2 - IPv6

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2.1 Introduction

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2.4 IPv6 subnetting

2.5 IPv6 static routing

2.6 OSPFv3

2.7 RIPng

2.1 Introduction

The need for IPv6

- IPv6 is designed to be the successor to IPv4.
- Reduction of available IPv4 address space has been the motivating factor for moving to IPv6.
- IPv4 addresses have run out in many places.
- IPv4 address space: 32 bits plus private addresses and NAT.
- IPv6 address space: 128 bits.

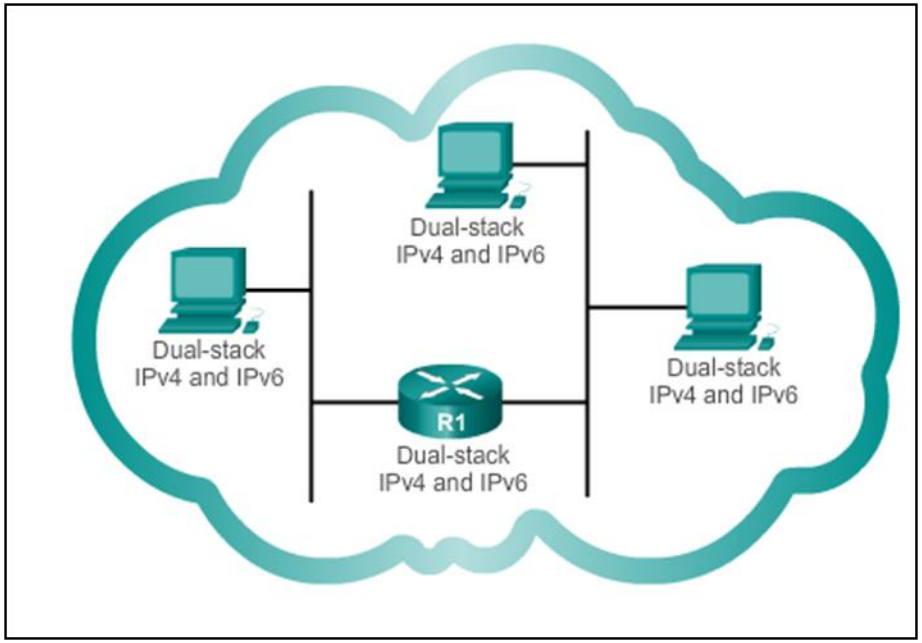
2.1 Introduction

IPv4 and IPv6 coexistence

- The migration techniques can be divided into three categories:
  - Dual-stack.
  - Tunnelling.
  - Translation.

