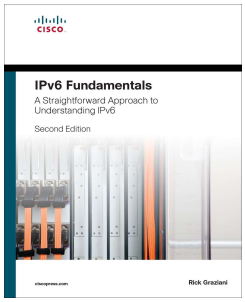

IPv6 Fundamentals, by Rick Graziani

IPv6 Primer

Selected by **Alvaro Barradas** for Redes II

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Chapter 2

IPv6 Primer

IPv6 Primer

- Hexadecimal number system
- IPv6 address types
- Address terminology
- ICMPv6 Neighbor Discovery Protocol (NDP)
- Dynamic address alocation

Number Systems

Three general rules for integer-based number systems:

1. Base *n* number system have *n* number digits
2. All number systems begin with 0
3. The rightmost column, or least significant digit, is always the column of 1s (ones). Each preceding column is *n* times the previous column (where *n* is the base *n* number system).

Table 2-1 *Number Systems*

Base *n* Number System	n^3	n^2	n^1	n^0
Base 10	1,000	100	10	1
Base 2	8	4	2	1
Base 16	4,096	256	16	1

Table 2-2 *Decimal, Hexadecimal, and Binary*

Decimal (Base 10)	Hexadecimal (Base 16)	Binary (Base 2)
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
10	A	1010
11	B	1011
12	C	1100
13	D	1101
14	E	1110
15	F	1111

Rule #2 Begin with 0

Rule #1 Base *n* *n* digits

Rule #3 All digits in the column of 1s

Hexadecimal number system

Why use hexadecimal digits to represente IPv6 addresses?

- 4 bits (half of na octet) can be represented by a single digit.
- 2 digits can represente a single octet.

Hexadecimal is a natural fit for IPv6 addresses.

IPv6 Address Types

- Global Unicast Address
  - Globally unique
  - Routable
  - (eq. to public IPv4 addresses)
  - Begins with 2 or 3
  - Can be source or destination

```
2001:db8:cafe:1::100
```

- Link-local Unicast Address
  - Link refers to a logical network segment or subnet
  - Limited to a particular link
  - Not routable beyond the local subnet
  - Any IPv6-enabled device requires one
  - Typically auto-created by the device's OS
  - Commonly begin with fe80
  - Can be source or destination

```
fe80::a299:9bff:fe18:50d1
```

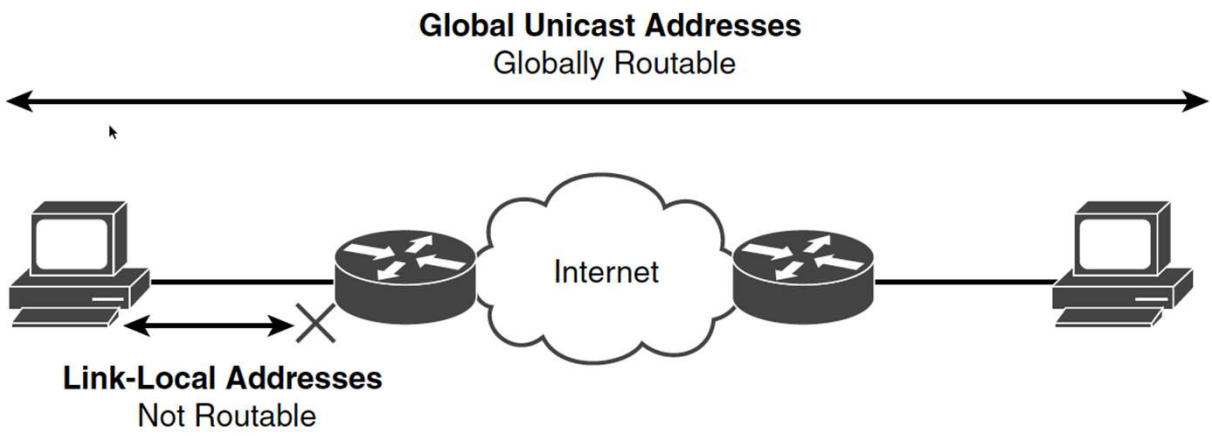

Figure 2-1 *Comparison Between IPv6 Global Unicast Address Addresses and Link-Local Addresses*

IPv6 Address Types

- Unspecified Address
  - All-0s address
  - Must never be assigned to a node
  - Indicates the absence of an address
  - Used only as a source by na initializing host
  - Never forwarded by na IPv6 router

  `0:0:0:0:0:0:0:0`

- Multicast Address
  - Is an identifier for a group of interfaces (typically on diferente nodes).
  - Defines a group of devices known as a multicast group.
  - Use prefix ff00::/8 (eq. to IPv4 multicast 224.0.0.0/4).
  - Can only be a destination address.
  - IPv6 does not have a broadcast address but does include na all-IPv6 devices multicast address.

