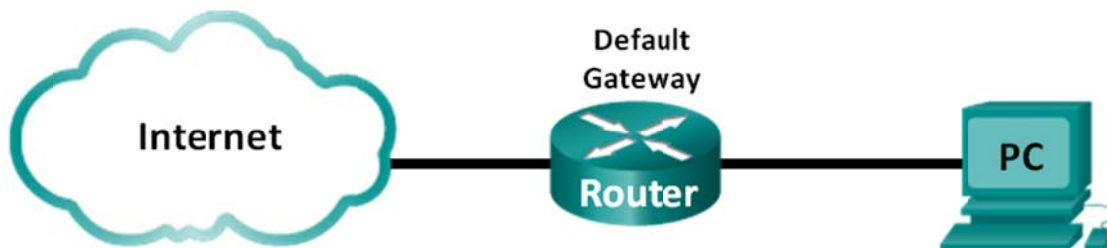


Lab – Identifying IPv6 Addresses (Instructor Version)

Instructor Note: Red font color or Gray highlights indicate text that appears in the instructor copy only.

Topology



Objectives

Part 1: Identify the Different Types of IPv6 Addresses

- Review the different types of IPv6 addresses.
- Match the IPv6 address with the correct type.

Part 2: Examine a Host IPv6 Network Interface and Address

- Check PC IPv6 network address settings.

Part 3: Practice IPv6 Address Abbreviation

- Study and review the rules for IPv6 address abbreviation.
- Practice compressing and decompressing IPv6 addresses.

Part 4: Identify the Hierarchy of the IPv6 Global Unicast Address Network Prefix

- Study and review the hierarchy of the IPv6 network prefix.
- Practice deriving network prefix information from an IPv6 address.

Background / Scenario

With the depletion of the Internet Protocol version 4 (IPv4) network address space and the adoption and transition to IPv6, networking professionals must understand how both IPv4 and IPv6 networks function. Many devices and applications already support IPv6. This includes extensive Cisco device Internetwork Operating System (IOS) support and workstation/server operating system support, such as that found in Windows and Linux.

This lab focuses on IPv6 addresses and the components of the address. In Part 1, you will identify the IPv6 address types, and in Part 2, you will view the IPv6 settings on a PC. In Part 3, you will practice IPv6 address abbreviation, and in Part 4, you will identify the parts of the IPv6 network prefix with a focus on global unicast addresses.

Instructor Note: This lab has four sections that can be split up into two parts (Part 1/2 and Part 3/4). It can be performed in multiple sessions, or assigned as homework.

Required Resources

- 1 PC (Windows 7 or Vista with Internet access)

Note: The IPv6 protocol is enabled in Windows 7 and Vista by default. The Windows XP operating system does not enable IPv6 by default and is not recommended for use with this lab. This lab uses Windows 7 PC hosts.

Instructor Note: For instructions on how to enable IPv6 and configure host addresses with Windows XP, refer to the Instructor Lab Manual.

Part 1: Identify the Different Types of IPv6 Addresses

In Part 1, you will review the characteristics of IPv6 addresses to identify the different types of IPv6 addresses.

Step 1: Review the different types of IPv6 addresses.

An IPv6 address is 128 bits long. It is most often presented as 32 hexadecimal characters. Each hexadecimal character is the equivalent of 4 bits ($4 \times 32 = 128$). A non-abbreviated IPv6 host address is shown here:

2001:0DB8:0001:0000:0000:0000:0000:0001

A hextet is the hexadecimal, IPv6 version of an IPv4 octet. An IPv4 address is 4 octets long, separated by dots. An IPv6 address is 8 hextets long, separated by colons.

An IPv4 address is 4 octets and is commonly written or displayed in decimal notation.

255.255.255.255

An IPv6 address is 8 hextets and is commonly written or displayed in hexadecimal notation.

FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF

In an IPv4 address, each individual octet is 8 binary digits (bits). Four octets equals one 32-bit IPv4 address.

11111111 = 255

11111111.11111111.11111111.11111111 = 255.255.255.255

In an IPv6 address, each individual hextet is 16 bits long. Eight hextets equals one 128-bit IPv6 address.

1111111111111111 = FFFF

1111111111111111.1111111111111111.1111111111111111.1111111111111111.