2.1 Introduction

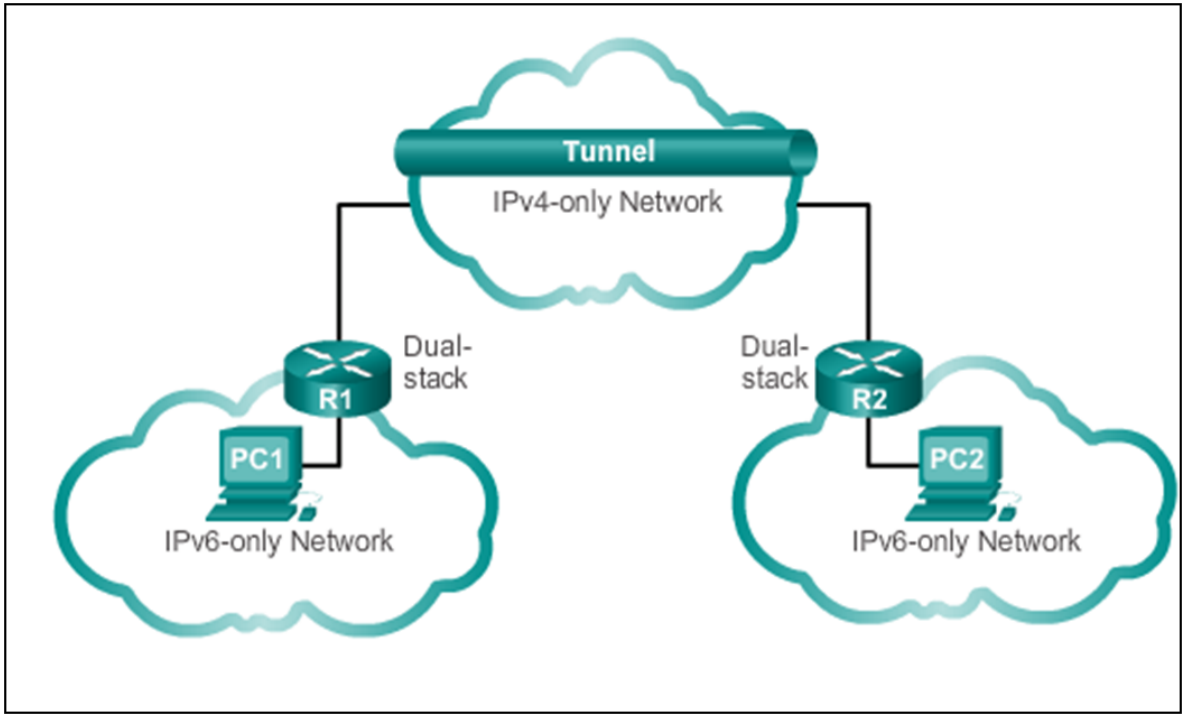
Dual-stack



Dual-stack: Allows IPv4 and IPv6 to coexist on the same network. Devices run both IPv4 and IPv6 protocol stacks simultaneously.

2.1 Introduction

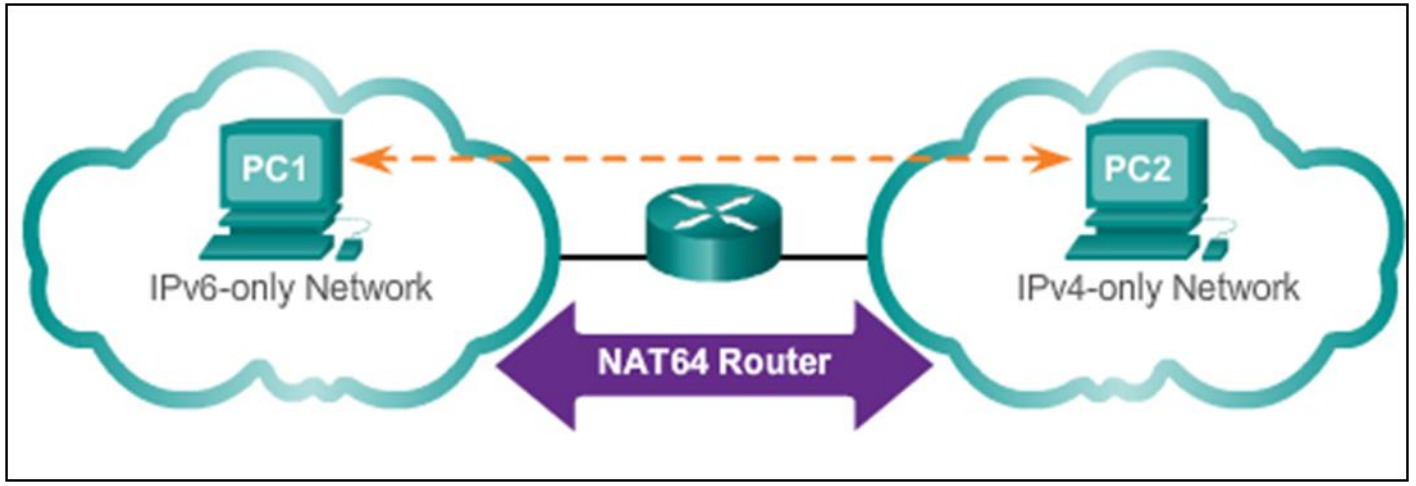
Tunnelling



Tunnelling: A method of transporting an IPv6 packet over an IPv4 network. The IPv6 packet is encapsulated inside an IPv4 packet.

2.1 Introduction

Translation



Translation: The Network Address Translation 64 (NAT64) allows IPv6-enabled devices to communicate with IPv4-enabled devices using a translation technique similar to NAT for IPv4. An IPv6 packet is translated to an IPv4 packet, and vice versa.

