config-if)# router ospf 1
R2(config-router)# network 192.168.2.0 0.0.0.255 area 0
```

- Five steps to configuring a GRE tunnel:
  - Step 1. Create a tunnel interface using the **interface tunnel** *number* command.
  - Step 2. Configure an IP address for the tunnel interface. (Usually a private address)
  - Step3. Specify the tunnel source IP address.
  - Step 4. Specify the tunnel destination IP address.
  - Step 5. (Optional) Specify GRE tunnel mode as the tunnel interface mode.

Note: The tunnel source and tunnel destination commands reference the IP addresses of the preconfigured physical interfaces.

Verify GRE

- Use the **show ip interface brief** command to verify that the tunnel interface is up.
- Use the **show interface tunnel** command to verify the state of the tunnel.
- Use the **show ip ospf neighbor** command to verify that an OSPF adjacency has been established over the tunnel interface.

```
R1# show ip interface brief | include Tunnel

Tunnel0              192.168.2.1     YES manual up        up
```

```
R1# show interface Tunnel 0
Tunnel0 is up, line protocol is up
  Hardware is Tunnel
  Internet address is 192.168.2.1/24
  MTU 17916 bytes, BW 100 Kbit/sec, DLY 50000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation TUNNEL, loopback not set
  Keepalive not set
  Tunnel source 209.165.201.1, destination 209.165.201.2
  Tunnel protocol/transport GRE/IP

<output omitted>
```

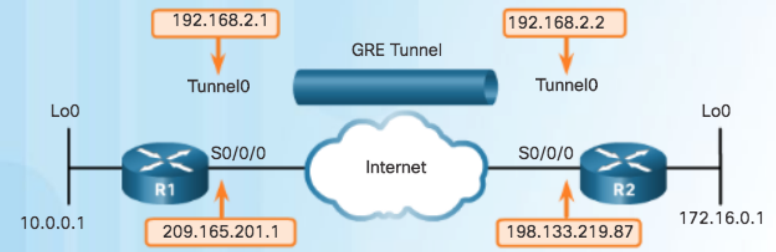
```
R1# show ip ospf neighbor

Neighbor ID     Pri State           Dead Time   Address         Interface
209.165.201.2     0   FULL/  -      00:00:37    192.168.2.2      Tunnel0
```

Troubleshoot GRE

- Issues with GRE are usually due to one or more of the following:
  - The tunnel interface IP addresses are not on the same network or the subnet masks do not match. Use the **show ip interface brief** command.
  - The interfaces for the tunnel source and/or destination are not configured with the correct IP address or are down. Use the **show ip interface brief** command.
  - Static or dynamic routing is not properly configured. Use **show ip route** or **show ip ospf neighbor.**

Verify that All Necessary Interfaces are Up




```
R1# show ip interface brief
<output omitted>
Interface              IP-Address      OK? Method Status                Protocol
Serial0/0/0            209.165.201.1   YES manual up                    up
Loopback0              10.0.0.1        YES manual up                    up
Tunnel0                192.168.2.1     YES manual up                    up
R1#
```

