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.

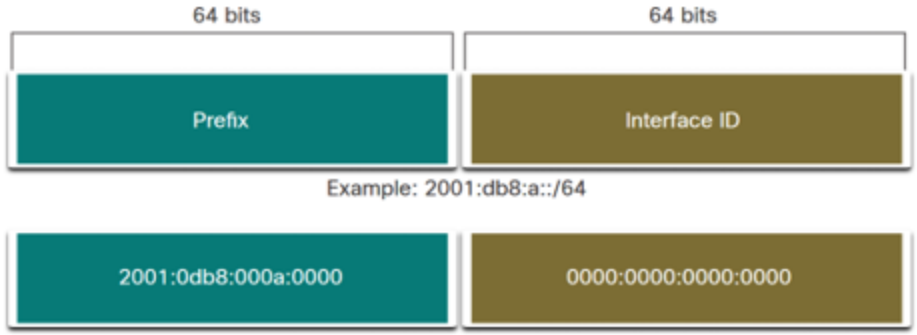
IPv4 and IPv6 Coexistence

- 👯 **Dual Stack**: devices run both IPv4 and IPv6 protocol stacks simultaneously.
- 🚇 **Tunneling**: 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)
- **Prefix Length:** Indicate the **network portion** (recommended /64)

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



IPv6 Compression

Rule 1️⃣ – 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 2️⃣ – Replace contiguous zero hextets with ::

⚠️ We can only use `::` once!

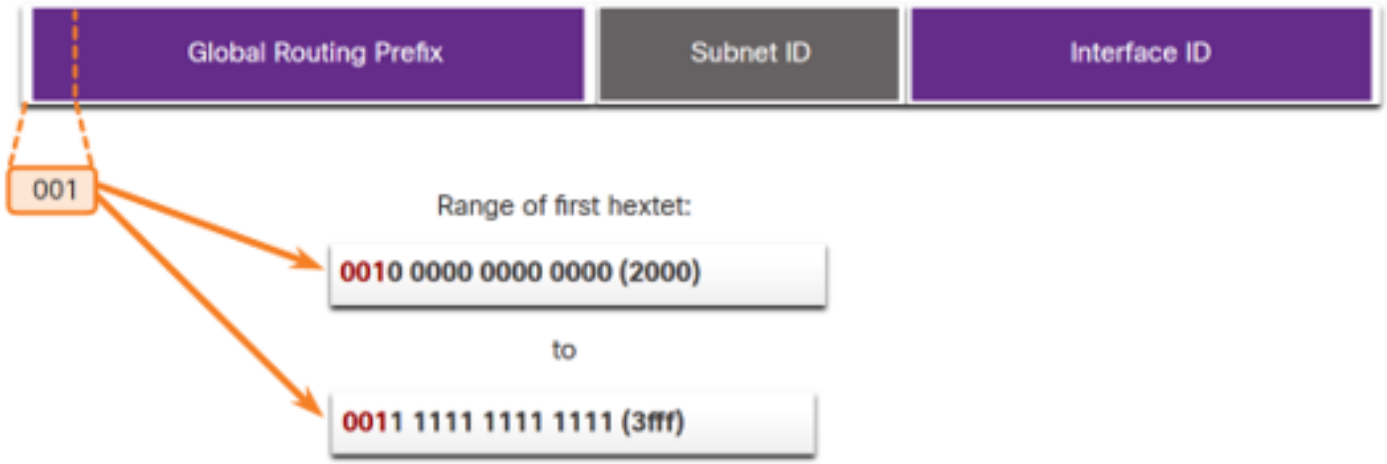
> **Example:**
> No leading zeros: `2001:db8:0:1111:0:0:0:200`
> Compressed: `2001:db8:0:1111::200`

IPv6 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 identify subnets within its site.
- **Interface ID** (64bits): **Host portion.**
- **Static GUA on a Router:** `ipv6 address 2001:db8:acad:1::1/64`



