

version 4



IEWB-RS Technology Labs

IPv6

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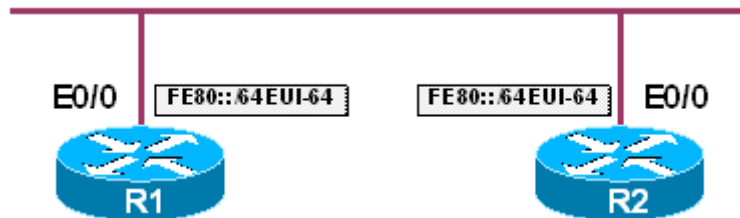
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| | |
|---|----|
| UNDERSTANDING LINK LOCAL AND EUI-64 IPV6 ADDRESSING | 1 |
| UNDERSTANDING SITE LOCAL IPV6 ADDRESSING..... | 4 |
| UNDERSTANDING GLOBAL UNICAST IPV6 ADDRESSING | 7 |
| IPV6 OVER FRAME RELAY – MULTIPOINT..... | 9 |
| IPV6 OVER FRAME RELAY – POINT-TO-POINT | 12 |

Understanding Link Local and EUI-64 IPv6 Addressing

Objective: Enable link-local IPv6 processing on the Ethernet segment between R1 and R2 using the modified EUI-64 addressing for the host portion of the addresses



Directions

- Enable IPv6 processing on the Ethernet interfaces of R1 and R2
- Verify connectivity between R1 and R2 using their link-local addresses

Ask Yourself

- What is the difference between a link-local, site-local, and global unicast IPv6 address?
- How do you verify what link-local address an interface has been assigned?
- What is modified EUI-64 addressing and what purpose does it serve?

Final Configuration

```
R1 & R2:
interface Ethernet0/0
  ipv6 enable
  no shutdown
```

Verification

```
R1#show interface ethernet0/0
Ethernet0/0 is up, line protocol is up
  Hardware is AmdP2, address is 0030.1969.81a0 (bia 0030.1969.81a0)
  (output omitted)

R1#show ipv6 interface ethernet0/0
Ethernet0/0 is up, line protocol is up
  IPv6 is enabled, link-local address is FE80::230:19FF:FE69:81A0
  No global unicast address is configured
  Joined group address(es):
    FF02::1
    FF02::1:FF69:81A0
  MTU is 1500 bytes
```

```
ICMP error messages limited to one every 100 milliseconds
ICMP redirects are enabled
ND DAD is enabled, number of DAD attempts: 1
ND reachable time is 30000 milliseconds

R2#show interface ethernet0/0
Ethernet0/0 is up, line protocol is up
  Hardware is AmdP2, address is 0002.4b51.7c00 (bia 0002.4b51.7c00)
  (output omitted)

R2#show ipv6 interface ethernet0/0
Ethernet0/0 is up, line protocol is up
  IPv6 is enabled, link-local address is FE80::202:4BFF:FE51:7C00
  No global unicast address is configured
  Joined group address(es):
    FE02::1
    FE02::1:FE51:7C00
  MTU is 1500 bytes
  ICMP error messages limited to one every 100 milliseconds
  ICMP redirects are enabled
  ND DAD is enabled, number of DAD attempts: 1
  ND reachable time is 30000 milliseconds

R1#ping FE80::202:4BFF:FE51:7C00
Output Interface: ethernet0/0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to FE80::202:4BFF:FE51:7C00, timeout is 2
seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/4/8 ms
```

Breakdown

A link-local IPv6 address is any address that begins with the bit pattern 111111010, or FE80::/10 as denoted in IPv6 addressing format. Link-local addresses are said to have "link-local scope", meaning that packets sourced from or destined to a link-local address cannot leave the local link. Link-local addresses are used in ICMPv6 neighbor discovery as well as stateless autoconfiguration in order to communicate with devices that do not have a global unicast address assigned and during duplicate address detection. When IPv6 is enabled on an interface either by issuing the `ipv6 enable` command or by configuring a global unicast/anycast address on the interface with the `ipv6 address` command a link-local address is automatically generated using the prefix FE80::/64 and the modified EUI-64 host addressing. Link-local addresses can also be manually configured by adding the `link-local` option on to the end of the `ipv6 address` interface level command.

