IPv6 Addressing

📕 CCNA1v7 Module 12 IPv6 Addressing
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Need for IPv6

- **IPv4 depletion**
  All RIRs (Regional Internet Registries) have exhausted their address pools, except those reserved for IPv6 transition.
- **Enhancements over IPv4**
  The development of IPv6 also included fixes for IPv4 limitations and other enhancements, with subnetting in mind.

IPv4 and IPv6 Coexistence

Protocols and tools to help network admins migrate to IPv6

- **Dual Stack**
  The devices run both IPv4 and IPv6 protocol stacks simultaneously.
- **Tunneling**
  The IPv6 packet is encapsulated inside an IPv4 packet.
- **Translation**
  Network Address Translation 64 (NAT64) allows IPv6-enabled devices to communicate with IPv4-enabled devices using a translation technique similar to NAT for IPv4

IPv6 Addressing Format

- **Length:** 128 bits
- **Representation:** Hexadecimal
- **Format:** `xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx`
- **IPv6 -> 8 hextets**

  1 hextet = 16 bit segment = 4 hexadecimal values

> **Example:**
> 2001:0db8:acad:1111:abde:cafe:010f:1234

IPv6 Compression

Rule 1 – Omit Hextets Leading Zero

> **Example:**
> Preferred: `2001:0db8:0000:1111:0000:0000:0000:0200`
> No leading zeros: `2001:db8:0:1111:0:0:0:200`

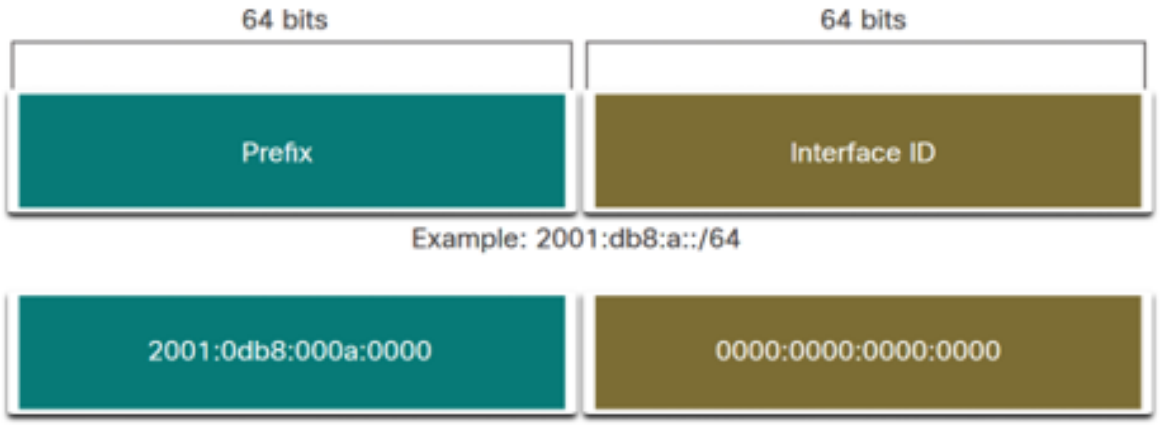
Rule 2. Replace contiguous zero hextets with ::

⚠️ **We can only use `::` once!**

> **Example:**
> No leading zeros: `2001:db8:0:1111:0:0:0:200`
> Compressed: `2001:db8:0:1111::200`

IPv6 Prefix Length

- Used to indicate the **network portion** of an IPv6 address
- **Recommended Prefix length:** /64