```
R2# show ip interface brief
<output omitted>
Interface              IP-Address      OK? Method Status                Protocol
Serial0/0/0            198.133.219.87  YES manual up                    up
Loopback0              172.16.0.1      YES manual up                    up
Tunnel0                192.168.2.2     YES manual up                    up
R2#
```

Implement GRE

Packet Tracer - Configuring GRE

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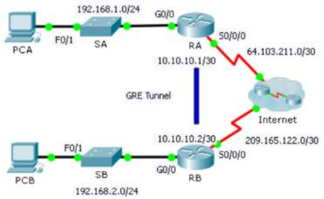
Packet Tracer – Configuring GRE

Topology



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
RA	G0/0	192.168.1.1	255.255.255.0	N/A
	S0/0/0	64.103.211.2	255.255.255.252	N/A
	Tunnel 0	10.10.10.1	255.255.255.252	N/A
RB	G0/0	192.168.2.1	255.255.255.0	N/A
	S0/0/0	209.165.122.2	255.255.255.252	N/A
	Tunnel 0	10.10.10.2	255.255.255.252	N/A
PC-A	NIC	192.168.1.2	255.255.255.0	192.168.1.1
PC-C	NIC	192.168.2.2	255.255.255.0	192.168.2.1

Objectives

Part 1: Verify Router Connectivity

Part 2: Configure GRE Tunnels

Part 3: Verify PC Connectivity

Scenario

You are the network administrator for a company which wants to set up a GRE tunnel to a remote office. Both networks are locally configured, and need only the tunnel configured.

Packet Tracer - Troubleshooting GRE

