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12.9.1

Packet Tracer - Implement a Subnetted IPv6 Addressing Scheme

Your network administrator wants you to assign five /64 IPv6 subnets to the network shown in the topology. Your job is to determine the IPv6 subnets, assign IPv6 addresses to the routers, and set the PCs to automatically receive IPv6 addressing. Your final step is to verify connectivity between IPv6 hosts.

Implement a Subne...

Implement a Subne...

12.9.2

Lab - Configure IPv6 Addresses on Network Devices

Skills Practice Opportunity

You have the opportunity to practice the following skills:

- Part 1: Set Up Topology and Configure Basic Router and Switch Settings

- Part 2: Configure IPv6 Addresses Manually
- Part 3: Verify End-to-End Connectivity

You can practice these skills using the Packet Tracer or lab equipment, if available.

Packet Tracer - Physical Mode (PTPM)

Configure IPv6 Add...

Configure IPv6 Add...

Lab Equipment

Configure IPv6 Add...

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What did I learn in this module?

IPv4 Issues

IPv4 has a theoretical maximum of 4.3 billion addresses. Private addresses in combination with NAT have helped to slow the depletion of IPv4 address space. With an increasing internet population, a limited IPv4 address space, issues with NAT and the IoT, the time has come to begin the transition to IPv6. Both IPv4 and IPv6 will coexist in the near future and the transition will take several years. The IETF has created various protocols and tools to help network administrators migrate their networks to IPv6. The migration techniques can be divided into three categories: dual stack, tunneling, and translation.

IPv6 Address Representation

IPv6 addresses are 128 bits in length and written as a string of hexadecimal values. Every 4 bits is represented by a single hexadecimal digit; for a total of 32

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hexadecimal values. The preferred format for writing an IPv6 address is x:x:x:x:x:x:x:x, with each “x” consisting of four hexadecimal values. For example: 2001:0db8:0000:1111:0000:0000:0000:0200. Two rules that help to reduce the number of digits needed to represent an IPv6 address. The first rule to help reduce the notation of IPv6 addresses is to omit any leading 0s (zeros) in any hextet. For example: 2001:db8:0:1111:0:0:0:200. The second rule to help reduce the notation of IPv6 addresses is that a double colon (::) can replace any single, contiguous string of one or more 16-bit hextets consisting of all zeros. For example: 2001:db8:0:1111::200.

IPv6 Address Types

There are three types of IPv6 addresses: unicast, multicast, and anycast. IPv6 does not use the dotted-decimal subnet mask notation. Like IPv4, the prefix length is represented in slash notation and is used to indicate the network portion of an IPv6 address. An IPv6 unicast address uniquely identifies an interface on an IPv6-enabled device. IPv6 addresses typically have two unicast addresses: GUA and LLA. IPv6 unique local addresses have the following uses: they are used for local addressing within a site or between a limited number of sites, they can be used for devices that will never need to access another network, and they are not globally routed or translated to a global IPv6 address. IPv6 global unicast addresses (GUAs) are globally unique and routable on the IPv6 internet. These addresses are equivalent to public IPv4 addresses. A GUA has three parts: a global routing prefix, a subnet ID, and an interface ID. An IPv6 link-local address (LLA) enables a device to communicate with other IPv6-enabled devices on the same link and only on that link (subnet). Devices can obtain an LLA either statically or dynamically.

GUA and LLA Static Configuration

The Cisco IOS command to configure an IPv4 address on an interface is **ip address** *ip-address subnet-mask*. In contrast, the command to configure an IPv6 GUA on an interface is **ipv6 address** *ipv6-address/prefix-length*. Just as with IPv4, configuring static addresses on clients does not scale to larger environments. For this reason, most network administrators in an IPv6 network will enable dynamic assignment of IPv6 addresses. Configuring the LLA manually lets you create an address

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that is recognizable and easier to remember. Typically, it is only necessary to create recognizable LLAs on routers. LLAs can be configured manually using the **ipv6 address** *ipv6-link-local-address* **link-local** command.

Dynamic Addressing for IPv6 GUAs

A device obtains a GUA dynamically through ICMPv6 messages. IPv6 routers periodically send out ICMPv6 RA messages, every 200 seconds, to all IPv6-enabled devices on the network. An RA message will also be sent in response to a host sending an ICMPv6 RS message, which is a request for an RA message. The ICMPv6 RA message includes: network prefix and prefix length, default gateway address, and the DNS addresses and domain name. RA messages have three methods: SLAAC, SLAAC with a stateless DHCPv6 server, and stateful DHCPv6 (no SLAAC). With SLAAC, the client device uses the information in the RA message to create its own GUA because the message contains the prefix and the interface ID. With SLAAC with stateless DHCPv6 the RA message suggests devices use SLAAC to create their own IPv6 GUA, use the router LLA as the default gateway address, and use a stateless DHCPv6 server to obtain other necessary information. With stateful DHCPv6 the RA suggests that devices use the router LLA as the default gateway address, and the stateful DHCPv6 server to obtain a GUA, a DNS server address, domain name and all other necessary information. The interface ID can be created using the EUI-64 process or a randomly generated 64-bit number. The EUIs process uses the 48-bit Ethernet MAC address of the client and inserts another 16 bits in the middle of MAC address to create a 64-bit interface ID. Depending upon the operating system, a device may use a randomly generated interface ID.