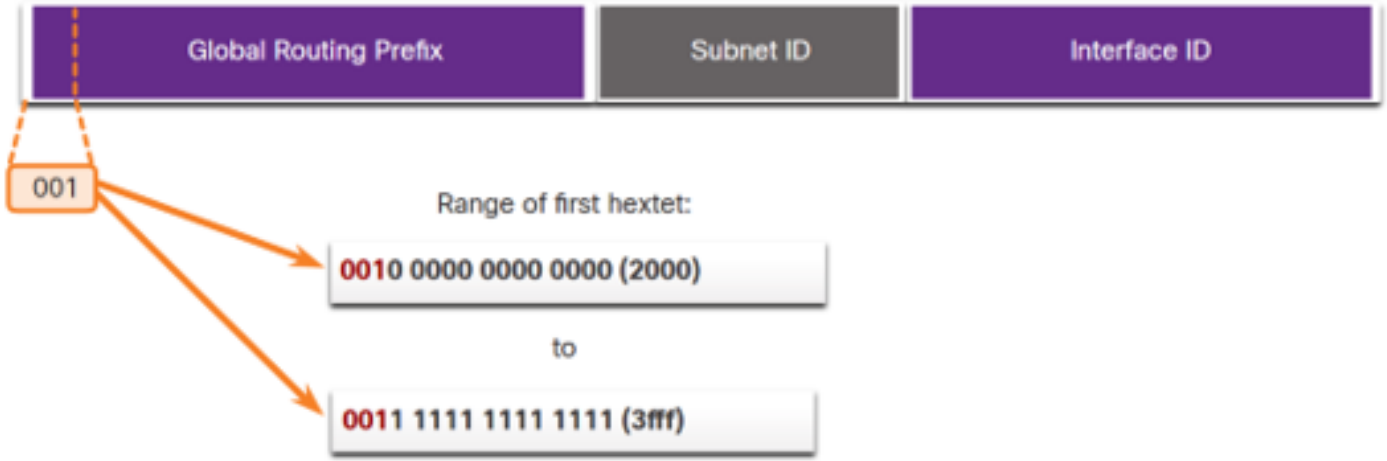


IPv6 Unicast Addresses

- **Global Unicast Address (GUA)**
  - Similar to public IPv4 addresses.
  - Globally unique, **internet-routable addresses**.
- **Link-Local Address (LLA)**
  - Used to communicate to other devices on the same local link.
  - **Not routable, confined to a single link**.
- **Loopback** `::1/128`
- **Unspecified Address** `::/128`
- **Unique local** `fc00::/7 - fdff::/7`
  Similar to IPv4 private addresses.

IPv6 GUA

- **Currently Range:** `2000::/3` <--> `3fff::/3`
- **Global Routing Prefix** (48bits): **Network portion.** Assigned by provider.
- **Subnet ID** (16bits): **Subnet.** To identy subnets within its site.
- **Interface ID** (64bits): **Host portion.**
- **Static GUA on a Router:** `ipv6 address 2001:db8:acada:1::1/64`



IPv6 LLA

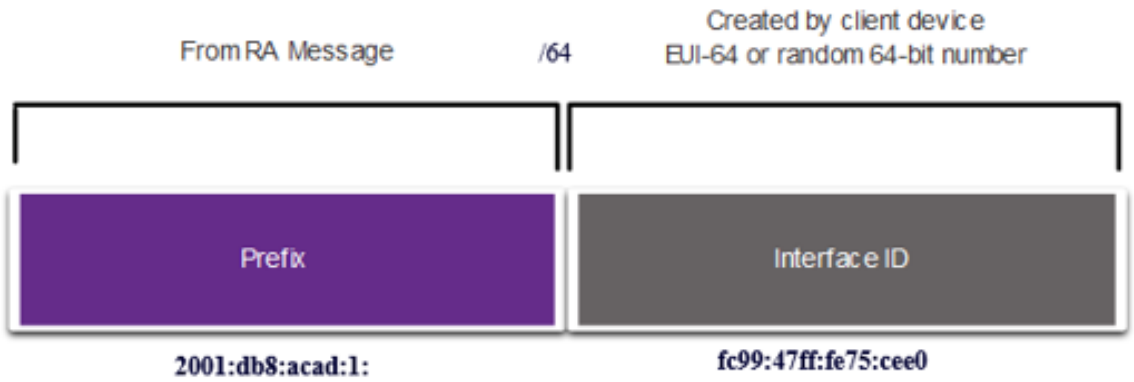
- **Range:** `fe80::/10`
- An IPv6 LLA enables a device to communicate with other IPv6-enabled devices on the same link and only on that link (subnet).
- **Cannot be routed.**
- Every IPv6-enabled network interface must have an LLA.
- **If an LLA is not configured manually on an interface, the device will automatically create one.**
- **Static LLA on a Router:** `ipv6 address fe80::1/64 link-local`

