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IPv6 Addressing

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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

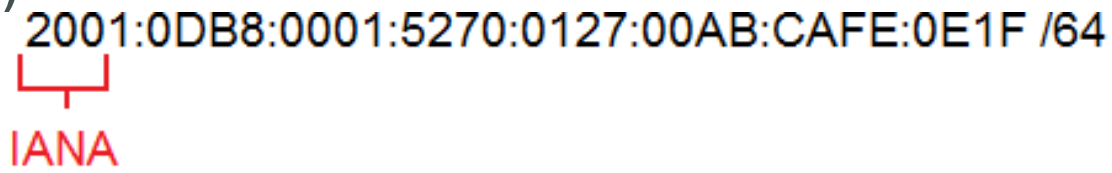
- 2001 in hexadecimal is 0010 0000 0000 0001 in binary

IPv6 Addressing Structure

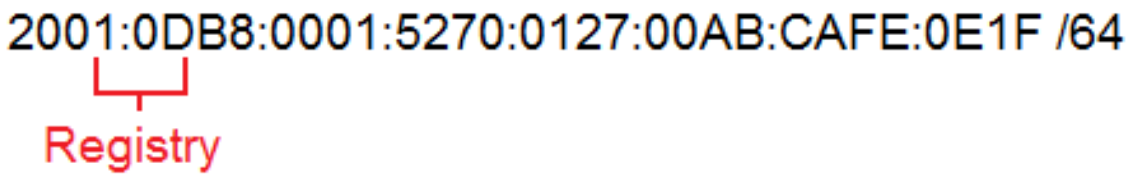
- The **Site Prefix or Global Routing Prefix** is the first 3 hextets or 48-bits of the address. It is assigned by the service provider.
- The **Site Topology or Subnet ID** Is the 4th hextet of the address.
- The **Interface ID** is the last 4 hextets or 64-bits of the address. It can be manually or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



- Bits 13-24 identifies the Regional Registry:
  - AfriNIC, APNIC, LACNIC, RIPE NCC and ARIN



2001:0000::/23 – IANA

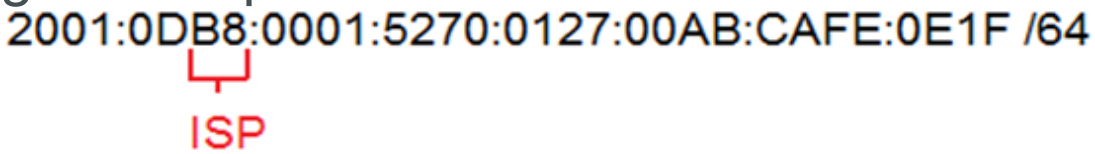
2001:0200::/23 – APNIC (Asia/Pacific Region)

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

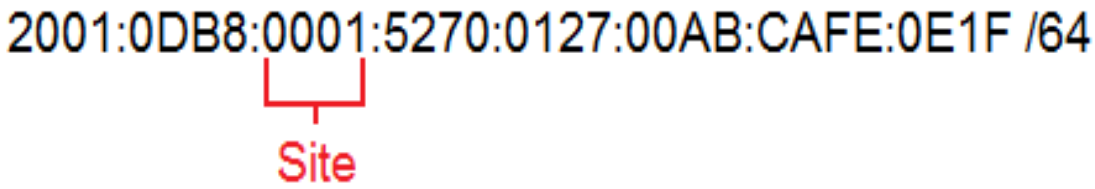
2001:0600::/23 – RIPE (Europe, Middle East and Central Asia)

IPv6 Addressing Structure

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

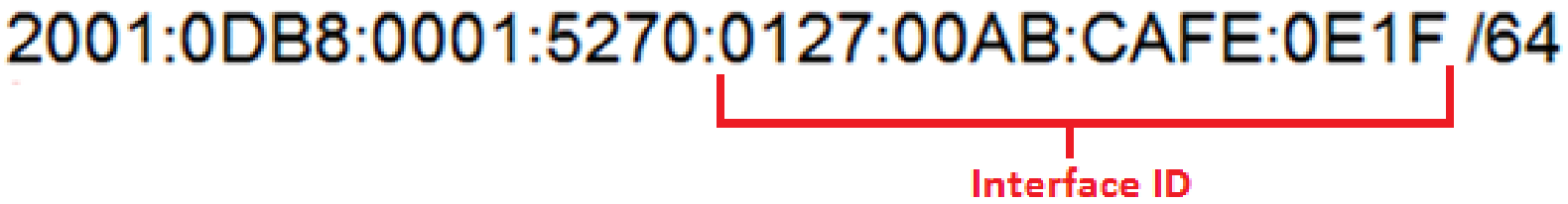


- The 3rd hextet represents the Site/Customer Identifier.