Dynamic Addressing for IPv6 LLAs

All IPv6 devices must have an IPv6 LLA. An LLA can be configured manually or created dynamically. Operating systems, such as Windows, will typically use the same method for both a SLAAC-created GUA and a dynamically assigned LLA. Cisco routers automatically create an IPv6 LLA whenever a GUA is assigned to the interface. By default, Cisco IOS routers use EUI-64 to generate the Interface ID for all LLAs on IPv6 interfaces. For serial interfaces, the router will use the MAC address of an Ethernet interface. To make it easier to recognize and remember these addresses on routers, it is common

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to statically configure IPv6 LLAs on routers. To verify IPv6 address configuration use the following three commands: **show ipv6 interface brief**, **show ipv6 route**, and **ping**.

IPv6 Multicast Addresses

There are two types of IPv6 multicast addresses: well-known multicast addresses and solicited node multicast addresses. Assigned multicast addresses are reserved multicast addresses for predefined groups of devices. Well-known multicast addresses are assigned. Two commonIPv6 assigned multicast groups are: ff02::1 All-nodes multicast group and ff02::2 All-routers multicast group. A solicited-node multicast address is similar to the all-nodes multicast address. The advantage of a solicited-node multicast address is that it is mapped to a special Ethernet multicast address.

Subnet an IPv6 Network

IPv6 was designed with subnetting in mind. A separate subnet ID field in the IPv6 GUA is used to create subnets. The subnet ID field is the area between the Global Routing Prefix and the interface ID. The benefit of a 128-bit address is that it can support more than enough subnets and hosts per subnet for each network. Address conservation is not an issue. For example, if the global routing prefix is a /48, and using a typical 64 bits for the interface ID, this will create a 16-bit subnet ID:

- 16-bit subnet ID - Creates up to 65,536 subnets.
- 64-bit interface ID - Supports up to 18 quintillion host IPv6 addresses per subnet (i.e., 18,000,000,000,000,000,000).

With over 65,536 subnets to choose from, the task of the network administrator becomes one of designing a logical scheme to address the network. Address conservation is not a concern when using IPv6. Similar to configuring IPv4, each router interface can be configured to be on a different IPv6 subnet.

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Module Quiz - IPv6 Addressing

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1. What is the valid most compressed format possible of the IPv6 address 2001:0DB8:0000:AB00:0000:0000:0000:1234?

- 2001:DB8::AB00::1234
- 2001:DB8:0:AB:0:1234
- 2001:DB8:0:AB::1234
- 2001:DB8:0:AB00::1234

2. What is the prefix associated with the IPv6 address 2001:DB8:D15:EA:CC44::1/64?

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- 2001:DB8::/64
- 2001:DB8:D15:EA:CC44::/64

3. What type of address is automatically assigned to an interface when IPv6 is enabled on that interface?

- unique local
- global unicast
- link-local
- loopback

4. Which IPv6 network prefix is only intended for local links and can not be routed?

- FC00::/7
- FF00::/12
- 2001::/3
- FE80::/10

5. What is the purpose of the command **ping ::1**?

- It tests the reachability of the default gateway for the network.
- It tests the multicast connectivity to all hosts on the subnet.

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It tests the internal configuration of an IPv6 host.

It tests the broadcast capability of all hosts on the subnet.

6. What is the interface ID of the IPv6 address 2001:DB8::1000:A9CD:47FF:FE57:FE94/64?

- 47FF:FE57:FE94
- 1000:A9CD:47FF:FE57:FE94
- FE57:FE94
- A9CD:47FF:FE57:FE94
- FE94

7. What is the network address for the IPv6 address 2001:DB8:AA04:B5::1/64?

- 2001::/64
- 2001:DB8::/64
- 2001:DB8:AA04::/64
- 2001:DB8:AA04:B5::/64

8. Which address type is not supported in IPv6?

- unicast
- private
- broadcast
- multicast

9. What is indicated by a successful ping to the ::1 IPv6 address?

- The link-local address is correctly configured.
- All hosts on the local link are available.
- The host is cabled properly.
- The default gateway address is correctly configured.
- IP is properly installed on the host.

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10. What is the most compressed representation of the IPv6 address 2001:0db8:0000:abcd:0000:0000:0000:0001?

- 2001:db8::abcd:0:1
- 2001:db8:0:abcd::1
- 2001:0db8:abcd::1
- 2001:0db8:0000:abcd::1
- 2001:0db8:abcd::0001

11. What is the minimum configuration for a router interface that is enabled for IPv6?

- to have both an IPv4 and an IPv6 address
- to have both a link-local and a global unicast IPv6 address
- to have a link-local IPv6 address
- to have a self-generated loopback address

12. At a minimum, which address is required on IPv6-enabled interfaces?

- unique local
- global unicast
- link-local
- site local

13. What are three parts of an IPv6 global unicast address? (Choose three.)

- [x] a subnet ID that is used to identify networks inside of the local enterprise site
- [ ] a global routing prefix that is used to identify the portion of the network address provided by a local administrator
- [x] a global routing prefix that is used to identify the network portion of the address that has been provided by an ISP
- [ ] an interface ID that is used to identify the local network for a particular host
- [x]

an interface ID that is used to identify the local host on the network

14. Your organization is issued the IPv6 prefix of 2001:db8:130f::/48 by your service provider. With this prefix, how many bits are available for your organization to create /64 subnetworks if interface ID bits are not borrowed?

- 16
- 8
- 80
- 128

15. Which type of IPv6 address is not routable and used only for communication on a single subnet?

- global unicast address
- unspecified address
- link-local address
- unique local address
- loopback address

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