Dynamic Addressing for IPv6 GUAs

- Devices obtain addresses dynamically through **ICMPv6 messages**:
  - **Router Solicitation (RS) messages**
    - Sent by host devices to discover IPv6 routers
  - **Router Advertisement (RA) messages**
    - Sent by routers to inform hosts on how to obtain an IPv6 GUA/LLA.
  - 3 methods for configuring IPv6 GUA:
    - SLAAC
    - SLAAC with Stateless DHCPv6 server
    - Stateful DHCPv6 (no SLAAC)

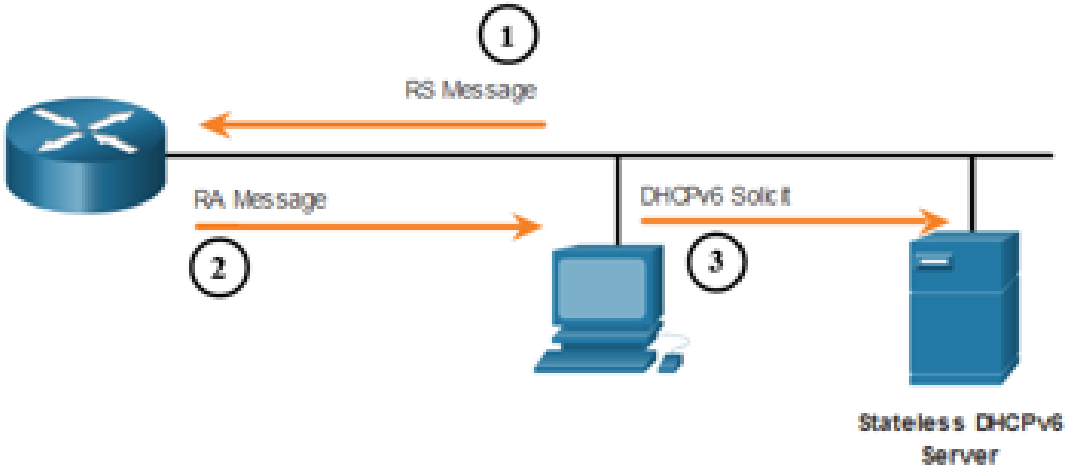
Method 1: SLAAC

- Devices configure a GUA without the services of DHCPv6, obtaining the necessary information from the ICMPv6 RA messages of the local router.
- **Prefix:** provided by the RA message
- **Interface ID:** created by the device using one of these 2 methods:
  - EUI-64
  - Random generation



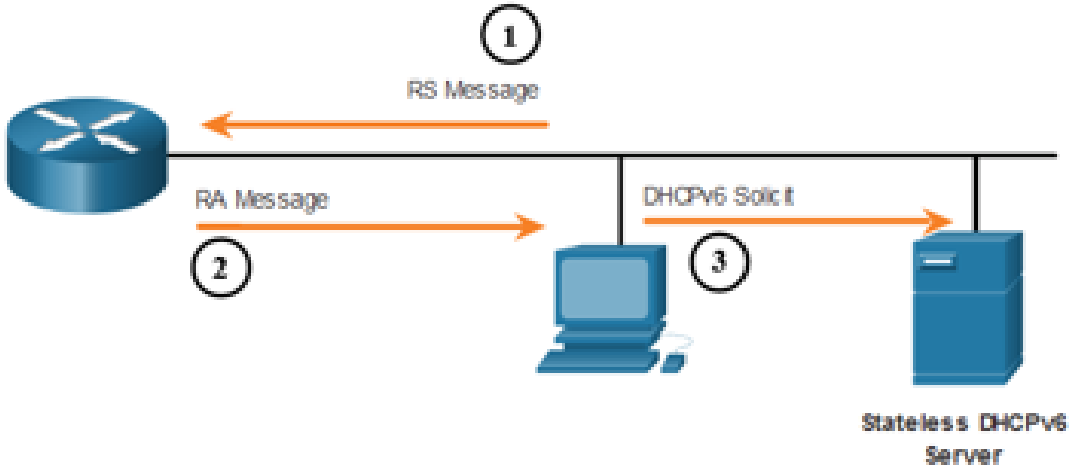
Method 2: SLAAC with Stateless DHCPv6 server