IPv6 LLA

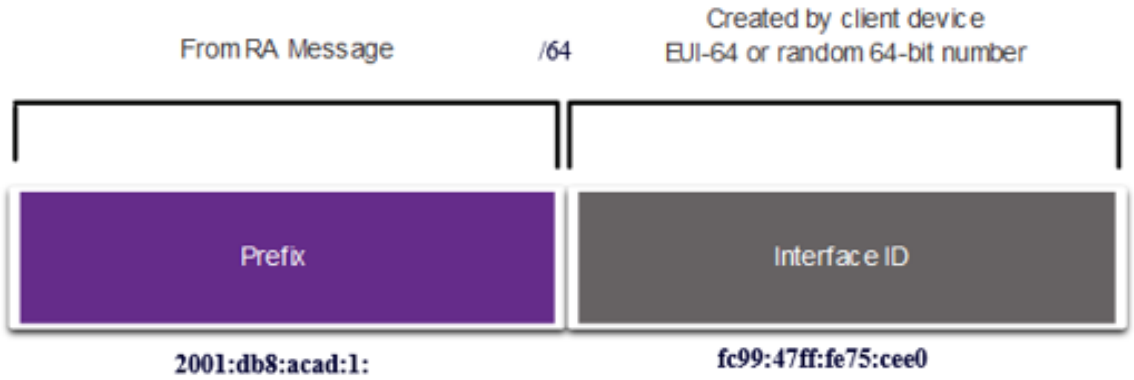
- **Range:** `fe80::/10`
- An IPv6 LLA enables a device to communicate with other IPv6-enabled devices on the same link and only on that link (subnet).
- ⚠️ **Cannot be routed.**
- Every IPv6-enabled network interface must have an LLA.
- **If an LLA is not configured manually on an interface, the device 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 hosts 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:
  1. SLAAC
  2. SLAAC with Stateless DHCPv6 server
  3. Stateful DHCPv6 (no SLAAC)

