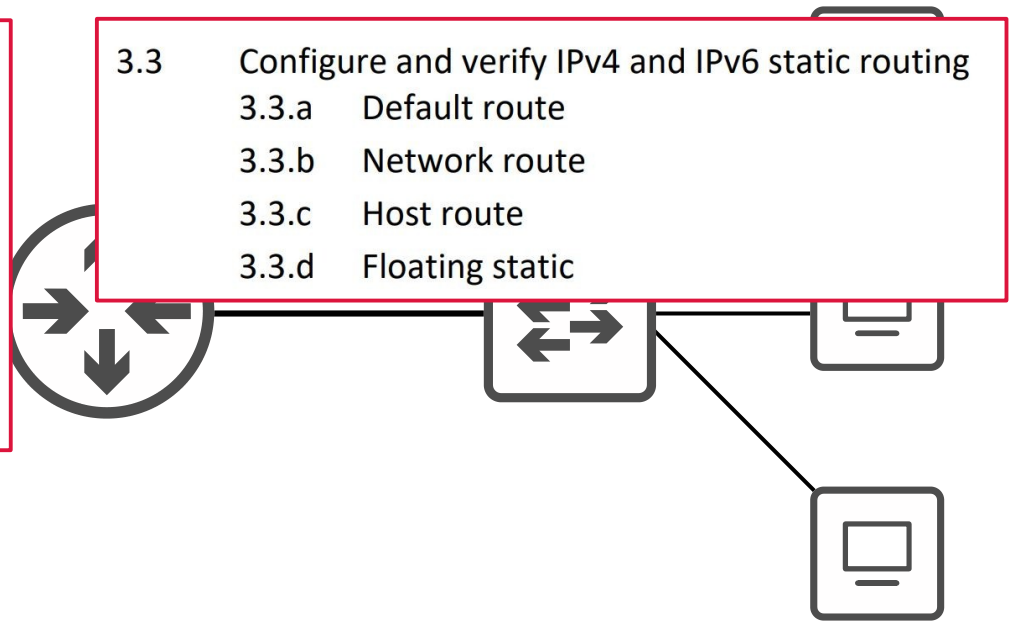
CCNA 200-301 Day 32

IPv6 Part 2

1.8 Configure and verify IPv6 addressing and prefix

1.9 Compare IPv6 address types
- 1.9.a Global unicast
- 1.9.b Unique local
- 1.9.c Link local
- 1.9.d Anycast
- 1.9.e Multicast
- 1.9.f Modified EUI 64

3.3 Configure and verify IPv4 and IPv6 static routing
- 3.3.a Default route
- 3.3.b Network route
- 3.3.c Host route
- 3.3.d Floating static

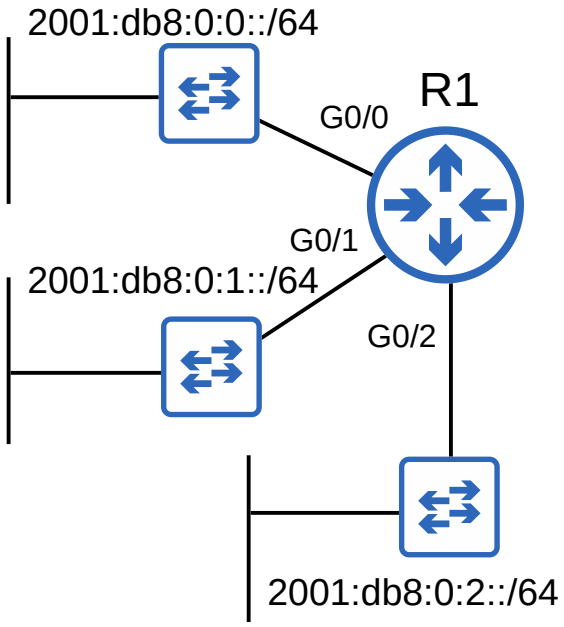


Things we'll cover

- IPv6 address configuration (continued)
  - ↳ Modified EUI-64
- IPv6 address types
  - ↳ Global unicast
  - ↳ Unique local
  - ↳ Link local
  - ↳ Multicast
  - ↳ others...

