CCNA 200-301, Volume I

Chapter 24 Implementing IPv6 Addressing on Routers

Objectives

- Implementing Unicast IPv6 Addresses on Routers
- Special Addresses Used by Routers

Migration of Enterprise Networks to use TCP/IP Stack Only, IPv4



Likely Path Through Dual-Stack (IPv4 and IPv6) over a Long Period



128-bit IPv6 Addresses to be Configured on Cisco Router Interfaces



Configuring Static IPv6 Addresses on R1

ipv6 unicast-routing

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interface GigabitEthernet0/0

ipv6 address 2001:DB8:1111:1::1/64

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interface GigabitEthernet0/0/0

ipv6 address 2001:0db8:1111:0004:0000:0000:0000/64

Configuring Static IPv6 Addresses on R2

ipv6 unicast-routing

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interface GigabitEthernet0/0

ipv6 address 2001:DB8:1111:2::2/64

1

interface GigabitEthernet0/1/0

ipv6 address 2001:db8:1111:4::2/64

Verifying Static IPv6 Addresses on Router R1

! The first interface is in subnet 1 R1# show ipv6 interface GigabitEthernet 0/0 GigabitEthernet0/0 is up, line protocol is up IPv6 is enabled, link-local address is FE80::1:AAFF:FE00:1 No Virtual link-local address(es): Global unicast address(es): 2001:DB8:1111:1::1, subnet is 2001:DB8:1111:1::/64 Joined group address(es): FF02::1 FF02::2 FF02::1:FF00:1 MTU is 1500 bytes ICMP error messages limited to one every 100 milliseconds ICMP redirects are enabled ICMP unreachables are sent ND DAD is enabled, number of DAD attempts: 1 ND reachable time is 30000 milliseconds (using 30000) ND advertised reachable time is 0 (unspecified) ND advertised retransmit interval is 0 (unspecified) ND router advertisements are sent every 200 seconds ND router advertisements live for 1800 seconds ND advertised default router preference is Medium Hosts use stateless autoconfig for addresses. R1# show ipv6 interface brief GigabitEthernet0/0 [up/up] FE80::1:AAFF:FE00:1 2001:DB8:1111:1::1 GigabitEthernet0/1 [administratively down/down] unassigned GigabitEthernet0/0/0 [up/up] FE80::32F7:DFF:FE29:8568 2001:DB8:1111:4::1 GigabitEthernet0/1/0 [administratively down/down] unassigned

Verifying Static IPv6 Addresses on Router R1 (Continued)

R1#**show ipv6 interface So/o/o**

Serialo/0/0 is up, line protocol is up IPv6 is enabled, link-local address is FE80::1FF:FE01:101 No Virtual link-local address(es): Description: link to R2 Global unicast address(es): 2001:DB8:1111:2::1, subnet is 2001:DB8:1111:2::/64 Joined group address(es): FF02::1 FF02::2 FF02::A

FF02..A

FF02::1:FF00:1

FF02::1:FF01:101

MTU is 1500 bytes

! Lines omitted for brevity

R1#**show ipv6 interface brief**

GigabitEtherneto/o [up/up] FE80::1FF:FE01:101 2001:DB8:1111:1::1 GigabitEtherneto/1 [administratively down/down] unassigned Serialo/o/o [up/up] FE80::1FF:FE01:101 2001:DB8:1111:2::1 Serialo/o/1 [administratively down/down] unassigned