2.1 Introduction

NAT64 Translation

2001:2022:1011::1600

NAT64 prefix: 2001:DB4:DA4::

80.0.0.8

2001:2022:1011::1600 --- 40.0.0.4

Src IP	2001:2022:1011::1600
Dst IP	2001:DB4:DA4::80.0.0.8

→

Src IP	40.0.0.4
Dst IP	80.0.0.8

Src IP	2001:DB4:DA4::80.0.0.8
Dst IP	2001:2022:1011::1600

←

Src IP	80.0.0.8
Dst IP	40.0.0.4

2.2 IPv6 addressing

IPv6 address representation

- 128 bits written as a string of 32 hexadecimal values.
- Hextet used to refer to a segment of 16 bits or four hexadecimals.
- Can be written in either lowercase or uppercase.

2001:0DB8:0000:1111:0000:0000:0000:0200

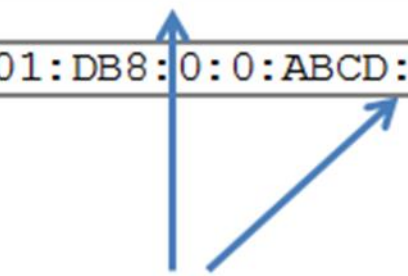
FE80:0000:0000:0000:0123:4567:89AB:CDEF

2.2 IPv6 addressing

IPv6 address representation rules

- Omitting leading 0s: any leading zeros in any 16-bit section or hextet can be omitted.
- Omitting all 0 segments: a double colon (::) can replace any single, contiguous string of one or more 16-bit segments (hextets) consisting of all 0's (compressed format).
  - Can be used only one time.

Preferred	2001:0DB8:0000:0000:ABCD:0000:0000:0100
Omit leading 0s	2001: DB8: 0: 0:ABCD: 0: 0: 100
Compressed	2001:DB8::ABCD:0:0:100
OR	
Compressed	2001:DB8:0:0:ABCD::100

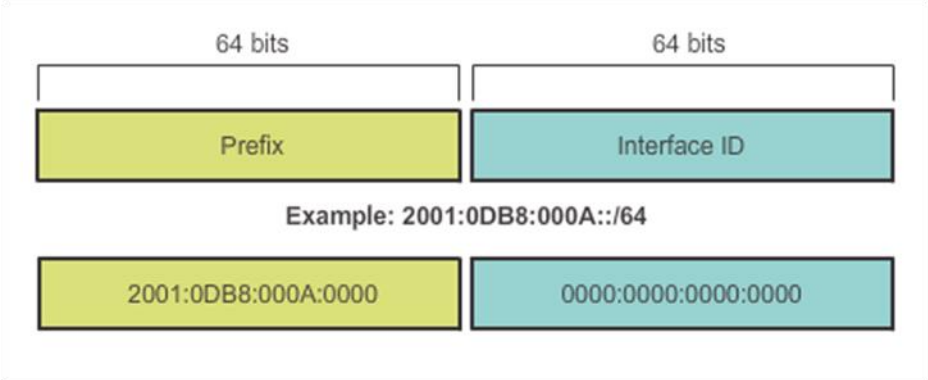


Only one : : may be used.

2.2 IPv6 addressing

IPv6 prefix lenght

- IPv6 adress: prefix + interface ID.
- IPv6 does not use the dotted-decimal subnet mask notation.
- Prefix length indicates the network portion of an IPv6 address using the following format:
  - IPv6 address/prefix length.
  - Prefix length can range from 0 to 128
  - Typical prefix length is /64.