1111111111111111.1111111111111111.1111111111111111.1111111111111111 =

FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF

If we read an IPv6 address starting from the left, the first (or far left) hextet identifies the IPv6 address type. For example, if the IPv6 address has all zeros in the far left hextet, then the address is possibly a loopback address.

0000:0000:0000:0000:0000:0000:0000:0001 = loopback address

::1 = loopback address abbreviated

As another example, if the IPv6 address has FE80 in the first hextet, then the address is a link-local address.

FE80:0000:0000:0000:C5B7:CB51:3C00:D6CE = link-local address

FE80::C5B7:CB51:3C00:D6CE = link-local address abbreviated

Study the chart below to help you identify the different types of IPv6 address based on the numbers in the first hextet.

First Hextet (Far Left)	Type of IPv6 Address
0000 to 00FF	Loopback address, any address, unspecified address, or IPv4-compatible
2000 to 3FFF	Global unicast address (a routable address in a range of addresses that is currently being handed out by the Internet Assigned Numbers Authority [IANA])
FE80 to FEBF	Link-local (a unicast address which identifies the host computer on the local network)
FC00 to FCFF	Unique-local (a unicast address which can be assigned to a host to identify it as being part of a specific subnet on the local network)
FF00 to FFFF	Multicast address

There are other IPv6 address types that are either not yet widely implemented, or have already become deprecated, and are no longer supported. For instance, an **anycast address** is new to IPv6 and can be used by routers to facilitate load sharing and provide alternate path flexibility if a router becomes unavailable. Only routers should respond to an anycast address. Alternatively, **site-local addresses** have been deprecated and replaced by unique-local addresses. Site-local addresses were identified by the numbers FEC0 in the initial hextet.

In IPv6 networks, there are no network (wire) addresses or broadcast addresses as there are in IPv4 networks.

Step 2: Match the IPv6 address to its type.

Match the IPv6 addresses to their corresponding address type. Notice that the addresses have been compressed to their abbreviated notation and that the slash network prefix number is not shown. Some answer choices must be used more than once.

IPv6 Address	Answer
2001:0DB8:1:ACAD::FE55:6789:B210	1. ____
::1	2. ____
FC00:22:A:2::CD4:23E4:76FA	3. ____
2033:DB8:1:1:22:A33D:259A:21FE	4. ____
FE80::3201:CC01:65B1	5. ____
FF00::	6. ____
FF00::DB7:4322:A231:67C	7. ____
FF02::2	8. ____

Answer Choices

- a. Loopback address
- b. Global unicast address
- c. Link-local address
- d. Unique-local address
- e. Multicast address

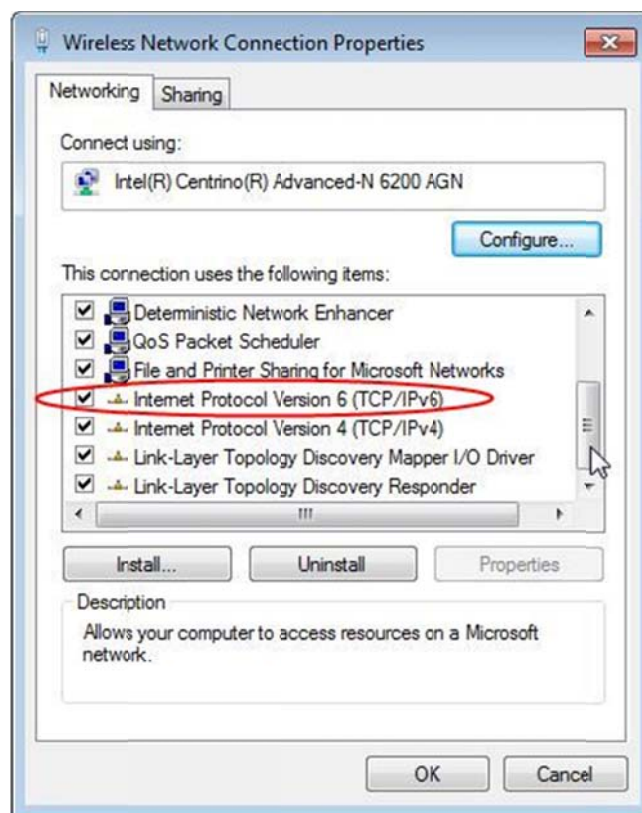
Answers: 1. B, 2. A, 3. D, 4. B, 5. C, 6. E, 7. E, 8. E

Part 2: Examine a Host IPv6 Network Interface and Address

In Part 2, you will check the IPv6 network settings of your PC to identify your network interface IPv6 address.