  `ff02::1:` All IPv6 devices
  `ff02::2:` All IPv6 routers

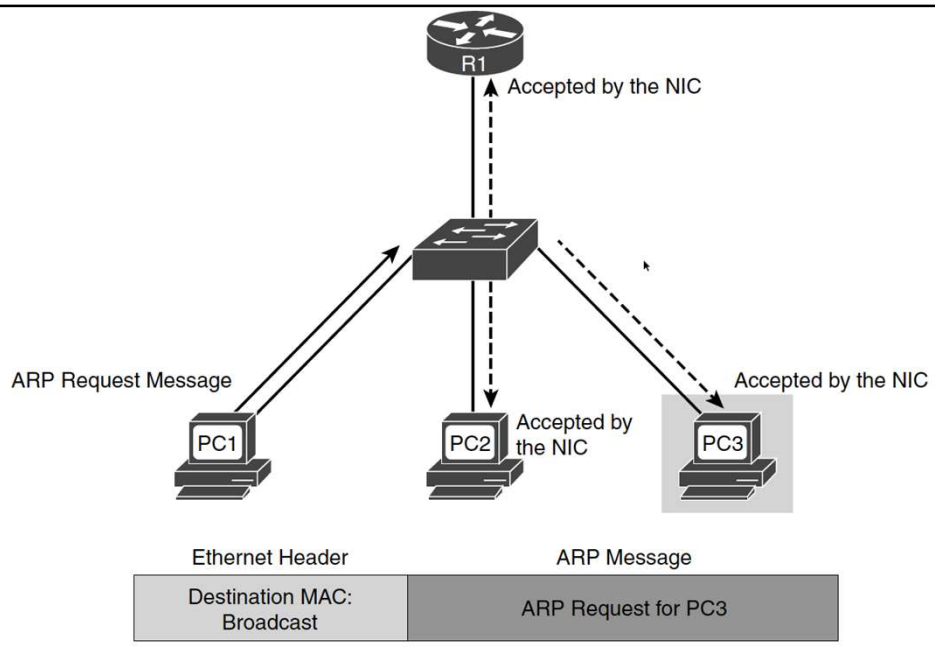

Figure 2-2 *ARP Request in IPv4*

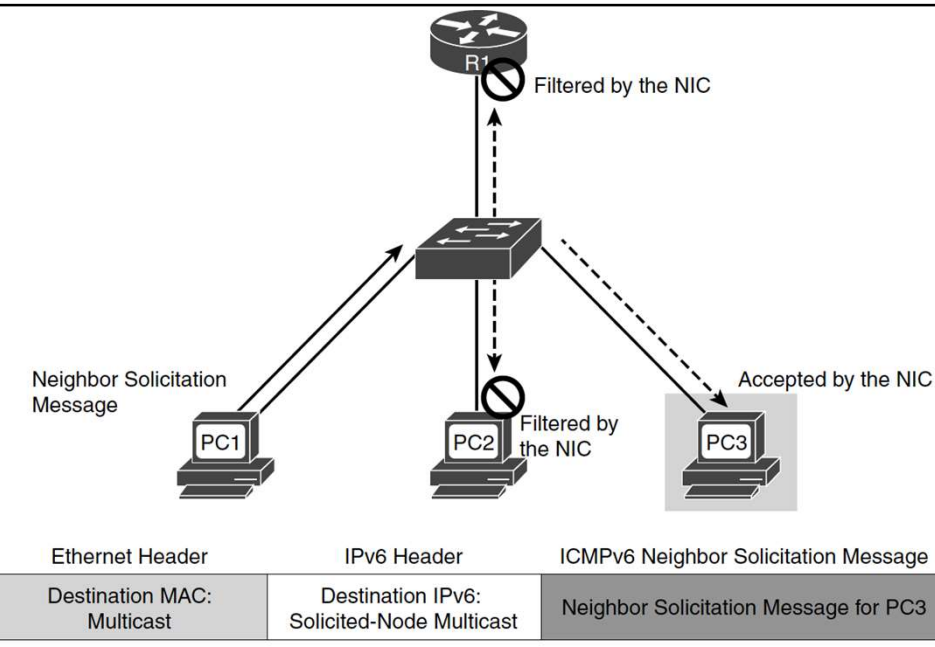

Figure 2-3 *Neighbor Solicitation Message in IPv6*

Address Terminology

- **Prefix:** the network portion of na IPv6 address.
- **Prefix length:** the number of most-significant (leftmost) bits, that define the prefix.
- **Node or device:** anything that can have na IPv6 address.
- **Interface ID:** eq. to the host portion of na IPv4 address. This name is used because na IP address is assigned to na interface, and a device may have multiple interfaces.