1.8	Configure and verify IPv6 addressing and prefix
1.9	Compare IPv6 address types
1.9.a	Global unicast
1.9.b	Unique local
1.9.c	Link local
1.9.d	Anycast
1.9.e	Multicast
1.9.f	Modified EUI 64

Configuring IPv6 addresses (EUI-64)



- EUI stands for Extended Unique Identifier
- (Modified) EUI-64 is a method of converting a MAC address (48 bits) into a 64-bit interface identifier.
- This interface identifier can then become the ‘host portion’ of a /64 IPv6 address.
- How to convert the MAC address:

  1: Divide the MAC address in half

  1234 5678 90AB → **1234 56** | **78 90AB**

  2: Insert FFFE in the middle

  1234 56FF FE78 90AB

  3: Invert the 7th bit

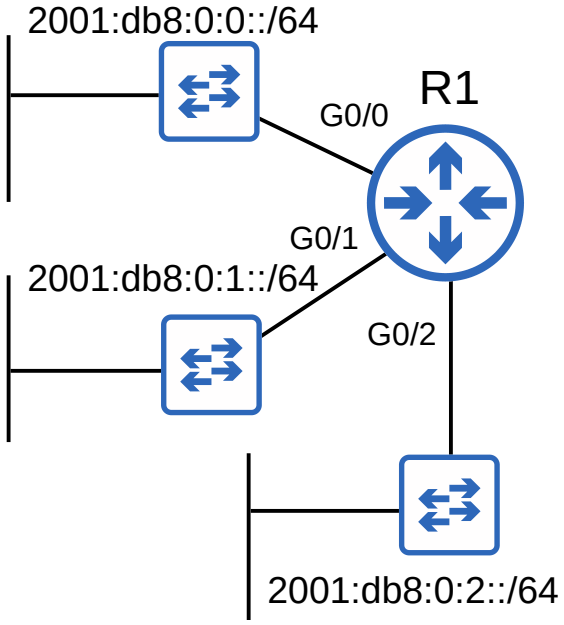
  1234 56FF FE78 90AB → **1034 56FF FE78 90AB**

  0010 → 0000

Configuring IPv6 addresses (EUI-64)

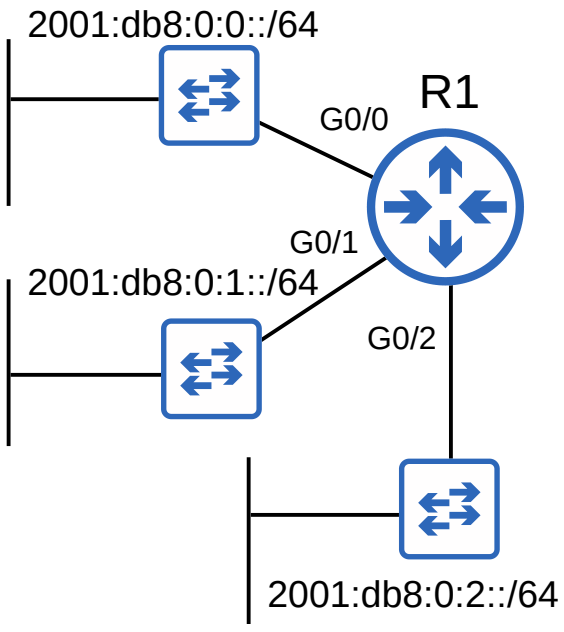
MAC Address	EUI-64 Interface Identifier
782B CBAC 0867	7A2B CBFF FEAC 0867
0200 4C4F 4F50	0000 4CFF FE4F 4F50
0050 56C0 0001	0250 56FF FEC0 0001
00FF 6BA6 F456	02FF 6BFF FEA6 F456
96AB 6D6B 98AE	94AB 6DFF FE6B 98AE

