



Cisco Networking Academy
Mind Wide Open

IPv6 Addressing

John Rullan

Cisco Certified Instructor Trainer
Thomas A. Edison CTE HS

Stephen Lynch

Network Architect, CCIE #36243
ABS Technology Architects



IPv6 Addressing Structure


- 128-bit hexadecimal format (0-9, A-F)
- Uses 16-bit hexadecimal number fields separated by colons (:))
- Every 4-hexadecimal digits are equivalent to 16-bits.
- Consists of 8 hextets/quartets which is the equivalent to 16-bits per-hextet.

2001:0DB8:0001:5270:0127:00AB:CAFE:0E1F /64

- 2001 in hexadecimal is 0010 0000 0000 0001 in binary

IPv6 Addressing Structure

2001:0DB8:0001:5270:0127:00AB:CAFE:0E1F/64



The diagram shows the IPv6 address 2001:0DB8:0001:5270:0127:00AB:CAFE:0E1F/64. Red brackets are used to group the address into three parts: the first three hextets (2001:0DB8:0001) are bracketed and labeled 'Global Routing Prefix'; the fourth hextet (5270) is bracketed and labeled 'Subnet ID'; and the last four hextets (0127:00AB:CAFE:0E1F) are bracketed and labeled 'Interface ID'.

Global Routing Prefix Subnet ID Interface ID

- The **Site Prefix or Global Routing Prefix** is the first 3 hextets or 48-bits of the address. It is assigned by the service provider.
- The **Site Topology or Subnet ID** Is the 4th hextet of the address.
- The **Interface ID** is the last 4 hextets or 64-bits of the address. It can be manually or dynamically assigned using the EUI-64 command. (Extended Unique Identifier)

IPv6 Addressing Structure

- First 3 bits are fixed at 001 or 200::/12 (IANA Global Routing Number)

2001:0DB8:0001:5270:0127:00AB:CAFE:0E1F /64



IANA

- Bits 16-24 identifies the Regional Registry:
 - AfriNIC, APNIC, LACNIC, RIPE NCC and ARIN

2001:0DB8:0001:5270:0127:00AB:CAFE:0E1F /64



Registry

2001:0000::/23 – IANA

2001:0200::/23 – APNIC (Asia/Pacific Region)

2001:0400::/23 – ARIN (North America Region)

2001:0600::/23 – RIPE (Europe, Middle East and Central Asia)

IPv6 Addressing Structure

- Remaining 8-bits up to /32 identifies the ISP.

2001:0DB8:0001:5270:0127:00AB:CAFE:0E1F /64


ISP

- The 3rd hextet represents the Site/Customer Identifier.

2001:0DB8:0001:5270:0127:00AB:CAFE:0E1F /64


Site

- The 4th hextet represent the Site Topology/Subnet ID.

- Allows 65,536 subnets with 18,446,744,073,709,551,616 (18 quintillion) for each subnet.
- Not part of the host address field.

2001:0DB8:0001:5270:0127:00AB:CAFE:0E1F /64


Subnet

IPv6 Addressing Scheme and Subnets

2001:0DB8:0001:5270:0127:00AB:CAFE:0E1F /64



- The **Interface ID** are the remaining 64-bits of the address.
- Can be manually configured or dynamically by using the EUI-64 (Extended Unique Identifier).
- The EUI-64 command uses the device 48-bits MAC Address and convert it into 64-bits by adding FF:FE in the middle of the address.
- The first (network) and last (broadcast) address may be assigned to an interface. An interface may contain more than one IPv6 address.
- There are no broadcast addresses, multicast is used instead.

IPv6 Addressing Scheme and Subnets

- IPv6 uses the same method as IPv4 to subnet their addresses.
- /127 gives you 2 addresses.
- /124 gives you 16 addresses
- /120 gives you 256 addresses
- The first address in a network consists of all 0's and the last address consists of all F's.
- It's recommended for simplicity and design purposes to use /64 everywhere. Using anything less than /64 could potentially break IPv6 features and cause increased design complexity.

Leading Zeroes and Double Colons (::)

- Leading 0s (zeroes) in any 16-bit section can be omitted.

Address before omission:

2001:0DB8:0001:5270:0127:00AB:CAFE:0E1F /64

Address after omission:

2001:DB8:1:5270:127:AB:CAFE:E1F /64

- This rule applies only to leading 0s; if trailing 0s are omitted, the address would be vague.

2001:0DB8:0001:5270:0127:00AB:CAFE:0E1F /64

Leading Zeroes and Double Colons (::)

- A Double Colons or Compressing Zeroes can be used to shorten an IPv6 address when one or more hextets consist of all 0s.

2001:0DB8:0000:0000:ACAD:0000:0000:E175
→ 2001:DB8::ACAD:0:0:E175

- Double Colons can only be used to compress a single contiguous 16-bits blocks. You cannot use double colons to include part of a block.