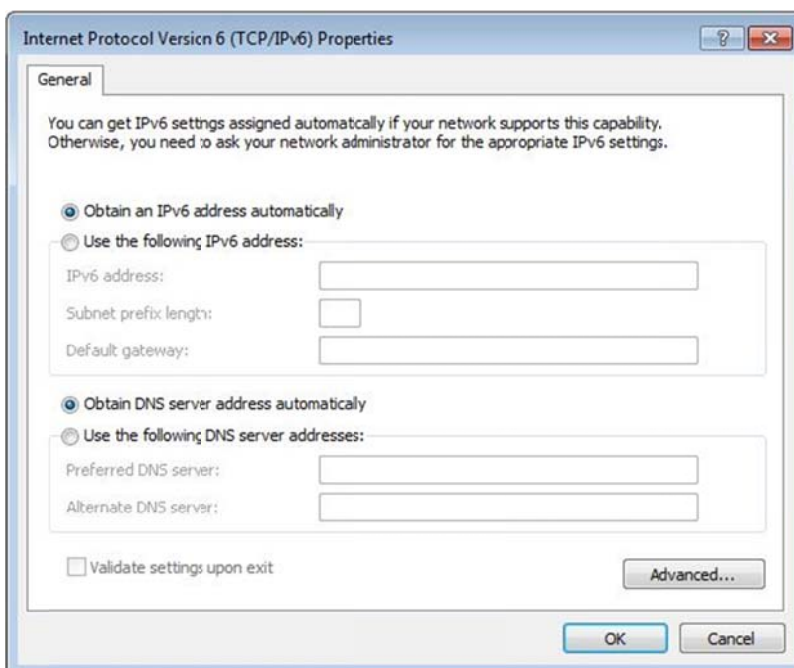
Step 1: Check your PC IPv6 network address settings.

- a. Verify that the IPv6 protocol is installed and active on your PC-A (check your Local Area Connection settings).
- b. Click the Windows **Start** button and then **Control Panel** and change **View by: Category** to **View by: Small icons**.
- c. Click the **Network and Sharing Center** icon.
- d. On the left side of the window, click **Change adapter settings**. You should now see icons representing your installed network adapters. Right-click your active network interface (it may be a **Local Area Connection** or a **Wireless Network Connection**), and then click **Properties**.
- e. You should now see your Network Connection Properties window. Scroll through the list of items to determine whether IPv6 is present, which indicates that it is installed, and if it is also check marked, which indicates that it is active.



- f. Select the item **Internet Protocol Version 6 (TCP/IPv6)** and click **Properties**. You should see the IPv6 settings for your network interface. Your IPv6 properties window is likely set to **Obtain an IPv6 address automatically**. This does not mean that IPv6 relies on the Dynamic Host Configuration Protocol (DHCP). Instead of using DHCP, IPv6 looks to the local router for IPv6 network information and then auto-configures its own IPv6 addresses. To manually configure IPv6, you must provide the IPv6 address, the subnet prefix length, and the default gateway.

Note: The local router can refer host requests for IPv6 information, especially Domain Name System (DNS) information, to a DHCPv6 server on the network.



- g. After you have verified that IPv6 is installed and active on your PC, you should check your IPv6 address information. To do this, click the **Start** button, type **cmd** in the *Search programs and files* form box, and press Enter. This opens a Windows command prompt window.
- h. Type **ipconfig /all** and press Enter. Your output should look similar to this:

```
C:\Users\user> ipconfig /all
```

```
Windows IP Configuration
```

```
<output omitted>
```

```
Wireless LAN adapter Wireless Network Connection:
```

```

Connection-specific DNS Suffix . : 
Description . . . . . : Intel(R) Centrino(R) Advanced-N 6200 AGN
Physical Address. . . . . : 02-37-10-41-FB-48
DHCP Enabled. . . . . : Yes
Autoconfiguration Enabled . . . . : Yes
Link-local IPv6 Address . . . . . : fe80::8d4f:4f4d:3237:95e2%14(Preferred)
IPv4 Address. . . . . : 192.168.2.106(Preferred)
Subnet Mask . . . . . : 255.255.255.0
Lease Obtained. . . . . : Sunday, January 06, 2013 9:47:36 AM
Lease Expires . . . . . : Monday, January 07, 2013 9:47:38 AM
Default Gateway . . . . . : 192.168.2.1
DHCP Server . . . . . : 192.168.2.1
DHCPv6 IAID . . . . . : 335554320
DHCPv6 Client DUID. . . . . : 00-01-00-01-14-57-84-B1-1C-C1-DE-91-C3-5D

DNS Servers . . . . . : 192.168.1.1