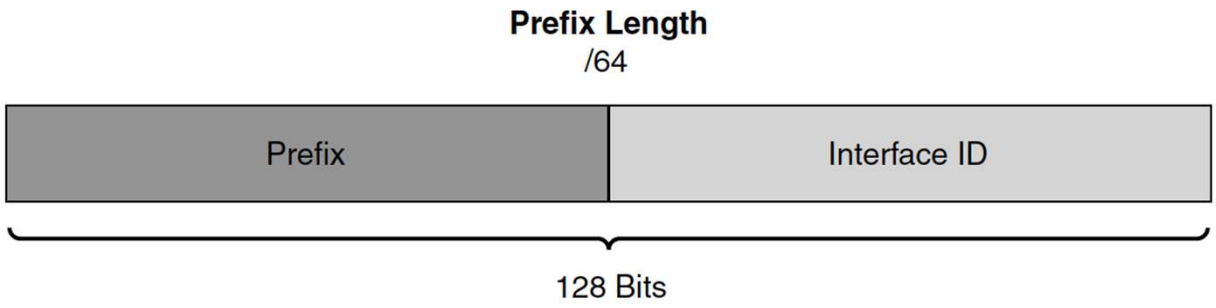

Figure 2-4 *Example of an IPv6 Global Unicast Address*

ICMPv6 NDP

- The ICMPv6 Neighbour Discovery Protocol (NDP) adds new functionality used for on-link (same subnet) device discovery and messaging.

- NDP includes 5 message types:
  - Router Solicitation
  - Router Advertisement
  - Neighbour Solicitation
  - Neighbour Advertisement
  - Redirect Messages

Used for messaging between a device and a router on the same link (subnet)

Used for messaging between any two devices on the same link (subnet)

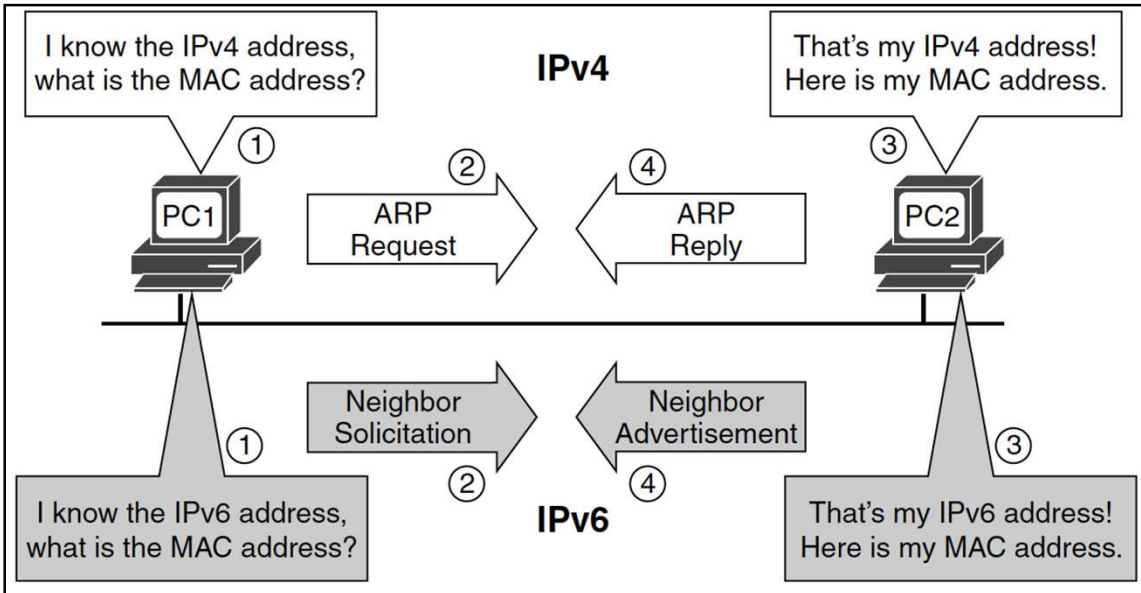

Figure 2-5 *Comparison of IPv4 ARP Request and ARP Reply to IPv6 NS and NA Messages*