The modified EUI-64 host portion of the link-local address is derived from the MAC address of the interface, or if the interface does not have a MAC address (such as a serial or tunnel interface), from the MAC address pool of the router. The EUI-64 address is specifically derived as follows: In the above example R1 is seen to have the burnt-in MAC address 0030.1969.81a0. First, the sequence

FFFE is inserted between the vendor-id (3 most significant bytes) and the extension-id (3 least significant bytes), resulting in the address 0030.19FF.FE69.81A0. Next, the 7th most significant bit, known as the universal/local bit, is inverted. Lastly the dots are replaced with colons to follow the IPv6 address notation and any leading zeros are dropped, resulting in the final address 230:19FF:FE69:81A0. Combined with the FE80::/64 prefix, the resulting address is FE80::230:19FF:FE69:81A0/64.

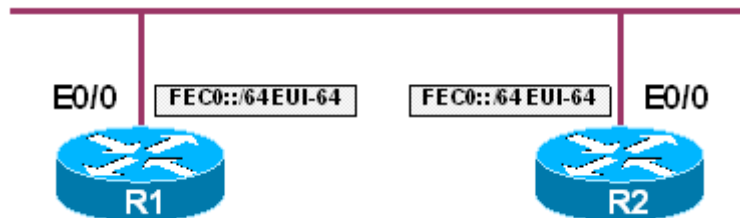


Recommended Reading

[Implementing Basic Connectivity for IPv6](#)

Understanding Site Local IPv6 Addressing

Objective: Configure IPv6 on the Ethernet segment between R1 and R2 using the site local network FEC0::/64 and EUI-64 based host addresses



Directions

- Configure IPv6 processing on the Ethernet segment between R1 and R2 using the site local network FEC0::/64
- The host portion of R1 and R2's IPv6 addresses should be derived from the modified EUI-64 addressing

Ask Yourself

- What is the difference between link-local, site-local, and global unicast/anycast IPv6 addresses?
- What prefix does a site-local address begin with?
- What are the advantages of using site-local addressing over assigned global-unicast addressing?

Final Configuration

```
R1 & R2:
interface Ethernet0/0
  ipv6 address FEC0::/64 eui-64
  no shutdown
```

Verification

```
R1#show ipv6 int brief
Ethernet0/0          [up/up]
  FE80::230:19FF:FE69:81A0
  FEC0::230:19FF:FE69:81A0
(output omitted)

R1#show ipv6 int ethernet0/0
Ethernet0/0 is up, line protocol is up
  IPv6 is enabled, link-local address is FE80::230:19FF:FE69:81A0
  Global unicast address(es):
    FEC0::230:19FF:FE69:81A0, subnet is FEC0::/64
```

```

Joined group address(es):
  FF02::1
  FF02::1:FF69:81A0
MTU is 1500 bytes
ICMP error messages limited to one every 100 milliseconds
ICMP redirects are enabled
ND DAD is enabled, number of DAD attempts: 1
ND reachable time is 30000 milliseconds

R2#show ipv6 int brief
Ethernet0/0                [up/up]
  FE80::202:4BFF:FE51:7C00
  FEC0::202:4BFF:FE51:7C00
(output omitted)

R2#show ipv6 int ethernet0/0
Ethernet0/0 is up, line protocol is up
IPv6 is enabled, link-local address is FE80::202:4BFF:FE51:7C00
Global unicast address(es):
  FEC0::202:4BFF:FE51:7C00, subnet is FEC0::/64
Joined group address(es):
  FF02::1
  FF02::1:FF51:7C00
MTU is 1500 bytes
ICMP error messages limited to one every 100 milliseconds
ICMP redirects are enabled
ND DAD is enabled, number of DAD attempts: 1
ND reachable time is 30000 milliseconds

R1#ping ipv6 FEC0::202:4BFF:FE51:7C00

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to FEC0::202:4BFF:FE51:7C00, timeout is 2
seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/3/8 ms

R1#show ipv6 neighbors
IPv6 Address                               Age Link-layer Addr State Interface
FE80::202:4BFF:FE51:7C00                   0 0002.4b51.7c00 DELAY Et0/0
FEC0::202:4BFF:FE51:7C00                   0 0002.4b51.7c00 REACH Et0/0

R2#show ipv6 neighbors
IPv6 Address                               Age Link-layer Addr State Interface
FE80::230:19FF:FE69:81A0                   0 0030.1969.81a0 REACH Et0/0
FEC0::230:19FF:FE69:81A0                   0 0030.1969.81a0 REACH Et0/0

```

Breakdown

Site-local IPv6 addresses are similar to private addresses defined in RFC 1918 for IPv4, as they are designed to be used as address space only routable within a private network. Site-local IPv6 addresses start with the bit pattern 111111011, expressed as FEC0::/10 in IPv6 address format (not to be confused with the link-local FE80::/10 address space). By identifying the site-local address space with a unique prefix (FEC0::/10) ingress and egress filtering can be easily

applied to prevent traffic from/to hosts using this address space moving between site boundaries at the network edge.