- **IPv6 GUA:** SLAAC
- **Default gateway:** Router LLA (RA source IPv6 address)
- **DNS Server and domain name:** obtained from an stateless DHCPv6 server



Method 3: Stateful DHCPv6

- Similar to DHCPv4
- **IPv6 GUA, prefix length, DNS server and domain:** From Stateful DHCPv6 server
- **Default gateway:** Router LLA (RA source IPv6 address)



Auto Generated Interface ID: EUI-64 Process

- Used by Linux and CISCO devices
- Split Ethernet MAC address of the client (48bits): OUI <--> Serial Number
- Insert `ff:fe` into the middle (64bits)
- Reverse from binary 0 to 1 the 7th bit

> **Example:**
> MAC: `fc:99:47:75:ce:e0`
> EUI-64 Interface ID: `fe:99:47:ff:fe:75:ce:e0`

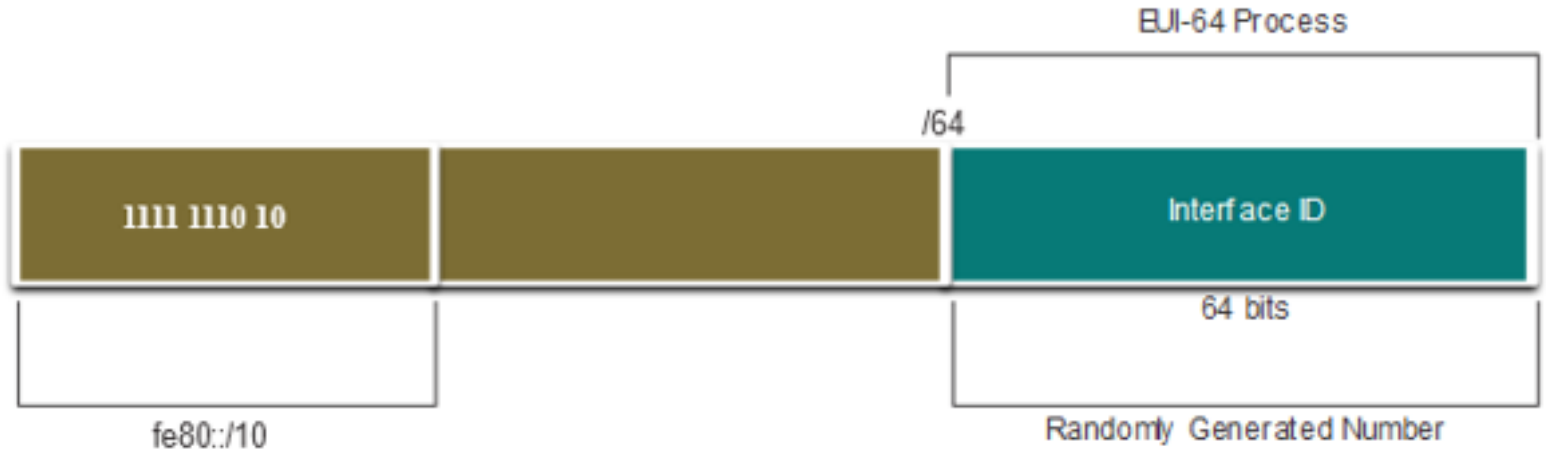
Randomly Generated Interface ID

- Used by Windows
- **Interface ID:** Random number

⚠️ Client may use DAD (Duplicate Address Detection) to ensure the uniqueness of the generated IPv6. No reply => unique.

Dynamic LLA

- **Interface ID:**
  - Created by the device using one of these 2 methods:
    - EUI-64
    - Random generation



IPv6 Multicast

- **Prefix:** `ff00::/8`. 2 types:
  - **Well-known multicast addresses**
    - `ff02::1` **All-nodes multicast group**: All IPv6-enabled devices join
    - `ff02::2` **All-routers multicast group**: All IPv6 routers join
  - **Solicited node multicast addresses**
    - Similar to the all-nodes multicast address.

IPv6 Anycast

- Any IPv6 unicast address that can be assigned to multiple devices.
- Routed to the nearest device having that address.

IPv6 Subnetting

- A separate **Subnet ID** field in the IPv6 GUA is used to create subnets.
- Subnet ID: **4th hextext**