Configuring IPv6 addresses (EUI-64)




```
R1(config)#int g0/0
R1(config-if)#ipv6 address 2001:db8::/64 eui-64
R1(config-if)#no shutdown
R1(config-if)#
R1(config-if)#int g0/1
R1(config-if)#ipv6 address 2001:db8:0:1::/64 eui-64
R1(config-if)#no shutdown
R1(config-if)#
R1(config-if)#int g0/2
R1(config-if)#ipv6 address 2001:db8:0:2::/64 eui-64
R1(config-if)#no shutdown
```

Configuring IPv6 addresses (EUI-64)




```
R1#show interfaces g0/0
GigabitEthernet0/0 is administratively down, line protocol is down
  Hardware is iGbE, address is 0cf8.2236.8500 (bia 0cf8.2236.8500)
```

```
R1#show interfaces g0/1
GigabitEthernet0/1 is administratively down, line protocol is down
  Hardware is iGbE, address is 0cf8.2236.8501 (bia 0cf8.2236.8501)
```

```
R1#show interfaces g0/2
GigabitEthernet0/2 is administratively down, line protocol is down
  Hardware is iGbE, address is 0cf8.2236.8502 (bia 0cf8.2236.8502)
```

```
R1(config-if)#do show ipv6 interface brief
GigabitEthernet0/0     [up/up]
    FE80::EF8:22FF:FE36:8500
    2001:DB8::EF8:22FF:FE36:8500
GigabitEthernet0/1     [up/up]
    FE80::EF8:22FF:FE36:8501
    2001:DB8:0:1:EF8:22FF:FE36:8501
GigabitEthernet0/2     [up/up]
    FE80::EF8:22FF:FE36:8502
    2001:DB8:0:2:EF8:22FF:FE36:8502
GigabitEthernet0/3     [administratively down/down]
    unassigned
```

Why invert the 7th bit?

- MAC addresses can be divided into two types:
  - → **UAA** (Universally Administered Address)
    - ↳ Uniquely assigned to the device by the manufacturer

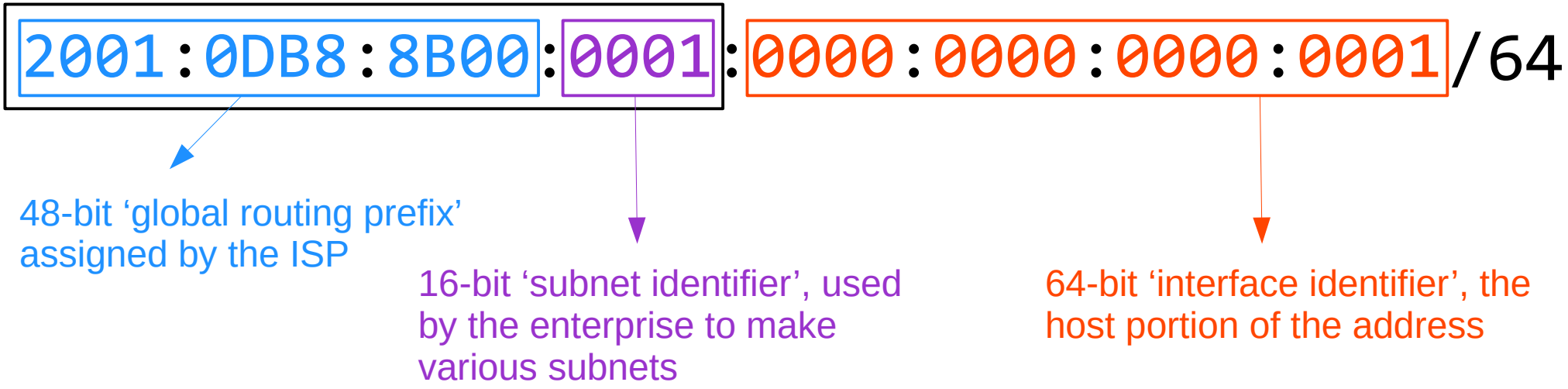
  - → **LAA** (Locally Administered Address)
    - ↳ Manually assigned by an admin (with the **`mac-address`** command on the interface) or protocol. Doesn't have to be globally unique.