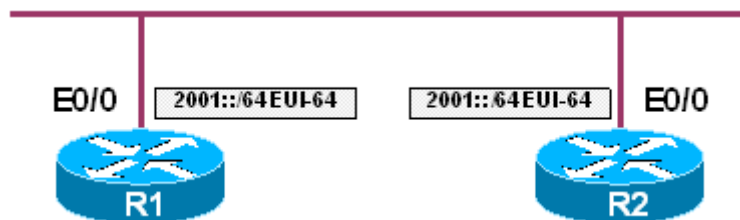
Due to the lack of a proper definition of what actually constitutes a "site", and for other design consideration, site-local addresses have been formally deprecated in RFC 3879, "Deprecating Site Local Addresses".



Recommended Reading

[RFC 3879: Deprecating Site Local Addresses](#)
[Implementing Basic Connectivity for IPv6](#)

Understanding Global Unicast IPv6 Addressing



Objective: Configure IPv6 on the Ethernet segment between R1 and R2 using the global unicast network 2001::/64 and host addresses derived from the modified EUI-64 formatting

Directions

- Configure the IPv6 network 2001::/64 on the Ethernet interfaces of R1 and R2
- Use the modified EUI-64 addressing for the host portion of their IPv6 addresses

Ask Yourself

- What is the difference between link-local, site-local, and global unicast/anycast IPv6 addresses?
- How many possible hosts are there in the entire global-unicast address space?

Final Configuration

```
R1 & R2:
interface Ethernet0/0
  ipv6 address 2001::/64 eui-64
```

Verification

```
R1#show ipv6 int brief
Ethernet0/0          [up/up]
  FE80::230:19FF:FE69:81A0
  2001::230:19FF:FE69:81A0
(output omitted)

R1#show ipv6 int e0/0
Ethernet0/0 is up, line protocol is up
  IPv6 is enabled, link-local address is FE80::230:19FF:FE69:81A0
  Global unicast address(es):
    2001::230:19FF:FE69:81A0, subnet is 2001::/64
```

```
Joined group address(es):
  FE02::1
  FE02::1:FF69:81A0
MTU is 1500 bytes
ICMP error messages limited to one every 100 milliseconds
ICMP redirects are enabled
ND DAD is enabled, number of DAD attempts: 1
ND reachable time is 30000 milliseconds

R2#show ipv6 int brief
Ethernet0/0 [up/up]
  FE80::202:4BFF:FE51:7C00
  2001::202:4BFF:FE51:7C00
(output omitted)

R2#show ipv6 int e0/0
Ethernet0/0 is up, line protocol is up
IPv6 is enabled, link-local address is FE80::202:4BFF:FE51:7C00
Global unicast address(es):
  2001::202:4BFF:FE51:7C00, subnet is 2001::/64
Joined group address(es):
  FE02::1
  FE02::1:FF51:7C00
MTU is 1500 bytes
ICMP error messages limited to one every 100 milliseconds
ICMP redirects are enabled
ND DAD is enabled, number of DAD attempts: 1
ND reachable time is 30000 milliseconds

R1#ping ipv6 2001::202:4BFF:FE51:7C00

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001::202:4BFF:FE51:7C00, timeout is 2
seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
R1#
```

Breakdown

A global-unicast IPv6 address, also known as an aggregatable global address, is an address that begins with the binary sequence 001, denoted as 2000::/3 in IPv6 addressing format. The entire global unicast address range runs from 2000::/128 to 3FFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF/128, resulting in a total usable space of over 42,535,295,865,117,307,932,921,825,928,971,000,000 addresses, which is only 1/8th of the entire IPv6 address space!