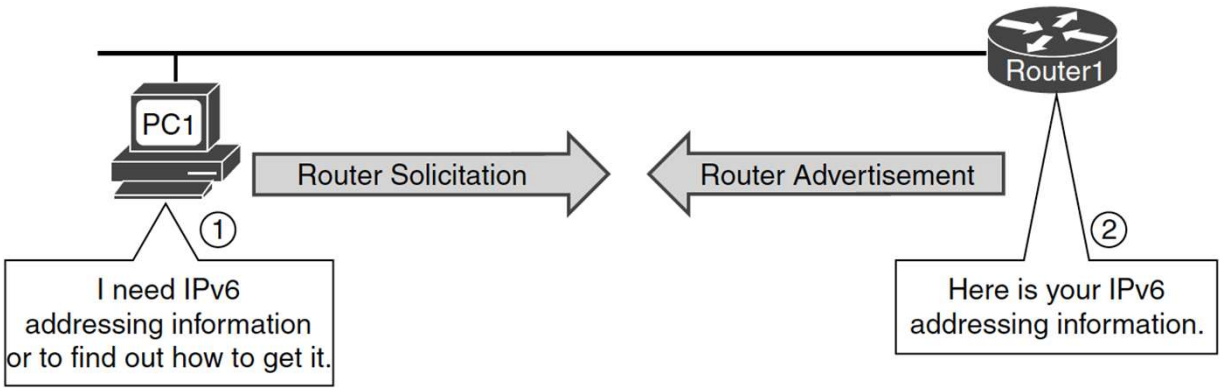

Figure 2-6 *ICMPv6 Router Solicitation and Router Advertisement Messages*

Dynamic Address Allocation

IPv4 devices have 2 ways to get addressing information:

- IP address
- Subnet mask
- Default gateway address
- Domain name
- DNS server address

- Static configuration
- Dynamic configuration from a DHCP server

In IPv6, addresses can also be statically or dynamically assigned

Dynamic addressing

- IPv6 uses the ICMPv6 Router Advertisement (RA) message to suggest how to obtain IPv6 addressing information.
- An IPv6 router sends a RA message periodically (every 200 seconds) or when it receives a Router Solicitation request.
- The RA message is typically sent to the all-IPv6 devices multicast address (ff02::1), so every device on the link receives it. (It can also be sent in unicast).
- Other routers do not forward RA messages.

Dynamic Address Allocation

The RA message will advertise one of 3 methods:

- Method 1: Stateless Address Autoconfiguration (SLAAC)
- Method 2: SLAAC and stateless DHCPv6 server
- Method 3: Statefull DHCPv6 server

Dynamic Address Allocation

The RA message will advertise one of 3 methods:

- Method 1: Stateless Address Autoconfiguration (SLAAC)
  - The device uses the information in the RA message for all of its addressing needs.
  - It uses the prefix in the RA to create na IPv6 global unicast address.
  - Will use the source IPv6 address of the RA as its default gateway.
  - This is the default in Cisco IOS.
- Method 2: SLAAC and stateless DHCPv6 server
- Method 3: Statefull DHCPv6 server

Dynamic Address Allocation

The RA message will advertise one of 3 methods:

- Method 1: Stateless Address Autoconfiguration (SLAAC)
- Method 2: SLAAC and stateless DHCPv6 server:
  - Devices use information in the RA message to create their IPv6 global unicast addresses. The RA message may contain other information but the device should contact a stateless DHCPv6 server for additional information (such as DNS server address).
- Method 3: Statefull DHCPv6 server:
  - This method is similar to DHCP for IPv4.

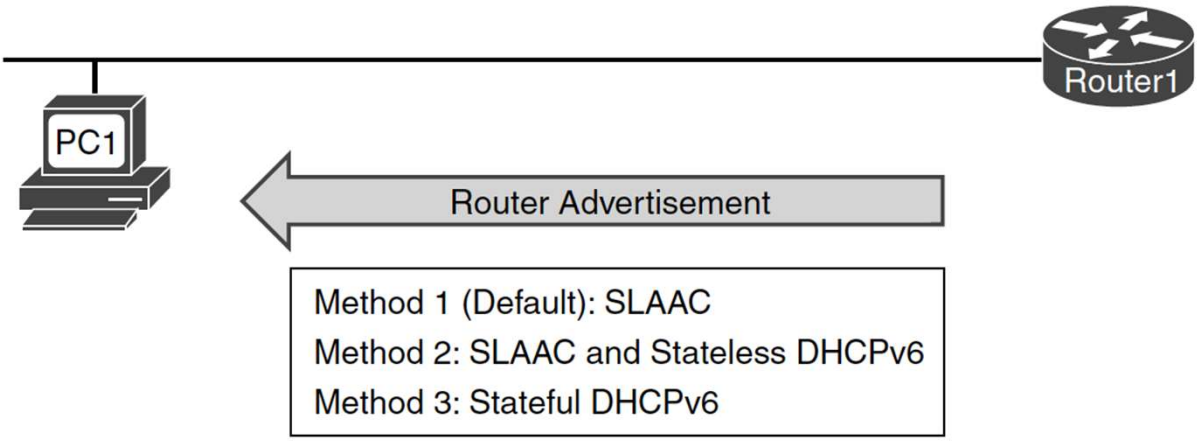

Figure 2-7 *ICMPv6 Router Advertisement Methods*