Displaying Connected IPv6 Routes on Router R1

R1# show ipv6 route connected IPv6 Routing Table - default - 5 entries Codes: C - Connected, L - Local, S - Static, U - Per-user Static route B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect RL - RPL, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1 OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2 la - LISP alt, lr - LISP site-registrations, ld - LISP dyn-eid 1A - LISP away, a - Application С 2001:DB8:1111:1::/64 [0/0] via GigabitEthernet0/0, directly connected С 2001:DB8:1111:4::/64 [0/0]

via GigabitEthernet0/0/0, directly connected

IPv6 Address Format with Interface ID and EUI-64



Two Examples of Most of the EUI-64 Interface ID Process



Inverting the 7th Bit of an EUI-64 Interface ID Field



A Mnemonic Device to Help Memorize Hex Digits before and after 3rd Bit Inversion



IPv6 EUI-64 Address Creation Practice

| Prefix | MAC Address | Unabbreviated IPv6 Address |
|---------------------|----------------|----------------------------|
| 2001:DB8:1:1::/64 | 0013.ABAB.1001 | |
| 2001:DB8:1:1::/64 | AA13.ABAB.1001 | |
| 2001:DB8:1:1::/64 | 000C.BEEF.CAFE | |
| 2001:DB8:1:1::/64 | B80C.BEEF.CAFE | |
| 2001:DB8:FE:FE::/64 | 0C0C.ABAC.CABA | |
| 2001:DB8:FE:FE::/64 | 0A0C.ABAC.CABA | |

Configuring R1's IPv6 Interfaces using EUI-64

ipv6 unicast-routing

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! The ipv6 address command now lists a prefix, not the full address

interface GigabitEthernet0/0

mac-address 0201.aa00.0001

ipv6 address 2001:DB8:1111:1::/64 eui-64

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interface GigabitEthernet0/0/0

ipv6 address 2001:DB8:1111:4::/64 eui-64

R1# show ipv6 interface brief

GigabitEthernet0/0 [up/up]

FE80::1:AAFF:FE00:1

2001:DB8:1111:1:1:AAFF:FE00:1

GigabitEthernet0/1 [administratively down/down]

unassigned

GigabitEthernet0/0/0 [up/up]

FE80::32F7:DFF:FE29:8568

2001:DB8:1111:4:32F7:DFF:FE29:8568

GigabitEthernet0/0/1 [administratively down/down]

unassigned

Router Configuration to Learn IPv6 Addresses with DHCP And SLAAC

```
! This interface uses DHCP to learn its IPv6 address
interface FastEthernet0/0
ipv6 address dhcp
!
! This interface uses SLAAC to learn its IPv6 address
interface FastEthernet0/1
ipv6 address autoconfig
```

IPv6 Using Link-local Addresses as the Next-Hop Address



Link-local Address Format



Comparing Link-local Addresses with EUI-generated Unicast Addresses

R1# show ipv6 interface brief

GigabitEthernet0/0 [up/up]

FE80::1:AAFF:FE00:1

2001:DB8:1111:1:1:AAFF:FE00:1

GigabitEthernet0/1 [administratively down/down]

unassigned

GigabitEthernet0/0/0 [up/up]

FE80::32F7:DFF:FE29:8568

2001:DB8:1111:4:32F7:DFF:FE29:8568

GigabitEthernet0/0/1 [administratively down/down]

unassigned

Key IPv6 Local-Scope Multicast Addresses

| Short Name | Multicast Address | Meaning | IPv4 Equivalent |
|---------------------------|----------------------|--|----------------------|
| All-nodes | FF02::1 | All-nodes (all interfaces that use IPv6 that are on the link) | 224.0.0.1 |
| All-routers | FF02::2 | All-routers (all IPv6 router interfaces on the link) | 224.0.0.2 |
| All-OSPF, All- OSPF-DR | FF02::5, FF02::6 | All OSPF routers and all OSPF-designated routers, respectively | 224.0.0.5, 224.0.0.6 |
| RIPng Routers | FF02::9 | All RIPng routers | 224.0.0.9 |
| EIGRPv6 Routers | FF02::A | All routers using EIGRP for IPv6 (EIGRPv6) | 224.0.0.10 |
| DHCP Relay Agent | FF02::1:2 | All routers acting as a DHCPv6 relay agent | None |