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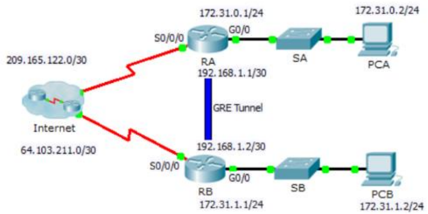
Packet Tracer – Troubleshooting GRE

Topology



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
RA	G0/0	172.31.0.1	255.255.255.0	N/A
	S0/0/0	209.165.122.2	255.255.255.252	N/A
	Tunnel 0	192.168.1.1	255.255.255.252	N/A
RB	G0/0	172.31.1.1	255.255.255.0	N/A
	S0/0/0	64.103.211.2	255.255.255.252	N/A
	Tunnel 0	192.168.1.2	255.255.255.252	N/A
PC-A	NIC	172.31.0.2	255.255.255.0	172.31.0.1
PC-C	NIC	172.31.1.2	255.255.255.0	172.31.1.1

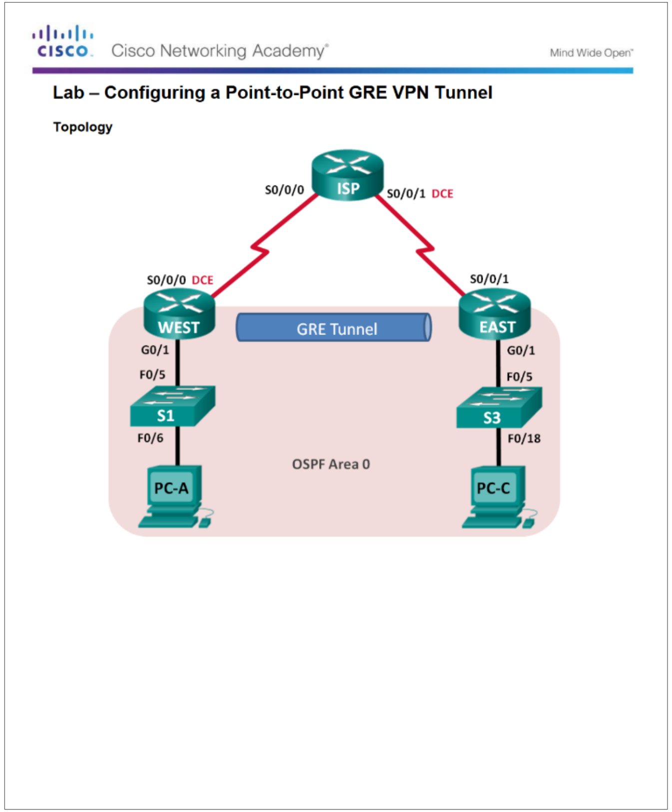
Objectives

- Find and Correct All Network Errors
- Verify Connectivity

Scenario

A junior network administrator was hired to set up a GRE tunnel between two sites and was unable to complete the task. You have been asked to correct configuration errors in the company network.

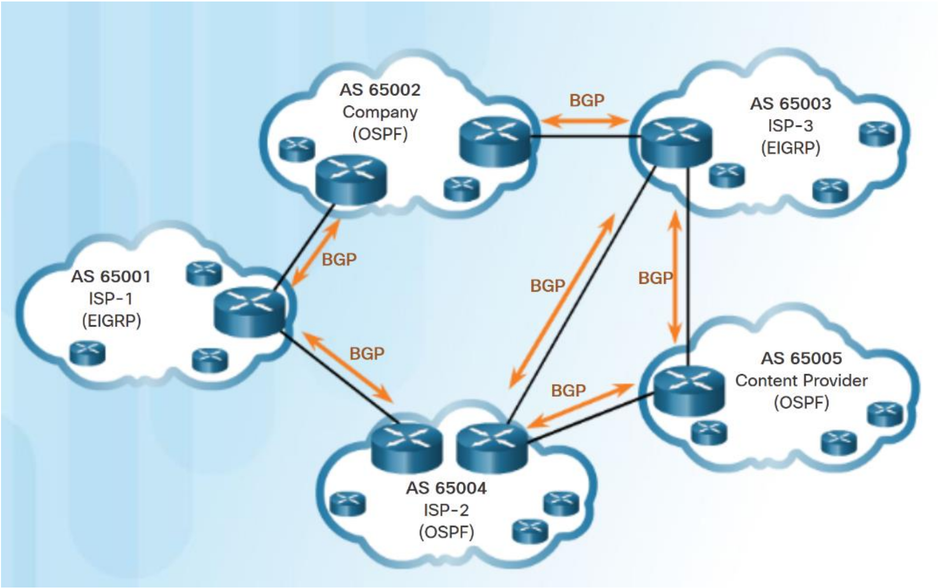
Lab – Configuring a Point-to-Point GRE VPN Tunnel



3.5 eBGP

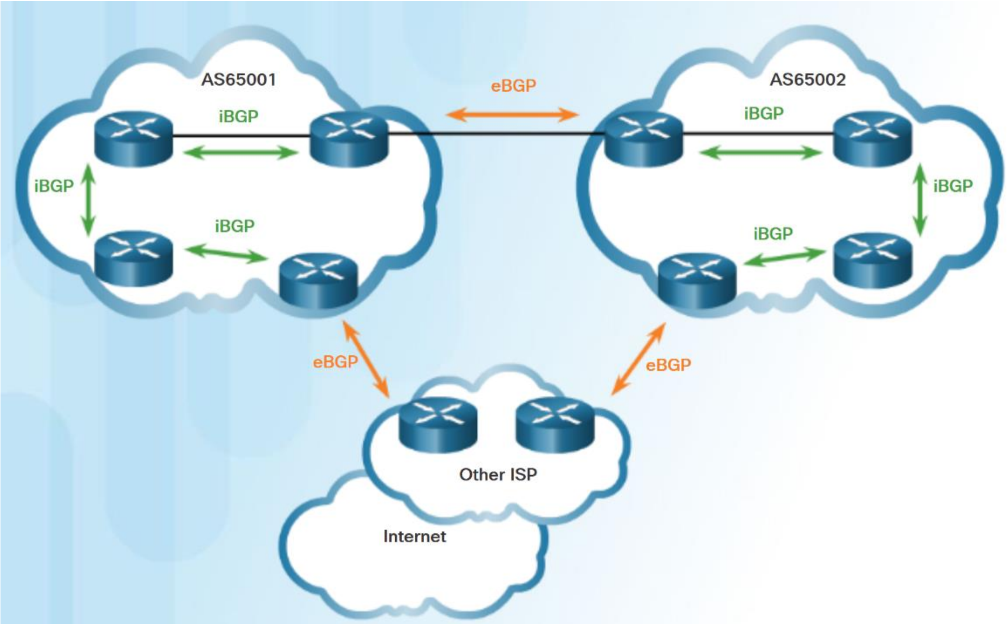
IGP and EGP Routing Protocols

- IGPs are used to exchange routing information within a company network or an autonomous system (AS).
- An Exterior Gateway Protocol (EGP) is used for the exchange of routing information between autonomous systems, such as ISPs.
- Border Gateway Protocol (BGP) is an Exterior Gateway Protocol (EGP).