2.2 IPv6 addressing

IPv6 address types

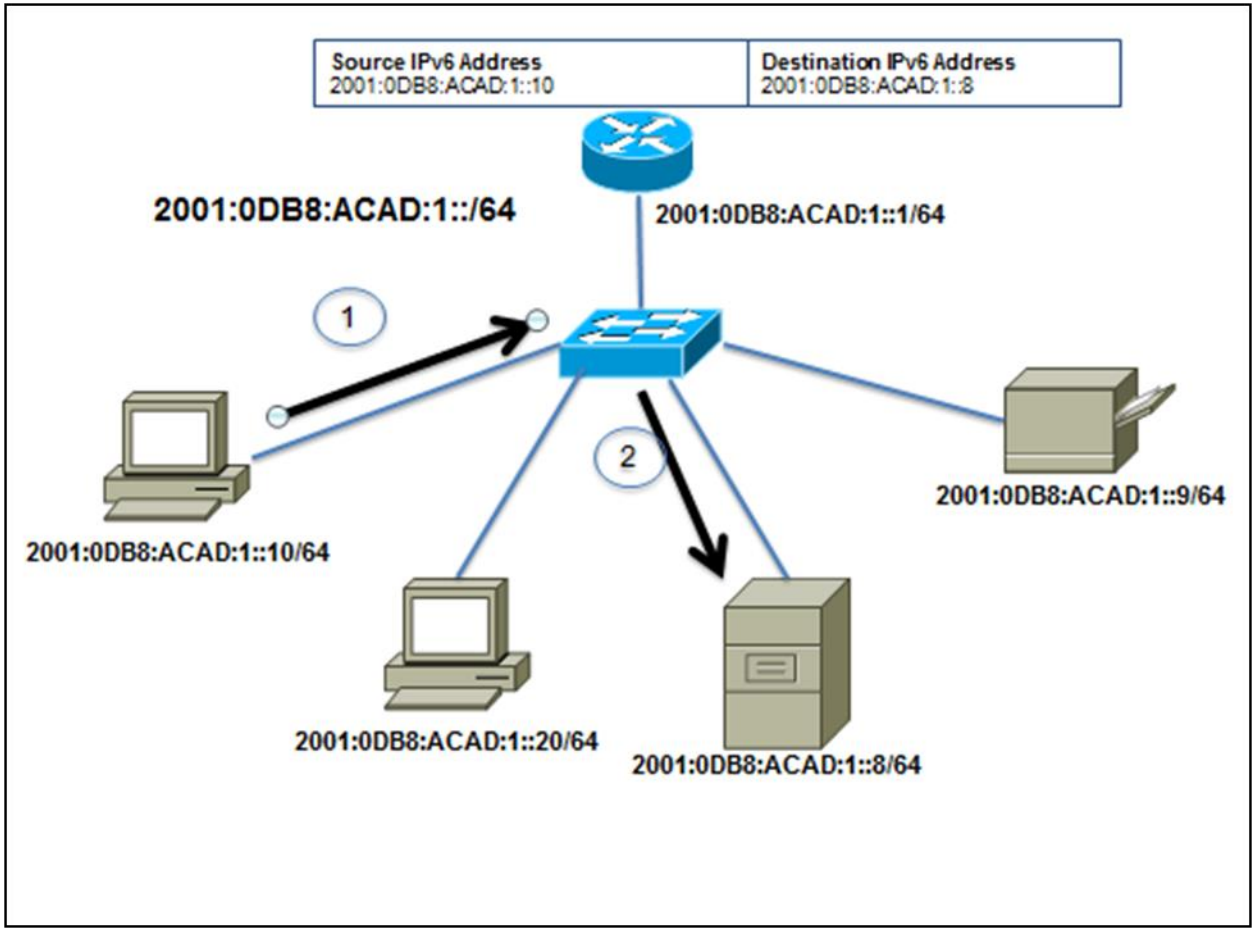
There are three types of IPv6 addresses:

- Unicast.
- Multicast.
- Anycast.

2.2 IPv6 addressing

Unicast addresses

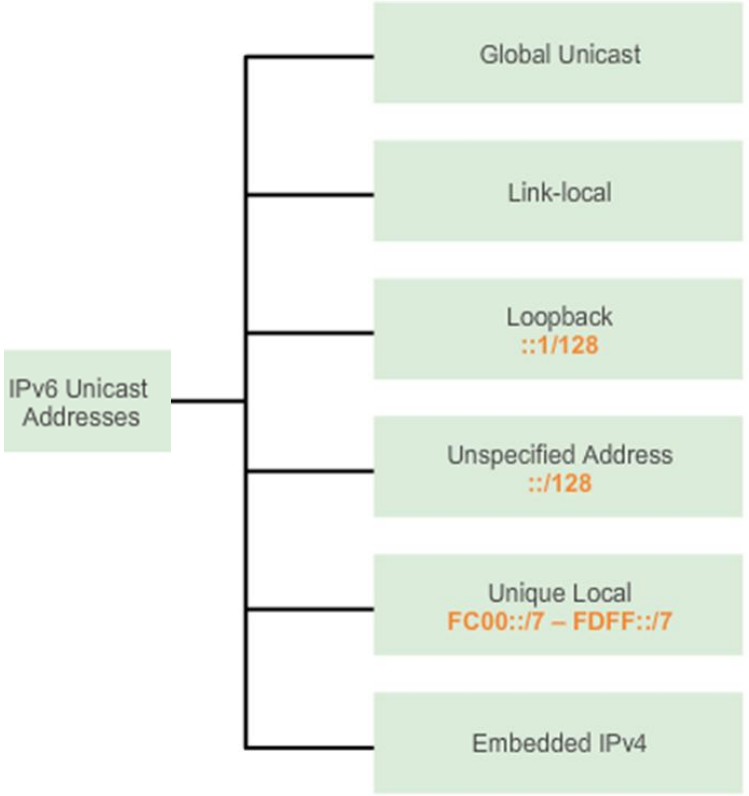
- Uniquely identifies an interface on an IPv6-enabled device.
- A packet sent to a unicast address is received by the interface that is assigned that address.