- You can identify a UAA or LAA by the 7th bit of the MAC address, called the U/L bit (Universal/Local bit):
  - → U/L bit set to **0** = **UAA**
  - → U/L bit set to **1** = **LAA**

- In the context of IPv6 addresses/EUI-64, the meaning of the U/L bit is reversed:
  - → U/L bit set to **0** = The MAC address the EUI-64 interface ID was made from was an **LAA**
  - → U/L bit set to **1** = The MAC address the EUI-64 interface ID was made from was a **UAA**

Global unicast addresses

- **Global unicast** IPv6 addresses are public addresses which can be used over the Internet.
- Must register to use them. Because they are public addresses, it is expected that they are globally unique.
- Originally defined as the `2000::/3` block (`2000::` to `3FFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF`).
- Now defined as all addresses which aren't reserved for other purposes.



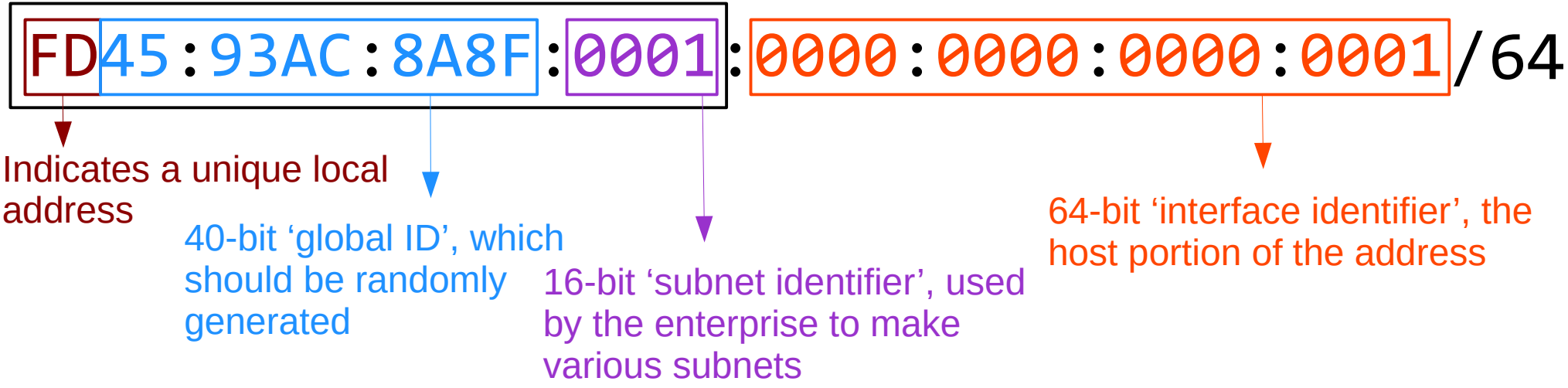
Unique local addresses

- **Unique local** IPv6 addresses are *private* addresses which **cannot be used over the Internet.**

- You do not need to register to use them. They can be used freely within internal networks and don't need to be globally unique (*). Can't be routed over the Internet.

- Uses the address block `FC00::/7` (`FC00::` to `FDFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF`)
- However, a later update requires the 8th bit to be set to 1, so the first two digits must be `FD`.

- *The global ID should be unique so that addresses don't overlap when companies merge.



Link local addresses

- **Link-local** IPv6 addresses are automatically generated on IPv6-enabled interfaces.

- Use command `R1(config-if)# ipv6 enable` on an interface to enable IPv6 on an interface.