  - Every AS is assigned a unique 16-bit or 32-bit AS number which uniquely identifies it on the Internet.



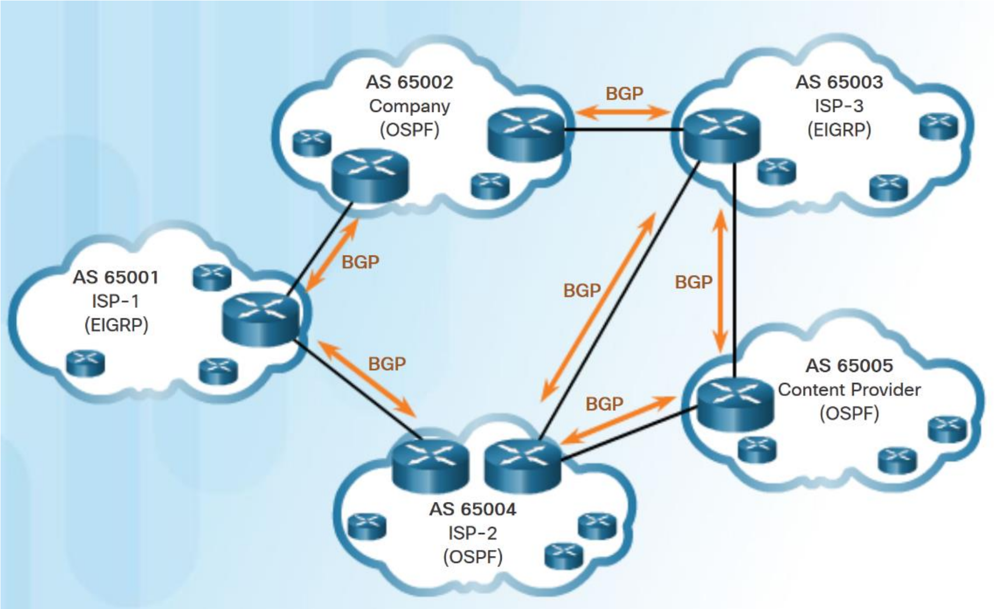
eBGP and iBGP

- **External BGP (eBGP)** – External BGP is the routing protocol used between routers in different autonomous systems.
- **Internal BGP (iBGP)** - Internal BGP is the routing protocol used between routers in the same AS.
- Two routers exchanging BGP routing information are known as BGP peers



When to use BGP

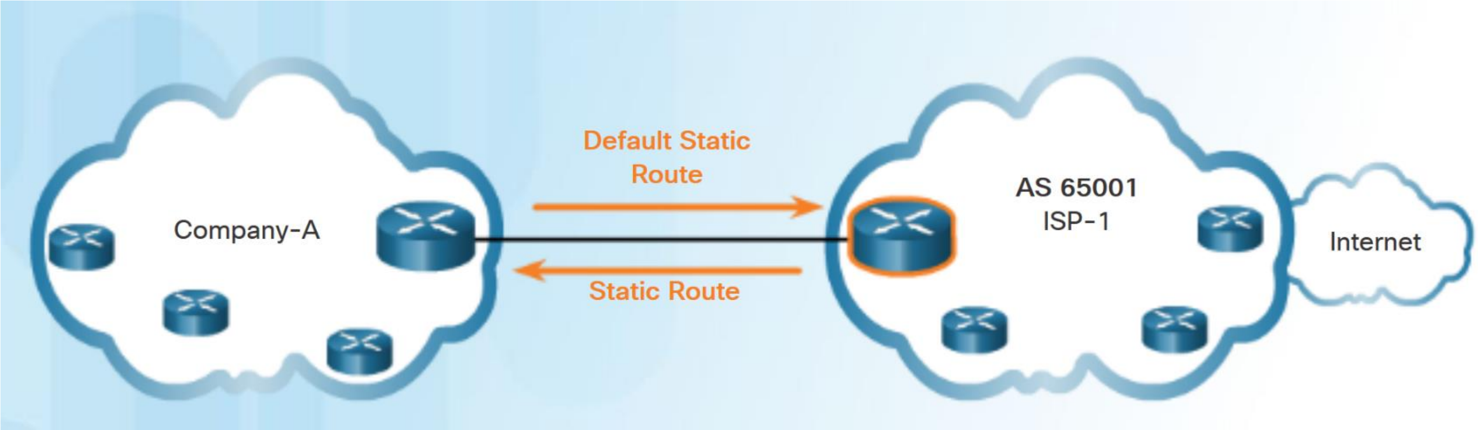
- BGP is used when an AS has connections to multiple autonomous systems. This is known as multi-homed.
- A misconfiguration of a BGP router could have negative effects throughout the Internet.



When not to use BGP

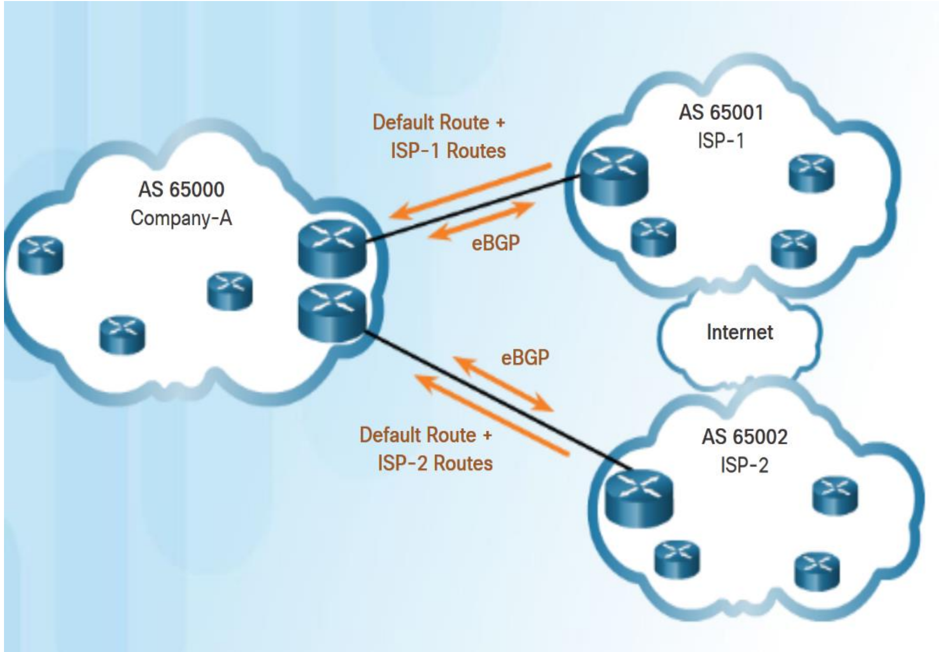
- BGP should not be used when one of the following conditions exist:
  - There is a single connection to the Internet or another AS. Known as single-homed.
  - When there is a limited understanding of BGP.

Note: Although it is recommended only in unusual situations, for the purposes of this course, you will configure single-homed BGP.



BGP Options

- Three common ways an organization can implement BGP in a multi-homed environment:
  - Default Route Only
  - Default Route and ISP Routes