2.2 IPv6 addressing

Types of IPv6 unicast address

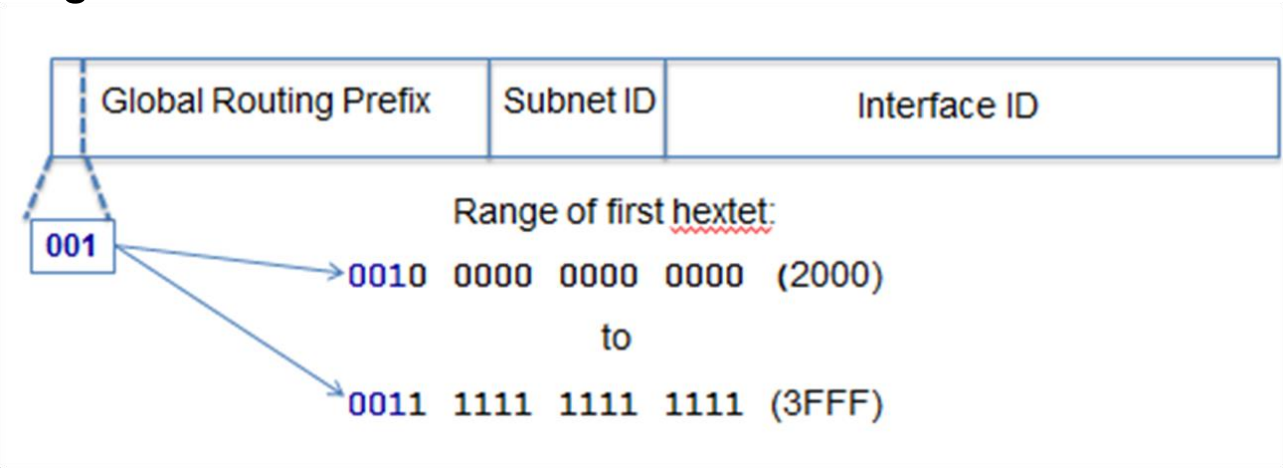
- Global unicast.
- Link-local.
- Loopback.
- Unspecified address.
- Unique local.
- Embedded IPv4.



2.2 IPv6 addressing

Global unicast

- Similar to a public IPv4 address.
- Globally unique.
- Internet routable addresses.
- Can be configured statically or assigned dynamically .
- Range 2000::/3.