```

8.8.4.4

<output omitted>

- i. You can see from the output that the client PC has an IPv6 link-local address with a randomly generated interface ID. What does it indicate about the network regarding IPv6 global unicast address, IPv6 unique-local address, or IPv6 gateway address?

It indicates that there is no IPv6 enabled gateway router providing global address, local address, or subnet information on the network.

- j. What kind of IPv6 addresses did you find when using **ipconfig /all**?

Answers will vary, but most likely they will be link-local addresses also.

Part 3: Practice IPv6 Address Abbreviation

In Part 3, you will study and review rules for IPv6 address abbreviation to correctly compress and decompress IPv6 addresses.

Step 1: Study and review the rules for IPv6 address abbreviation.

Rule 1: In an IPv6 address, a string of four zeros (0s) in a hextet can be abbreviated as a single zero.

2001:0404:0001:1000:**0000:0000**:0EF0:BC00

2001:0404:0001:1000:**0:0**:0EF0:BC00 (abbreviated with single zeros)

Rule 2: In an IPv6 address, the leading zeros in each hextet can be omitted, trailing zeros cannot be omitted.

2001:**0404:0001**:1000:0000:0000:**0EF0**:BC00

2001:404:1:1000:0:0:EF0:BC00 (abbreviated with leading zeros omitted)

Rule 3: In an IPv6 address, a single continuous string of four or more zeros can be abbreviated as a double colon (::). The double colon abbreviation can only be used one time in an IP address.

2001:0404:0001:1000:**0000:0000**:0EF0:BC00

2001:404:1:1000:**::**EF0:BC00 (abbreviated with leading zeroes omitted and continuous zeros replaced with a double colon)

The image below illustrates these rules of IPv6 address abbreviation:

```
FF01:0000:0000:0000:0000:0000:0000:1
= FF01:0:0:0:0:0:0:1
= FF01::1
```

```
E3D7:0000:0000:0000:51F4:00C8:C0A8:6420
= E3D7::51F4:C8:C0A8:6420
```

```
3FFE:0501:0008:0000:0260:97FF:FE40:EFAB
= 3FFE:501:8:0:260:97FF:FE40:EFAB
= 3FFE:501:8::260:97FF:FE40:EFAB
```

Step 2: Practice compressing and decompressing IPv6 addresses.

Using the rules of IPv6 address abbreviation, either compress or decompress the following addresses:

- 1) 2002:0EC0:0200:0001:0000:04EB:44CE:08A2

2002:EC0:200:1::4EB:44CE:8A2

- 2) FE80:0000:0000:0001:0000:60BB:008E:7402

FE80::1:0:60BB:8E:7402

- 3) FE80::7042:B3D7:3DEC:84B8

FE80:0000:0000:0000:7042:B3D7:3DEC:84B8

- 4) FF00::

FF00:0000:0000:0000:0000:0000:0000

- 5) 2001:0030:0001:ACAD:0000:330E:10C2:32BF

2001:30:1:ACAD::330E:10C2:32BF

Part 4: Identify the Hierarchy of the IPv6 Global Unicast Address Network Prefix

In Part 4, you will study and review the characteristics of the IPv6 network prefix to identify the hierarchical network components of the IPv6 network prefix.

Step 1: Study and review the hierarchy of IPv6 network prefix.