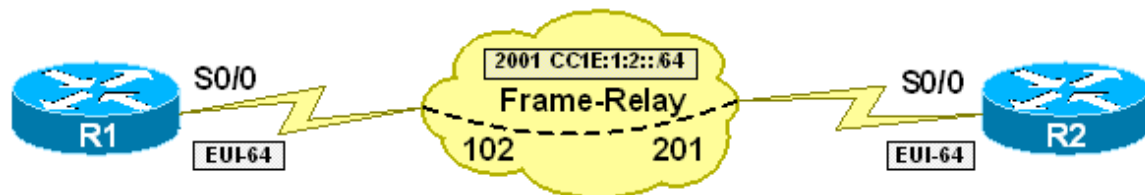


Recommended Reading

[Implementing Basic Connectivity for IPv6](#)

IPv6 over Frame Relay – Multipoint

Objective: Configure IPv6 over the Frame Relay circuit between R1 and R2 using only physical interfaces. Use the IPv6 network 2001:CC1E:1:2::/64 and host addresses based off the modified EUI-64 addressing



Directions

- Configure the serial interfaces of R1 and R2 with the IPv6 addresses 2001:CC1E:1:2::/64 using the modified EUI-64 host addressing
- Configure the Frame Relay circuit between R1 and R2 using static layer 3 to layer 2 resolution

Ask Yourself

- Does frame-relay inverse-arp have support for IPv6?
- How is the above configuration similar to configuring IPv4 over Frame Relay?

Step-by-Step Configuration

1. Configure IPv6 addressing on R1 and R2's serial interfaces

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#interface serial0/0
R1(config-if)#ipv6 address 2001:CC1E:1:2::/64 eui-64
R1(config-if)#

R2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R2(config)#interface serial0/0
R2(config-if)#ipv6 address 2001:CC1E:1:2::/64 eui-64
R2(config-if)#
```

2. Discover the IPv6 host addresses of R1 and R2 needed for Frame Relay mappings

```
R1(config-if)#do show ipv6 int brief
```

```

Ethernet0/0          [up/up]
  unassigned
Serial0/0            [administratively down/down]
  FE80::230:19FF:FE69:81A0
  2001:CC1E:1:2:230:19FF:FE69:81A0
Serial0/1            [administratively down/down]
  unassigned
Virtual-Access1     [up/up]
  unassigned
R1(config-if)#

R2(config-if)#do show ipv6 int brief
Ethernet0/0          [up/up]
  unassigned
Serial0/0            [administratively down/down]
  FE80::202:4BFF:FE51:7C00
  2001:CC1E:1:2:202:4BFF:FE51:7C00
Serial0/1            [administratively down/down]
  unassigned
Virtual-Access1     [up/up]
  unassigned
R2(config-if)#

```

3. Configure the Frame Relay circuit between R1 and R2 for IPv6

```

R1(config-if)#encapsulation frame-relay
R1(config-if)#frame-relay map ipv6 2001:CC1E:1:2:202:4BFF:FE51:7C00 102
R1(config-if)#no shut
R1(config-if)#end
R1#

R2(config-if)#encapsulation frame-relay
R2(config-if)#frame-relay map ipv6 2001:CC1E:1:2:230:19FF:FE69:81A0 201
R2(config-if)#no shut
R2(config-if)#end
R2#

```

Final Configuration

```

R1:
interface Serial0/0
  encapsulation frame-relay
  ipv6 address 2001:CC1E:1:2::/64 eui-64
  frame-relay map ipv6 2001:CC1E:1:2:202:4BFF:FE51:7C00 102

R2:
interface Serial0/0
  encapsulation frame-relay
  ipv6 address 2001:CC1E:1:2::/64 eui-64
  frame-relay map ipv6 2001:CC1E:1:2:230:19FF:FE69:81A0 201

```

Verification

```
R1#show frame-relay map
Serial0/0 (up): ipv6 2001:CC1E:1:2:202:4BFF:FE51:7C00 dlci 102(0x66,0x1860), static,
                CISCO, status defined, active

R2#show frame-relay map
Serial0/0 (up): ipv6 2001:CC1E:1:2:230:19FF:FE69:81A0 dlci 201(0xC9,0x3090), static,
                CISCO, status defined, active