  - All Internet Routes (this would include routes to over 550,000 networks)



Steps to Configure eBGP

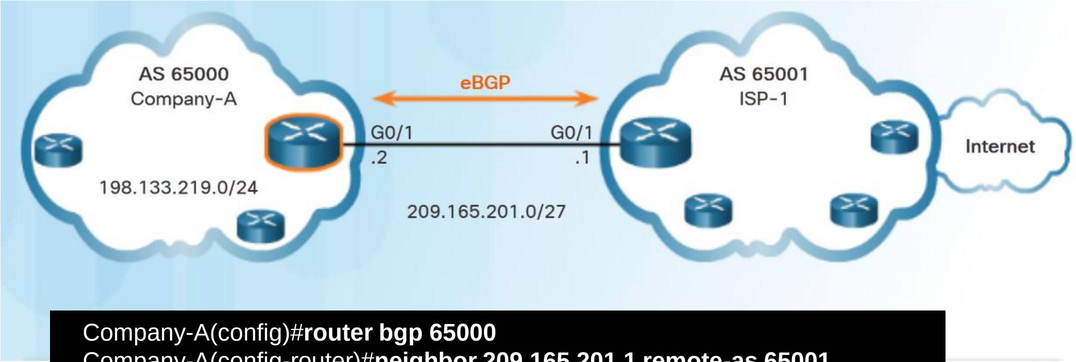
- To implement eBGP:
  - Enable BGP routing.
  - Configure BGP neighbor(s) (peering)
  - Advertise network(s) originating from this AS.

Command	Description
Router(config)# **router bgp** *as-number*	Enables a BGP routing process, and places the router in router configuration mode.
Router(config-router)# **neighbor** *ip-address* **remote-as** *as-number*	Specifies a BGP neighbor. The as-number is the neighbor's AS number.
Router(config-router)# **network** *network-address* [**mask** *network-mask*]	Advertises a network address to an eBGP neighbor as being originated by this AS. The network-mask is the subnet mask of the network.

BGP Sample Configuration

- The **router bgp** *as-number* global configuration command enables BGP and identifies the AS number.
- The **neighbor** *ip-address* **remote-as** *as-number* router configuration command identifies the BGP peer and its AS number.
- The **network** *network-address* [**mask** *network-mask*] router configuration command enters the network-address into the local BGP table.

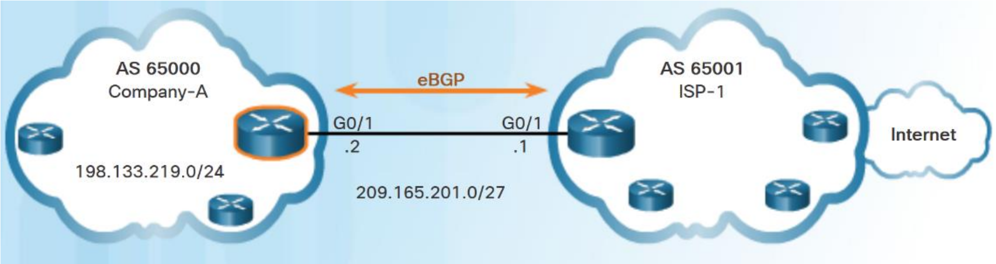
Note: The network-address used in the network command does not have to be a directly connected network.