An IPv6 address is a 128-bit address made up of two parts, the network portion, identified by the first 64 bits, or first four hextets, and the host portion, which is identified by the last 64 bits, or last four hextets. Remember that each number, or character, in an IPv6 address is written in hexadecimal, which is equivalent to four bits. The following is a typical global unicast address:

The network portion: **2001:DB8:0001:ACAD:XXXX:XXXX:XXXX:XXXX**

The host portion: **XXXX:XXXX:XXXX:XXXX:0000:0000:0000:0001**

Most global unicast (routable) addresses use a 64-bit network prefix and a 64-bit host address. However, the network portion of an IPv6 address is not restricted to 64 bits in length and its length is identified at the end of the address by slash notation, followed by a decimal number indicating its length. If the network prefix is /64, then the network portion of the IPv6 address is 64 bits long from left to right. The host portion, or interface ID, which is the last 64 bits, is the remaining length of the IPv6 address. In some cases, as with a loopback address, the network prefix can be /128, or one hundred and twenty eight bits long. In this case, there are no bits left over for the interface identifier, and therefore, the network is restricted to a single host. Here are some examples of IPv6 addresses with different network prefix lengths:

Global unicast address:	2001:DB8:0001:ACAD:0000:0000:0000:0001/64
Loopback address:	::1/128
Multicast address:	FF00::/8
All networks address:	::/0 (similar to a quad zero address in IPv4)
Link-local address	fe80::8d4f:4f4d:3237:95e2%14 (notice that the slash fourteen at the end of the address is represented by a percent sign and the decimal number of fourteen. This address was taken from the output of an ipconfig /all command in the Windows Command Prompt)

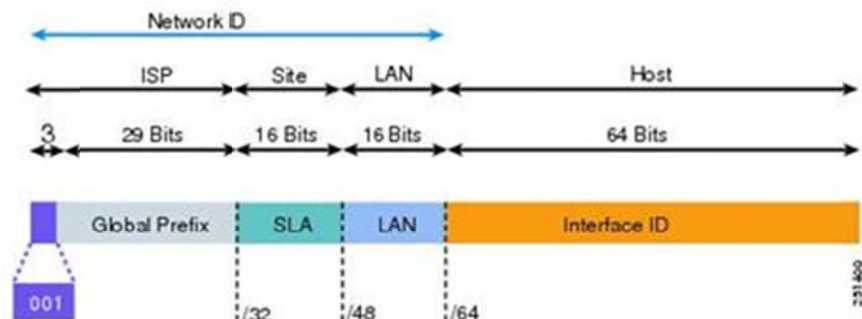
From left to right, the network portion of an IPv6 global unicast address has a hierarchical structure that will give the following information:

- 1) IANA Global Routing Number (the first three binary bits are fixed as 001)
200::/12
- 2) Regional Internet Registry (RIR) Prefix (bits /12 to /23)
2001:0D::/23 (the hexadecimal D character is 1101 in binary. Bits 21 to 23 are 110, and the last bit is part of the ISP Prefix)
- 3) Internet service provider (ISP) Prefix (the bits up to /32)
2001:0DB8::/32
- 4) Site Prefix or Site Level Aggregator (SLA) which is assigned to the customer by the ISP (the bits up to /48)
2001:0DB8:0001::/48
- 5) Subnet Prefix (assigned by the customer; the bits up to /64)
2001:0DB8:0001:ACAD::/64
- 6) Interface ID (the host is identified by the last 64 bits in the address)
2001:DB8:0001:ACAD:8D4F:4F4D:3237:95E2/64

The image below shows that the IPv6 address can be grouped into four basic parts:

- 1) Global Routing Prefix /32

- 2) Site Level Aggregator (SLA) /48
- 3) Subnet ID (LAN) /64
- 4) Interface ID (last 64 bits)



The host portion of the IPv6 address is called the Interface ID, because it does not identify the actual host, but rather the host's network interface card. Each network interface can have multiple IPv6 addresses, and therefore, can also have multiple interface IDs.

Step 2: Practice deriving network prefix information from an IPv6 address.

Given the following address, answer the following questions:

2000:1111:aaaa:0:50a5:8a35:a5bb:66e1/64

- a. What is the interface ID?

50a5:8a35:a5bb:66e1

- b. What is the subnet number?

0

- c. What is the site number?

aaaa

- d. What is the ISP number?

11

- e. What is the ISP number in binary?

0001 0001

- f. What is the Registry number?

011

- g. What is the Registry number in binary?

0000 0001 0001

- h. What is the IANA global number?

2

- i. What is the global routing prefix?

2000:1111:

Reflection

1. How do you think you must support IPv6 in the future?

Answers will vary.

2. Do you think IPv4 networks continue on, or will everyone eventually switch over to IPv6? How long do you think it will take?

Answers will vary.