5.6.2 IPv6 Facts

The addresses available under the current IPv4 addressing standard have been exhausted. In response to this situation, a new IP addressing system (IP version 6, or IPv6) has been developed. An IPv6 address is a 128-bit binary number. A sample IPv6 IP address looks like the following: 35BC:FA77:4898:DAFC:200C:FBBC:A007:8973.

The following list describes the features of an IPv6 address:

- It is made up of 32 hexadecimal numbers organized into 8 quartets.
- The quartets are separated by colons.
- Each quartet is represented as a hexadecimal number between 0 and FFFF. Each quartet represents 16 bits of data (FFFF = 1111 1111 1111 1111).
- Leading zeros can be omitted in each section. For example, the quartet 0284 could also be written as 284.
- An address with consecutive zeros can be expressed more concisely by substituting a double colon for the group of zeros. For example:
  - FEC0:0:0:0:78CD:1283:F398:23AB
  - FEC0::78CD:1283:F398:23AB (concise form)

    This is also called address compression. Address compression is when you take a fully-notated IPv6 address and remove empty octets from it, replacing them with a colon.

- If an address has more than one consecutive location where one or more quartets are all zeros, only one location can be abbreviated. For example, FEC2:0:0:0:78CA:0:0:23AB can be abbreviated as:
  - FEC2::78CA:0:0:23AB
    or
  - FEC2:0:0:0:78CA::23AB
    but not
  - FEC2::78CA::23AB
- The 128-bit address contains two parts:

Component	Description
Prefix	The first 64 bits are known as the *prefix*. ▪ The prefix can be divided into various parts that identify things such as geographic region, the ISP, the network, and the subnet. ▪ The *prefix length* identifies the number of bits in the relevant portion of the prefix. To indicate the prefix length, add a slash (/) followed by the prefix length number. Full quartets with trailing 0s in the prefix address can be omitted (e.g., 2001:0DB8:4898:DAFC::/64). ▪ Because addresses are allocated based on physical location, the prefix generally identifies the location of the host. The 64-bit prefix is often referred to as the *global routing* prefix.
Interface ID	The last 64 bits are known as the *interface ID*. This is the unique address assigned to an interface. ▪ Addresses are assigned to interfaces (network connections), not to the host. Technically, the interface ID is not a host address. ▪ In most cases, individual interface IDs are not assigned by ISPs but are rather generated automatically or managed by site administrators. ▪ Interface IDs must be unique within a subnet, but they can be the same if they are on different subnets. ▪ On Ethernet networks, the interface ID can be automatically derived from the MAC address. Using the automatic host ID simplifies administration. To ensure that the interface ID is unique for every host on the network, IPv6 uses the Extended Unique Identifier 64 (EUI-64) format. The following are some details of the EUI-64 format: ▪ Each host has a unique 48-bit hardware address called a *MAC address* (also called the *burned-in* address) that is assigned to each device by the vendor. The MAC address is guaranteed to be unique through design. The EUI-64 format uses the unique MAC address by: 1. Splitting the MAC address into 24-bit halves. 2. Inserting 16 bits (represented by hex FFFE) between the two halves. For example, a host with a MAC address of 20-0C-FB-BC-A0-07 would start with the following EUI-64 interface ID: 200C:FB**FF**:**FE**BC:A007. 3. To be complete, the EUI-64 format requires setting the seventh bit in the first byte to binary 1 (reading from left to right, this is the second hex value in the interface ID). This bit is called the *universal/local (U/L) bit*. ▪ When the U/L bit is set to 0, the MAC address is a burned-in MAC address. ▪ When the U/L bit is set to 1, the MAC address has been configured locally. EUI-64 requires the U/L bit to be set to 1. Review the following examples: ▪ 200C:FBFF:FEBC:A007 (Incorrect interface ID, as the U/L bit is still set to 0) ▪ 220C:FBFF:FEBC:A007 (Correct interface ID)

IPv6 adds the following features not included in IPv4:

Feature	Description
Auto-configuration	Because hardware IDs are used for node IDs, IPv6 nodes simply need to discover their network IDs. This can be done by communicating with a router.
Built-in Quality of Service	Built-in support for bandwidth reservations makes guaranteed data transfer rates possible. (Quality of service features are available as add-ons within an IPv4 environment but are not part of the native protocol.)
Built-in Security Features	IPv6 has built-in support for security protocols such as IPsec. (IPsec security features are available as add-ons within an IPv4 environment.)
Source Intelligent Routing	IPv6 nodes have the option to include addresses that determine part or all of the route a packet will take through the network.