R1#ping ipv6 2001:CC1E:1:2:202:4BFF:FE51:7C00

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:CC1E:1:2:202:4BFF:FE51:7C00, timeout is 2
seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/4/4 ms
```

Breakdown

Similar to IPv4 over multipoint Frame Relay interfaces, Frame Relay requires layer 3 to layer 2 resolution when running IPv6 over multipoint Frame Relay interfaces. As of the current IOS releases however, Frame Relay does not yet support IPv6 Inverse Neighbor Discovery, which is analogous to Frame Relay Inverse-ARP for IPv4. This implies that multipoint Frame Relay interfaces running IPv6 must be configured with static layer 3 to layer 2 resolution through the `frame-relay map ipv6` statement.

In the above example the host portion of the IPv6 addresses used on the Frame Relay network are derived from the modified EUI-64 addressing format. Therefore, in order to determine which address to use in the `frame-relay map ipv6` statement, the `show ipv6 int brief` command is used to determine what the entire global-unicast address assigned to the interface is (the prefix 2001:CC1E:1:2 plus the EUI-64).

Note that the broadcast command is omitted from the above configuration. The implications of configuring multicast support (IPv6 does not use broadcast packets) through layer 2 replicated unicast will be covered in additional scenarios of this series.



Recommended Reading

[Implementing Basic Connectivity for IPv6: Configuring IPv6 ATM and Frame Relay Interfaces](#)

IPv6 over Frame Relay – Point-to-Point

Objective: Configure IPv6 over the Frame Relay connection between R1 and R2 using point-to-point subinterfaces



Directions

- Configure Frame Relay encapsulation on the serial interfaces of R1 and R2
- Configure a point-to-point subinterface Serial0/0.1 on R1 and R2
- Configure these interfaces with the IPv6 network 2001:CC1E:1:2::/64 using the modified EUI-64 host address format
- Assign the respective Frame Relay DLCI to the subinterfaces of R1 and R2 per the diagram

Ask Yourself

- Do point-to-point NBMA interfaces require layer 3 to layer 2 resolution?
- How does this affect the configuration of IPv6 over Frame Relay?

Final Configuration

```
R1:
interface Serial0/0
  encapsulation frame-relay
  !
interface Serial0/0.1 point-to-point
  ipv6 address 2001:CC1E:1:2::/64 eui-64
  frame-relay interface-dlci 102

R2:
interface Serial0/0
  encapsulation frame-relay
  !
interface Serial0/0.1 point-to-point
  ipv6 address 2001:CC1E:1:2::/64 eui-64
  frame-relay interface-dlci 201
```

Verification

```
R1#show frame-relay map
Serial0/0.1 (up): point-to-point dlci, dlci 102(0x66,0x1860), broadcast
```

```
status defined, active

R1#show ipv6 int brief
Ethernet0/0 [administratively down/down]
  unassigned
Serial0/0 [up/up]
  unassigned
Serial0/0.1 [up/up]
  FE80::230:19FF:FE69:81A0
  2001:CC1E:1:2:230:19FF:FE69:81A0
  (output omitted)

R2#show frame-relay map
Serial0/0.1 (up): point-to-point dlci, dlci 201(0xC9,0x3090), broadcast
  status defined, active

R2#show ipv6 int brief
Ethernet0/0 [administratively down/down]
  unassigned
Serial0/0 [up/up]
  unassigned
Serial0/0.1 [up/up]
  FE80::202:4BFF:FE51:7C00
  2001:CC1E:1:2:202:4BFF:FE51:7C00
  (output omitted)

R1#ping ipv6 2001:CC1E:1:2:202:4BFF:FE51:7C00

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:CC1E:1:2:202:4BFF:FE51:7C00, timeout is
2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/4/8 ms
R1#
```

Breakdown

Similar to configuring other layer 3 protocols over point-to-point Frame Relay connections, the only steps to configuring IPv6 over a point-to-point Frame Relay circuit is to assign the layer 3 and layer 2 addresses to the point-to-point subinterface. Since protocol mappings are not required, IPv6 communication to global-unicast, link-local, and multicast destinations will be successful out the Frame Relay circuit.

Like in the previous example, the host portion of the IPv6 network used on the Frame Relay interface is derived from the modified EUI-64 addressing format. To determine the entire IPv6 address of the remote end of the link the `show ipv6 int brief` command is used. For more detailed information about IPv6 processing on the interface use the `show ipv6 interface` command, followed by the interface name and number.

**Recommended Reading**

[Implementing Basic Connectivity for IPv6: Configuring IPv6 ATM and Frame Relay Interfaces](#)