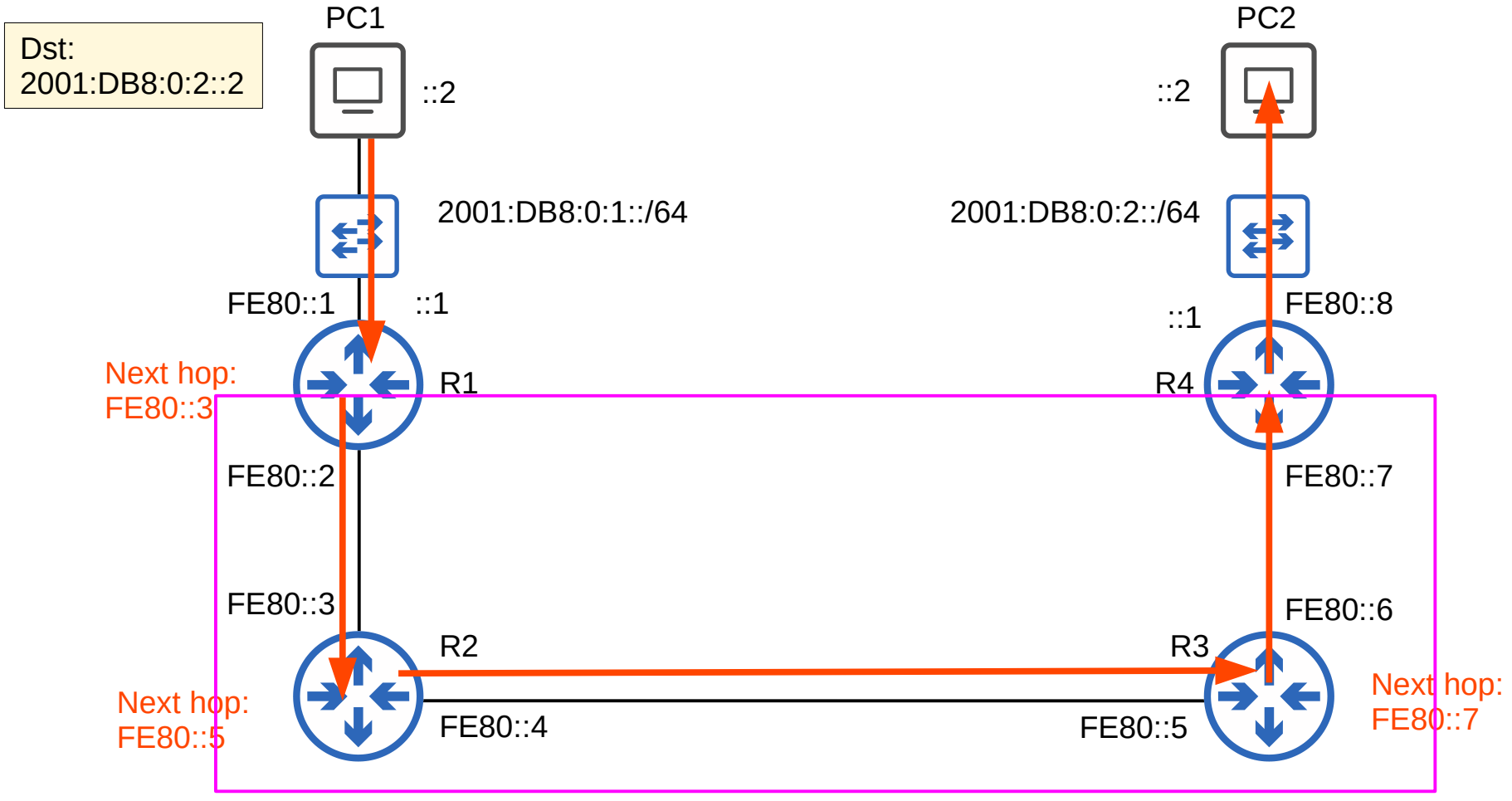
- Uses the address block `FE80::/10` (`FE80::` to `FEBF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF`)
- However, the standard states that the 54 bits after `FE80/10` should be all 0, so you won't see link local addresses beginning with `FE9`, `FEA`, or `FEB`. Only `FE8`.