- 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.

IPv6 Addressing Scheme and Subnets



- 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.

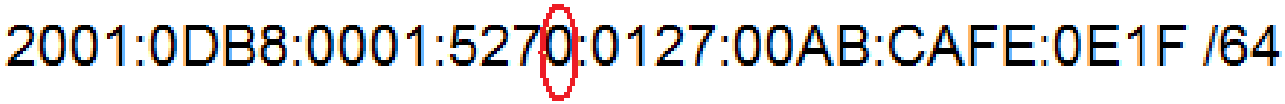
  Address **before** omission:

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

  Address **after** omission:

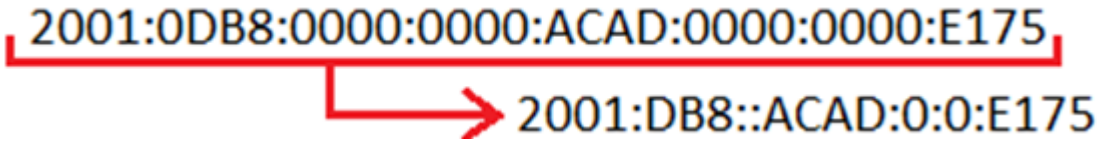
  2001:DB8:1:5270:127:AB:CAFE:E1F /64

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

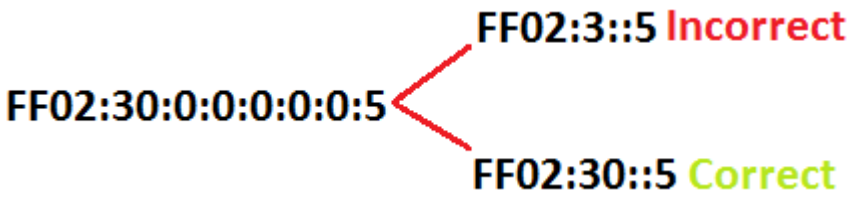


Leading Zeroes and Double Colons (::)

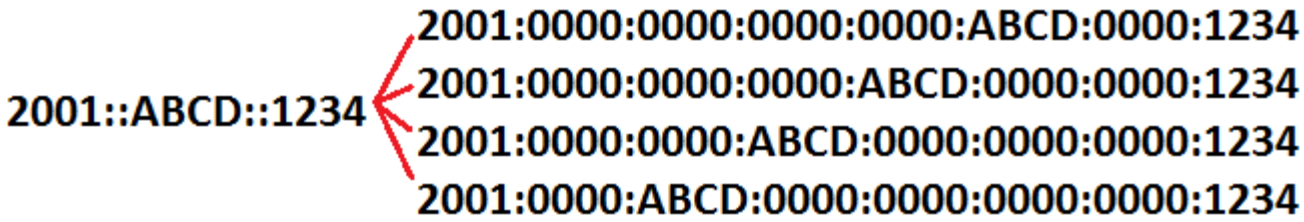
- A Double Colons or Compressing Zeroes can be used to shorten an IPv6 address when one or more hextets consist of all 0s.



- 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.