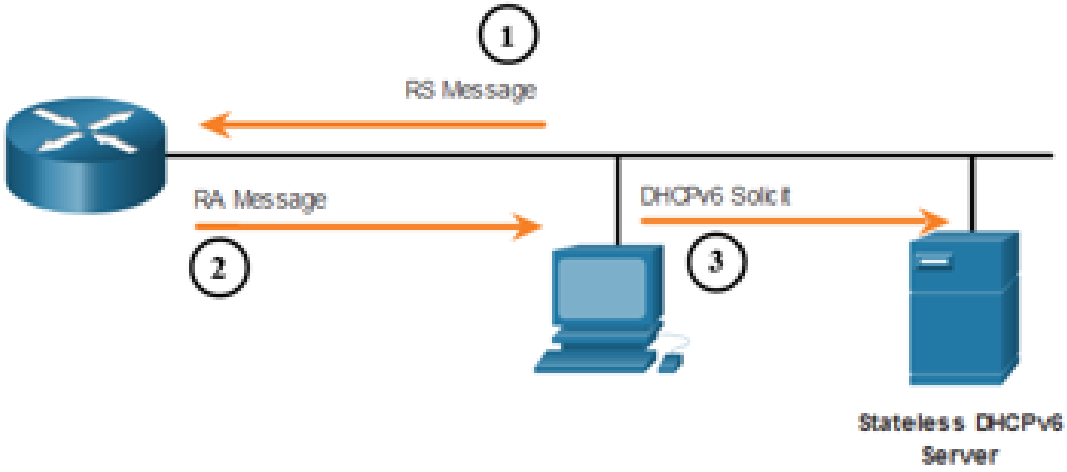
Method 1: SLAAC

- 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



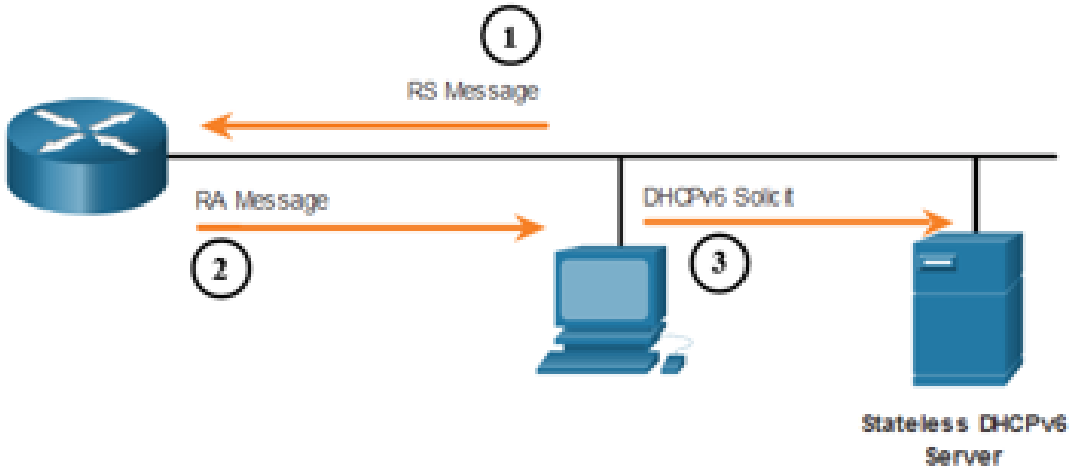
Method 2: SLAAC with Stateless DHCPv6 server

- **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

1️⃣ Split Ethernet MAC address of the client (48bits): OUI ↔️ Serial Number

2️⃣ Insert `ff:fe` into the middle (64bits)

3️⃣ 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`

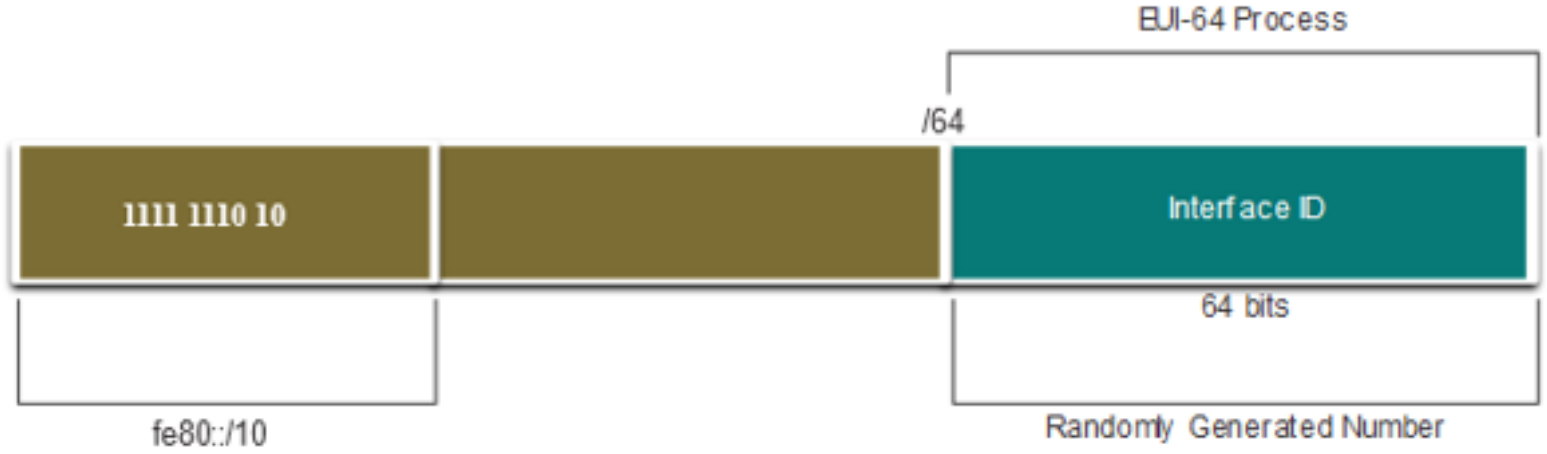
Randomly Generated Interface ID

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**