- The interface ID is generated using EUI-64 rules.

```
R1(config-if)#do show ipv6 interface brief
GigabitEthernet0/0     [up/up]
    FE80::EF8:22FF:FE36:8500
    2001:DB8::EF8:22FF:FE36:8500
GigabitEthernet0/1     [up/up]
    FE80::EF8:22FF:FE36:8501
    2001:DB8:0:1:EF8:22FF:FE36:8501
GigabitEthernet0/2     [up/up]
    FE80::EF8:22FF:FE36:8502
    2001:DB8:0:2:EF8:22FF:FE36:8502
GigabitEthernet0/3     [administratively down/down]
    unassigned
```

- L for communication within a single link (subnet). destination IPv6 address.
- C local addresses for neighbor adjacencies)
  placement for ARP) uses link-local addresses to

Link-local addresses



Multicast addresses

- **Unicast** addresses are one-to-one.
  ↪ One source to one destination.

- **Broadcast** addresses are one-to-all.
  ↪ One source to all destinations (within the subnet).

- **Multicast** addresses are one-to-many.
  → One source to multiple destinations (that have joined the specific *multicast group*).

- IPv6 uses range `FF00::/8` for multicast. (`FF00::` to `FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF`)

- **IPv6 doesn't use broadcast** (there is no 'broadcast address' in IPv6!)

Multicast addresses

Purpose	IPv6 Address	IPv4 Address
All nodes/hosts (functions like broadcast)	FF02::1	224.0.0.1
All routers	FF02::2	224.0.0.2
All OSPF routers	FF02::5	224.0.0.5
All OSPF DRs/BDRs	FF02::6	224.0.0.6
All RIP routers	FF02::9	224.0.0.9
All EIGRP routers	FF02::A	224.0.0.10

Multicast address scopes

- IPv6 defines multiple multicast ‘scopes’ which indicate how far the packet should be forwarded.
- The addresses in the previous slide all use the ‘link-local’ scope (`FF02`), which stays in the local subnet.
- IPv6 multicast scopes:
  ↪ **Interface-local** (`FF01`): The packet doesn’t leave the local device. Can be used to send traffic to a service within the local device.