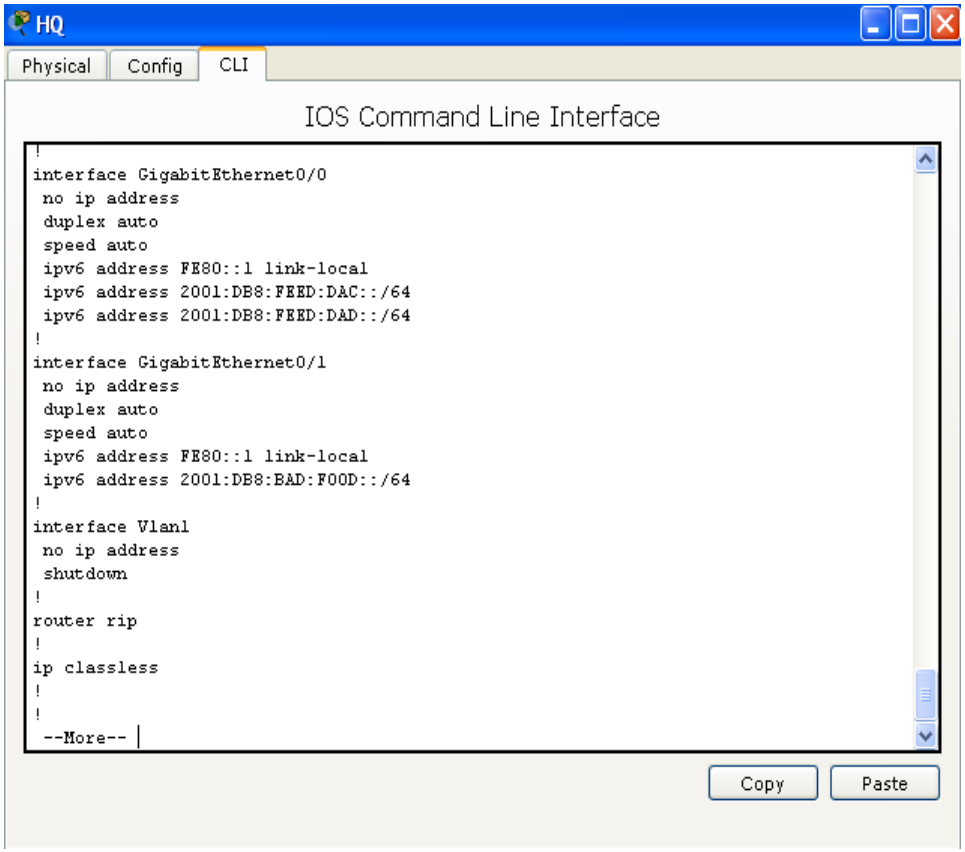


- Double Colons can only be used once in an address, if it's used more than once the address could be ambiguous



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)*



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)

Private Addresses:

A first octet value of "FE" in hexadecimal notation, with the next hexadecimal digit being a value from 8 to F

Link-Local Address

- Link-Local address are designed for use on a single local link.
- Link-Local address are automatically configured on all interfaces.
- Begin with "FE" and then have a value from "8" to "B" for the third hexadecimal digit. So, these addresses start with "FE8", "FE9", "FEA", or "FEB“
- Routers do not forward packet with a destination and source address containing a link-local address.

Site-local addresses

- Site-local addresses are equivalent to private IP addresses in IPv4. The address space reserved for these addresses, which are only routed within an organization and not on the public Internet
- Begin with "FE" and then "C" to "F" for the third hexadecimal digit. So, these addresses begin with "FEC", "FED", "FEE", or "FEF".

Types of IPv6 Addresses (cont'd)

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	IPv6 Loopback Address
Preferred	0000:0000:0000:0000:0000:0000:0000:0001
No Leading 0's	0:0:0:0:0:0:0:1
Compresses	::1

Types of IPv6 Addresses (cont'd)

The various methods of assigning IPv6 addresses to a device

Static assignment	Dynamic assignment
• Manual interface ID assignment • EUI-64 interface ID assignment	• Stateless autoconfiguration • DHCPv6 (stateful)

EUI-64 Process

The IEEE defined the Extended Unique Identifier (EUI) or modified EUI-64 process which performs the following:

- A 16 bit value of **fffe** (in hexadecimal) is inserted into the middle of the 48-bit Ethernet MAC address of the client.
- The 7th bit of the client MAC address is reversed from binary 0 to 1 (or vice versa 1 to 0).

Example:

48-bit MAC	fc:99:47:75:ce:e0
EUI-64 Interface ID	fe:99:47:ff:fe:75:ce:e0

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.

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