```
Company-A(config)#router bgp 65000
Company-A(config-router)#neighbor 209.165.201.1 remote-as 65001
Company-A(config-router)#network 198.133.219.0 mask 255.255.255.0
```

```
ISP-1(config)#router bgp 65001
ISP-1(config-router)#neighbor 209.165.201.2 remote-as 65000
ISP-1(config-router)#network 0.0.0.0
```

Verify eBGP



- Three commands to verify eBGP:
  - **show ip route**
  - **show ip bgp**
  - **show ip bgp summary**

```
Company-A# show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
<output omitted>

Gateway of last resort is 209.165.201.1 to network 0.0.0.0
B*    0.0.0.0/0 [20/0] via 209.165.201.1, 00:36:03
      10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        198.133.219.0/24 is directly connected, GigabitEthernet0/0
L        198.133.219.1/32 is directly connected, GigabitEthernet0/0
      209.165.201.0/24 is variably subnetted, 2 subnets, 2 masks
C        209.165.201.0/27 is directly connected, GigabitEthernet0/1
L        209.165.201.2/32 is directly connected, GigabitEthernet0/1
Company-A#
```

```
Company-A# show ip bgp
BGP table version is 3, local router ID is 209.165.201.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
*>   0.0.0.0          209.165.201.1            0             0 65001 i
*>   198.133.219.0/24 0.0.0.0                  0         32768 i
Company-A#
```

```
Company-A# show ip bgp summary
BGP router identifier 209.165.201.2, local AS number 65000
BGP table version is 3, main routing table version 3
2 network entries using 288 bytes of memory
2 path entries using 160 bytes of memory
2/2 BGP path/bestpath attribute entries using 320 bytes of memory
1 BGP AS-PATH entries using 24 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 792 total bytes of memory
BGP activity 2/0 prefixes, 2/0 paths, scan interval 60 secs