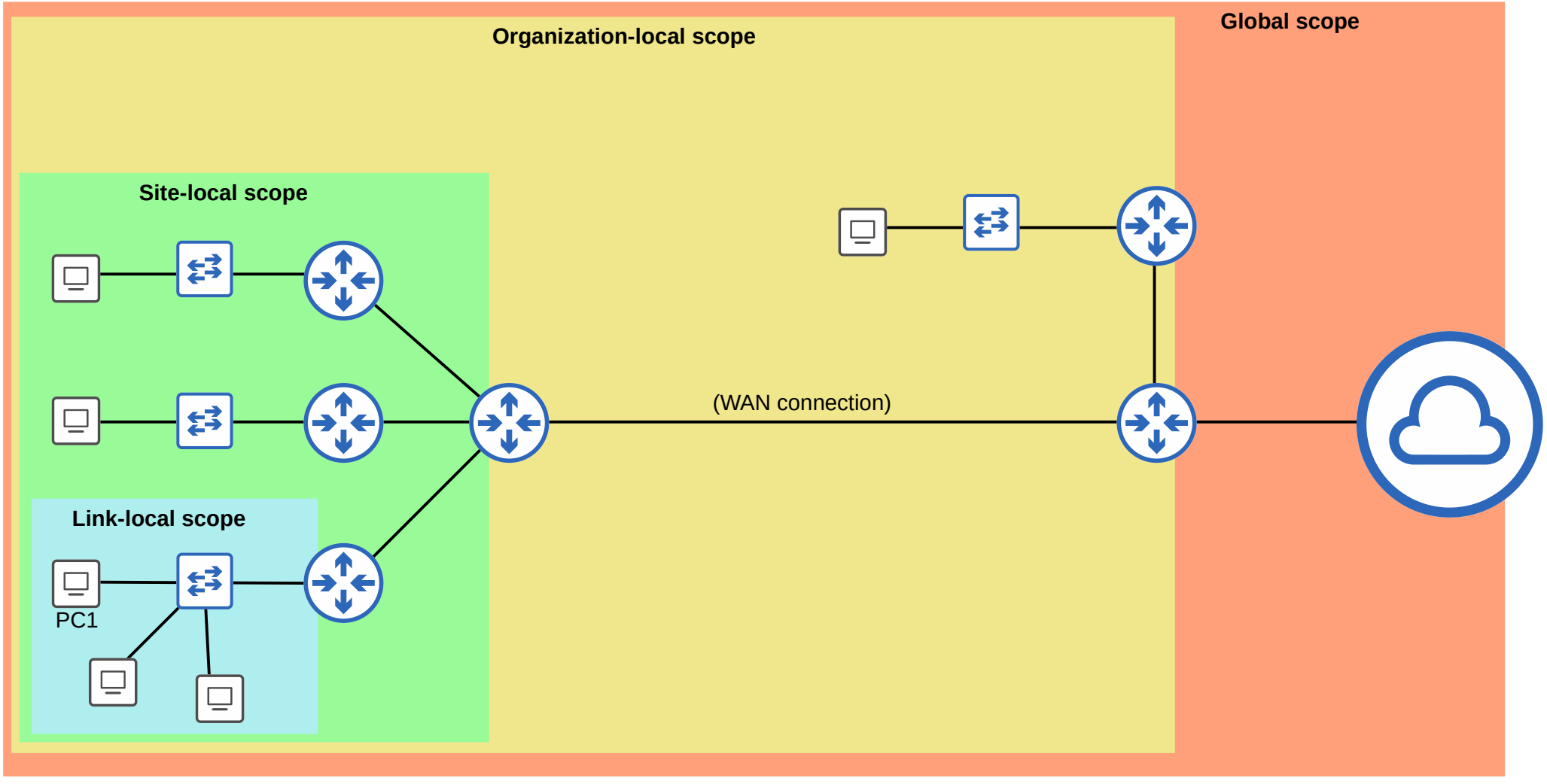
  ↪ **Link-local** (`FF02`): The packet remains in the local subnet. Routers will not route the packet between subnets.

  ↪ **Site-local** (`FF05`): The packet can be forwarded by routers. Should be limited to a single physical location (not forwarded over a WAN)

  ↪ **Organization-local** (`FF08`): Wider in scope than site-local (an entire company/organization).

  ↪ **Global** (`FF0E`): No boundaries. Possible to be routed over the Internet.

Multicast address scopes

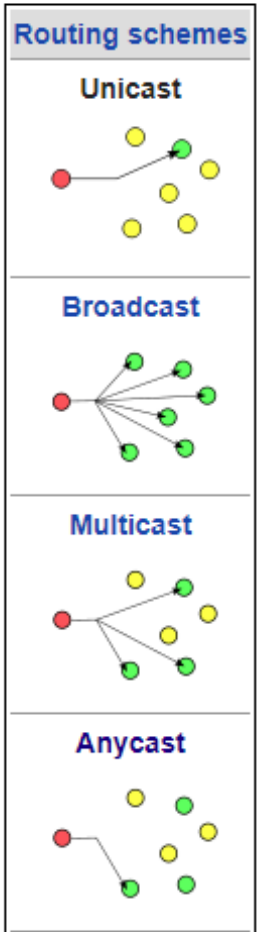


Multicast addresses

```
R1#sh ipv6 int g0/0
GigabitEthernet0/0 is up, line protocol is up
  IPv6 is enabled, link-local address is FE80::EF8:22FF:FE36:8500
  No Virtual link-local address(es):
  Global unicast address(es):
    2001:DB8::EF8:22FF:FE36:8500, subnet is 2001:DB8::/64 [EUI]
  Joined group address(es):
    FF02::1
    FF02::2
    FF02::1:FF36:8500
  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.
```