FF02:30:0:0:0:0:0:5
↙ FF02:3::5 **Incorrect**
↘ FF02:30::5 **Correct**

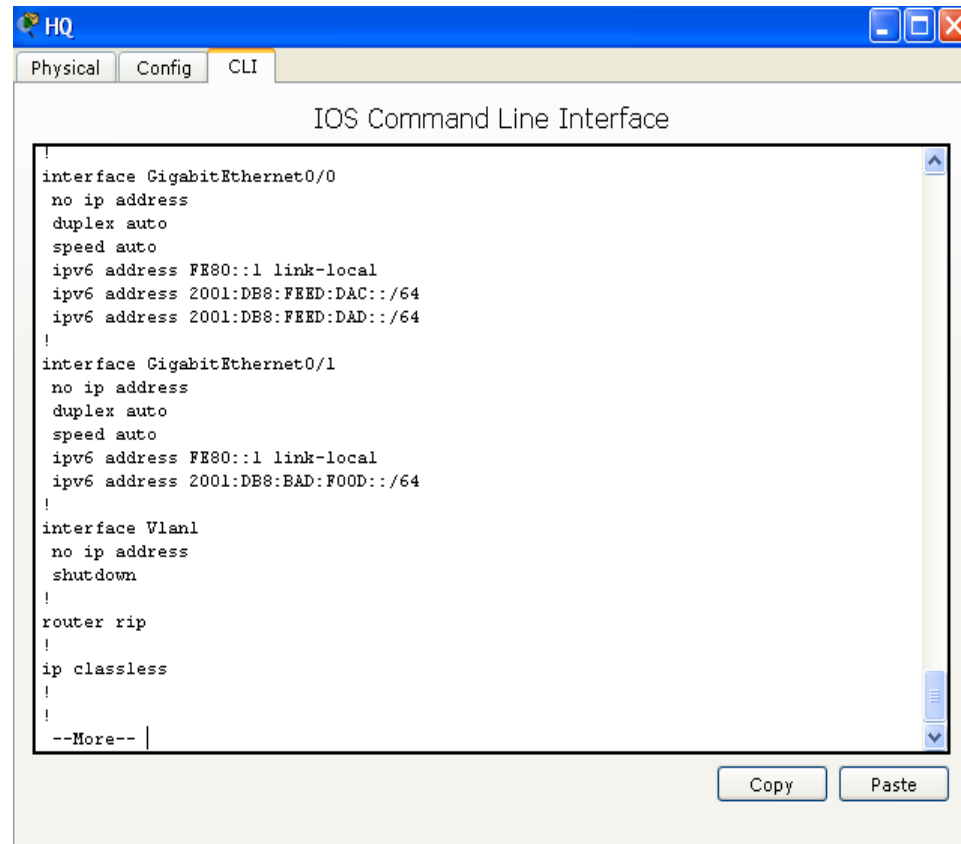
- Double Colons can only be used once in an address, if it's used more than once the address could be ambiguous

2001::ABCD::1234
↙ 2001:0000:0000:0000:0000:ABCD:0000:1234
↘ 2001:0000:0000:0000:ABCD:0000:0000:1234
↘ 2001:0000:0000:ABCD:0000:0000:0000:1234
↘ 2001:0000:ABCD:0000:0000:0000:0000:1234

Types of IPv6 Addresses

- Unicast Address

- Uniquely identifies a single interface on an IPv6 device.
- A packet sent to a unicast address destination travels from one host to the destination host.
- An interface may have more than one IPv6 address or an IPv6 and an IPv4 addresses which is referred as "Double Stack".
- When mistakes are made on Entering an address to the IPv6 interface, the user must issue the **no ipv6 address** command before entering the correct one or the address will remain on the interface. (see figure)



```
HQ
Physical Config CLI
IOS Command Line Interface

!
interface GigabitEthernet0/0
no ip address
duplex auto
speed auto
ipv6 address FE80::1 link-local
ipv6 address 2001:DB8:FEED:DAC::/64
ipv6 address 2001:DB8:FEED:DAD::/64
!
interface GigabitEthernet0/1
no ip address
duplex auto
speed auto
ipv6 address FE80::1 link-local
ipv6 address 2001:DB8:BAD:F00D::/64
!
interface Vlan1
no ip address
shutdown
!
router rip
!
ip classless
!
!
--More--
```

Types of IPv6 Addresses (cont'd)

• Multicast Address

- A Multicast address identifies a group of interfaces.
- All Multicast address are identified by their reserved address range FF00::0/8
- A packet sent to a multicast address is delivered to all devices that are identified by that address.

Protocol	IPv4 Multicast	IPv6 Multicast
OSPF (Router)	224.0.0.5	FF02::5
OSPF (DR/BDR)	224.0.0.6	FF02::6
RIPv2	224.0.0.9	FF02::9
EIGRP	224.0.0.10	FF02::A

• Anycast Address

- A unicast address can be assigned to several interfaces/devices.
- A packet sent to an Anycast address goes only to the nearest member of the group, according to the routing protocols measures of distance.
- Anycast is described as a cross between a Unicast and Multicast.
- The difference between an Anycast and Multicast is that in Anycast packet is only delivered to a single device, while Multicast send it to multiple devices.

Types of IPv6 Addresses (cont'd)

Link-Local Address

- Link-Local address are designed for use on a single local link.
- Link-Local address are automatically configured on all interfaces.
- The prefix used for a Link-Local address is FE80::X/10.
- Routers do not forward packet with a destination and source address containing a link-local address.

Loopback Address

- Similar function to IPv4 127.0.0.1 address
- The Loopback address is 0:0:0:0:0:0:0:1 or may be simplify by using double colons as ::1.
- It is used by a device to send a packet to itself

Representation

Preferred

No Leading 0's

Compresses

IPv6 Loopback Address

0000:0000:0000:0000:0000:0000:0000:0001

0:0:0:0:0:0:0:1

::1

IPv6

- 128-bits address containing global routing prefix, subnet ID and interface ID.
- Uses a hexadecimal format ranging from 0-9, A-F.
- Maximum Transmission Unit up to 1280 bytes.
- Network address and broadcasts address can be assigned to an interface or end device.
- Native IPsec encryption

IPv4

- 32-bits addressing scheme containing a host and a network portion.
- Use binary format between 0 and 1.
- Maximum Transmission Unit up to 576 bytes.
- Network address and broadcasts address cannot be assigned to an interface or end device.
- VPN technologies must be used to encrypt IPv4 packets.

Thank you.



Cisco Networking Academy
Mind Wide Open