Neighbor        V     AS MsgRcvd MsgSent   TblVer  InQ OutQ  Up/Down  State/PfxRcd
209.165.201.1   4  65001      66      66        3    0    0 00:56:11             1
Company-A#
```


Packet Tracer - Configure and Verify eBGP

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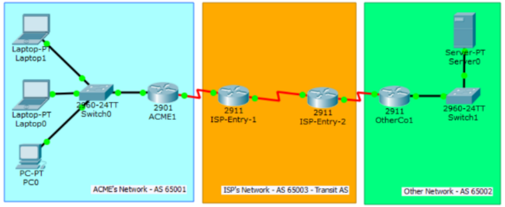
Packet Tracer - Configure and Verify eBGP

Topology



Objectives

Configure and verify eBGP between two autonomous systems.

Background / Scenario

In this activity, you will configure and verify the operation of eBGP between autonomous systems 65001 and 65002. ACME Inc. is a company that has a partnership with Other Company and must exchange routes. Both companies have their own autonomous systems and will use ISP as the transit AS to reach each other.

Note: Only companies with very large networks can afford their own autonomous system.

Lab - Configure and Verify eBGP

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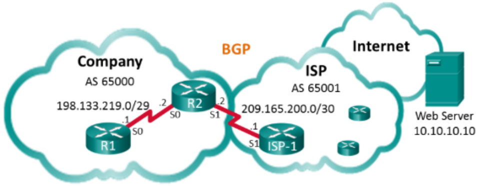
Lab - Configure and Verify eBGP

Topology



Addressing Table

Device	Interface	IP Address	Subnet Mask
R1	S0/0/0 (DCE)	198.133.219.1	255.255.255.248
R2	S0/0/0	198.133.219.2	255.255.255.248
	S0/0/1 (DCE)	209.165.200.2	255.255.255.252
ISP-1	S0/0/1	209.165.200.1	255.255.255.252
Web Server		10.10.10.10	255.255.255.255

Objectives

Part 1: Build the Network and Configure Basic Device Settings

Part 2: Configure eBGP on R1

Part 3: Verify eBGP Configuration

Background / Scenario

In this lab you will configure eBGP for the Company. The ISP will provide the default route to the Internet. After the configuration is complete, you will use various **show** commands to verify that the eBGP configuration is working as expected.

Required Resources

- 3 Routers (Cisco 1941 with Cisco IOS Release 15.2(4)M3 universal image or comparable)
- Console cables to configure the Cisco IOS devices via the console ports
- Serial cables as shown in the topology

3.6 Chapter Summary

Packet Tracer - Skills Integration Challenge

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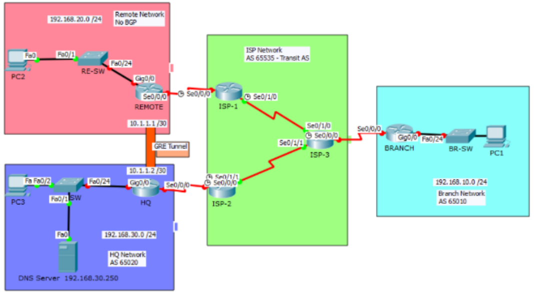
Packet Tracer – Skills Integration Challenge

Topology



Lab - Configure a Branch Connection

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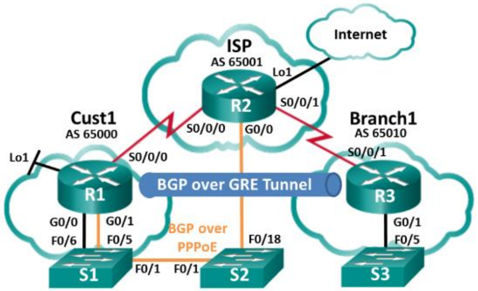
Lab – Configure a Branch Connection

Topology



Addressing Table

Device	Interface	IP Address	Subnet Mask
R1	G0/0	192.168.1.1	255.255.255.0
	G0/1	PPPoE Client	
	Lo1	209.165.200.49	255.255.255.240
	S0/0/0 (DCE)	209.165.200.81	255.255.255.252
R2	G0/0	PPPoE Provider	
	Lo1	209.165.200.65	255.255.255.240
	S0/0/0	209.165.200.82	255.255.255.252
	S0/0/1 (DCE)	209.165.200.85	255.255.255.252
R3	G0/1	192.168.3.1	255.255.255.0
	S0/0/1 (DCE)	209.165.200.86	255.255.255.252

Objectives

Part 1: Build the Network and Load Device Configurations

Chapter 3: Branch Connections

- Select broadband remote access technologies to support business requirements.
- Configure a Cisco router with PPPoE.
- Explain how VPNs secure site-to-site and remote access connectivity.
- Implement a GRE tunnel.
- Implement eBGP in a single-homed remote access network.

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