Anycast addresses

- **Anycast** is a new feature of IPv6.
- Anycast is ‘one-to-one-of-many’
- Multiple routers are configured with the same IPv6 address.
  → They use a routing protocol to advertise the address.
  → When hosts sends packets to that destination address, routers will forward it to the nearest router configured with that IP address (based on routing metric).
- There is no specific address range for anycast addresses. Use a regular unicast address (global unicast, unique local) and specify it as an anycast address:
  R1(config-if)# **ipv6 address 2001:db8:1:1::99/128 anycast**



Anycast address configuration

```
R1(config)#int g0/0
R1(config-if)#ipv6 address 2001:db8:1:1::99/128 anycast
R1(config-if)#
R1(config-if)#do show ipv6 interface g0/0
GigabitEthernet0/0 is up, line protocol is up
  IPv6 is enabled, link-local address is FE80::EF8:22FF:FE36:8500
  No Virtual link-local address(es):
  Global unicast address(es):
    2001:DB8::EF8:22FF:FE36:8500, subnet is 2001:DB8::/64 [EUI]
    2001:DB8:1:1::99, subnet is 2001:DB8:1:1::99/128 [ANY]
  Joined group address(es):
    FF02::1
    FF02::2
    FF02::1:FF00:99
    FF02::1:FF36:8500
  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)
```

Other IPv6 Addresses

- `::` = The *unspecified* IPv6 address
  - ↳ Can be used when a device doesn't yet know its IPv6 address.
  - ↳ IPv6 default routes are configured to `::/0`
  - ↳ IPv4 equivalent: `0.0.0.0`

- `::1` = The loopback address
  - ↳ Used to test the protocol stack on the local device.
  - ↳ Messages sent to this address are processed within the local device, but not sent to other devices.
  - ↳ IPv4 equivalent: `127.0.0.0/8` address range

Things we covered

- IPv6 address configuration (continued)
  - ↳ Modified EUI-64
- IPv6 address types
  - ↳ Global unicast
  - ↳ Unique local
  - ↳ Link local
  - ↳ Multicast
  - ↳ others...

Quiz 1

R1's G0/1 interface has a MAC address of `0D2A.4FA3.00B1`.
What will G0/1's IPv6 address be after issuing the following command?
R1(config-if)# **ipv6 address 2001:db8:0:1::/64 eui-64**

a) `2001:db8:0:1:0B2A:4FFF:FFA3:B1`

b) `2001:db8:0:1:C2A:4FFF:FEA3:B1`

c) `2001:db8:0:1:0F2A:4FFF:FFA3:B1`

d) `2001:db8:0:1:F2A:4FFF:FEA3:B1`

Quiz 2

Which portion of the IPv6 address below is the ‘global ID’?

FD89:3B12:3794:0020:0000:0000:2347:0001/64

a) FD89:3B12:3794:0020:0000:0000:2347:0001/64

b) FD89:3B12:3794:0020:0000:0000:2347:0001/64

c) FD89:3B12:3794:0020:0000:0000:2347:0001/64

d) FD89:3B12:3794:0020:0000:0000:2347:0001/64

Quiz 3

R3 sent an IPv6 multicast message to all other routers on the local subnet. What was the destination IPv6 address of that message? (select the best answer)

a) FF01::1

b) FF01::2

c) FF02::1

d) FF02::2

Quiz 4

What kind of IPv6 address is automatically configured on an interface when the following command is used? (select the best answer)

```
R1(config-if)# ipv6 enable
```

a) Unique local

b) Node-local

c) Link-local

d) EUI-64

Quiz 5

The diagrams on the right visualize different IPv6 message types.
Match them with the correct message type.

Unicast

Broadcast

Multicast

Anycast

1

2

3

4