Verifying Static IPv6 Addresses on Router R1

R1# show ipv6 interface GigabitEthernet 0/0
GigabitEthernet0/0 is up, line protocol is up
IPv6 is enabled, link-local address is FE80::1
No Virtual link-local address(es):
Global unicast address(es):
2001:DB8:1111:1::1, subnet is 2001:DB8:1111:1::/64 [EUI]
Joined group address(es):
FF02::1
FF02::2
FF02::5
FF02::6
FF02::1:FF00:1
! Lines omitted for brevity

IPv6 Multicast Scope Terms

| Scope Name | First Quartet | Scope Defined by | Meaning |
|------------------------|------------------|--------------------------|--|
| Interface- Local | FF01 | Derived by Device | Packet remains within the device. Useful for internally sending packets to services running on that same host. |
| Link-Local | FF02 | Derived by Device | Host that creates the packet can send it onto the link, but no routers forward the packet. |
| Site-Local | FF05 | Configuration on Routers | Intended to be more than Link-Local, so routers forward, but must be less than Organization-Local; generally meant to limit packets so they do not cross WAN links. |
| Organization- Local | FF08 | Configuration on Routers | Intended to be broad, probably for an entire company or organization. Must be broader than Site-Local. |
| Global | FF0E | No Boundaries | No boundaries. |

IPv6 Multicast Scopes



Solicited-node Multicast Address Format



Verifying Static IPv6 Addresses on Router R1

```
R1# show ipv6 interface GigabitEthernet 0/0
GigabitEthernet0/0 is up, line protocol is up
  IPv6 is enabled, link-local address is FE80::1
 No Virtual link-local address(es):
  Global unicast address(es):
    2001:DB8:1111:1::1, subnet is 2001:DB8:1111:1::/64 [EUI]
  Joined group address(es):
    FF02::1
                   2
    FF02::2
    FF02::5
    FF02::6
    FF02::1:FF00:1
 ! Lines omitted for brevity
```

IPv6 Anycast Addresses



Configuring and Verifying IPv6 Anycast Addresses

```
R1# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)# interface gigabitEthernet 0/0
R1(config-if)# ipv6 address 2001:1:1:1:1:1/64
R1(config-if)# ipv6 address 2001:1:1:2::99/128 anycast
R1(config-if)# ^Z
R1#
R1# show ipv6 interface g0/0
GigabitEthernet0/0 is up, line protocol is up
    IPv6 is enabled, link-local address is FE80::11FF:FE11:111
    No Virtual link-local address(es):
    Global unicast address(es):
       2001:1:1:1:1:1, subnet is 2001:1:1:1::/64
       2001:1:1:2::99, subnet is 2001:1:1:2::99/128 [ANY]
 ! Lines omitted for brevity
R1# show ipv6 interface brief g0/0
GigabitEthernet0/0 [up/up]
     FE80::11FF:FE11:1111
     2001:1:1:1:1
     2001:1:1:2::99
```

Summary of IPv6 Address Types and the Commands That Create Them Type Prefix/Address

| Туре | Prefix/Address Notes | Enabled with What Interface Subcommand |
|-----------------------------|-------------------------|--|
| Global unicast | Many prefixes | ipv6 address address/prefix-length |
| | | ipv6 address prefix/prefix-length eui-64 |
| Unique Local | FD00::/8 | ipv6 address prefix/prefix-length eui-64 |
| Link local | FE80::/10 | ipv6 address address link-local |
| | | Autogenerated by all ipv6 address commands |
| | | Autogenerated by the ipv6 enable command |
| All hosts multicast | FF02::1 | Autogenerated by all ipv6 address commands |
| All routers multicast | FF02::2 | Autogenerated by all ipv6 address commands |
| Routing protocol multicasts | Various | Added to the interface when the corresponding routing protocol is enabled on the interface |
| Solicited-node multicast | FF02::1:FF /104 | Autogenerated by all ipv6 address commands |