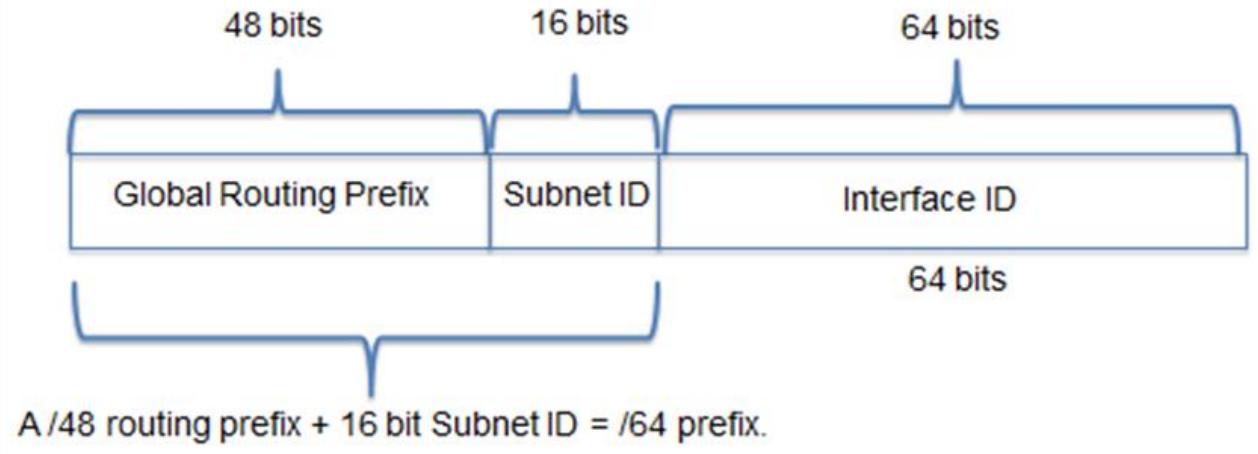


2.2 IPv6 addressing

Global unicast

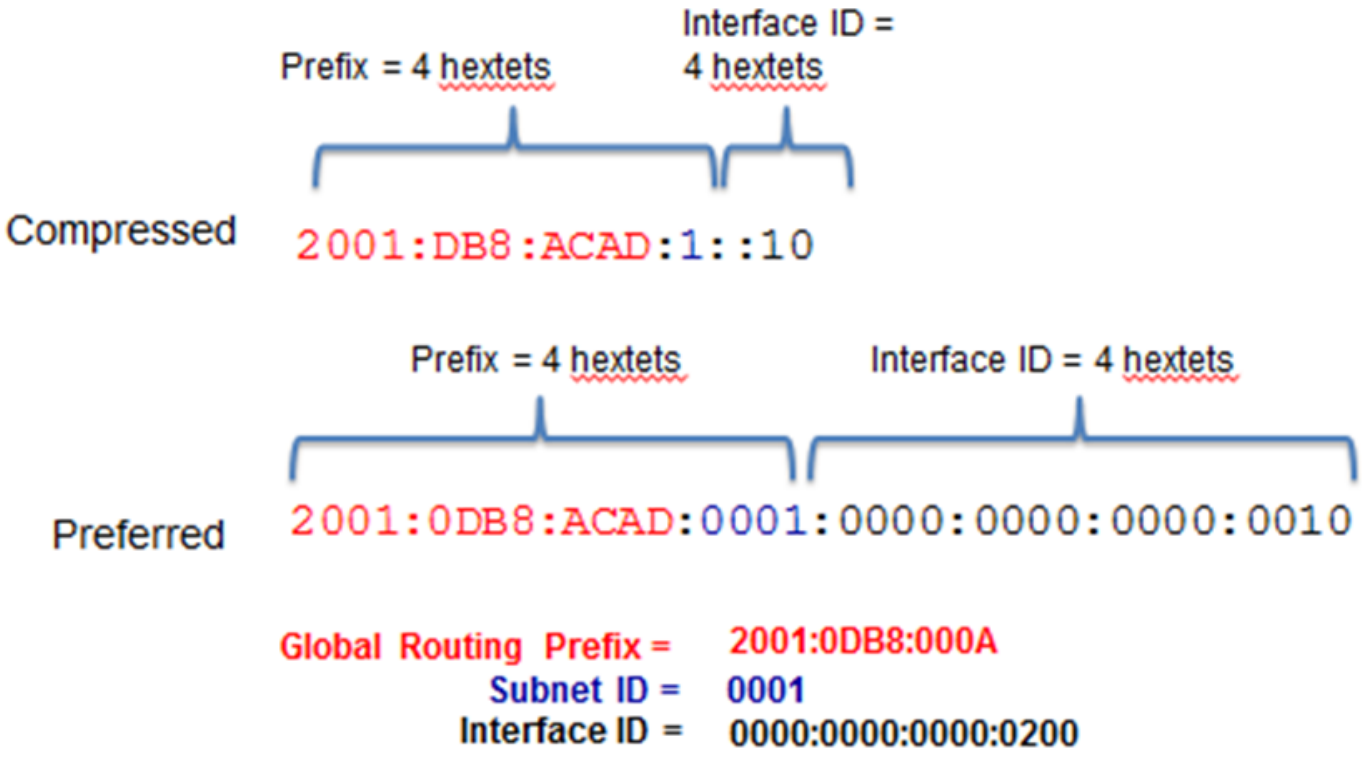
A global unicast address consists of:

- Global Routing Prefix: prefix or network portion of the address assigned by the provider.
- Subnet ID: used by an organization to identify subnets within its site.
- Interface ID: equivalent to the host portion of an IPv4 address.



2.2 IPv6 addressing

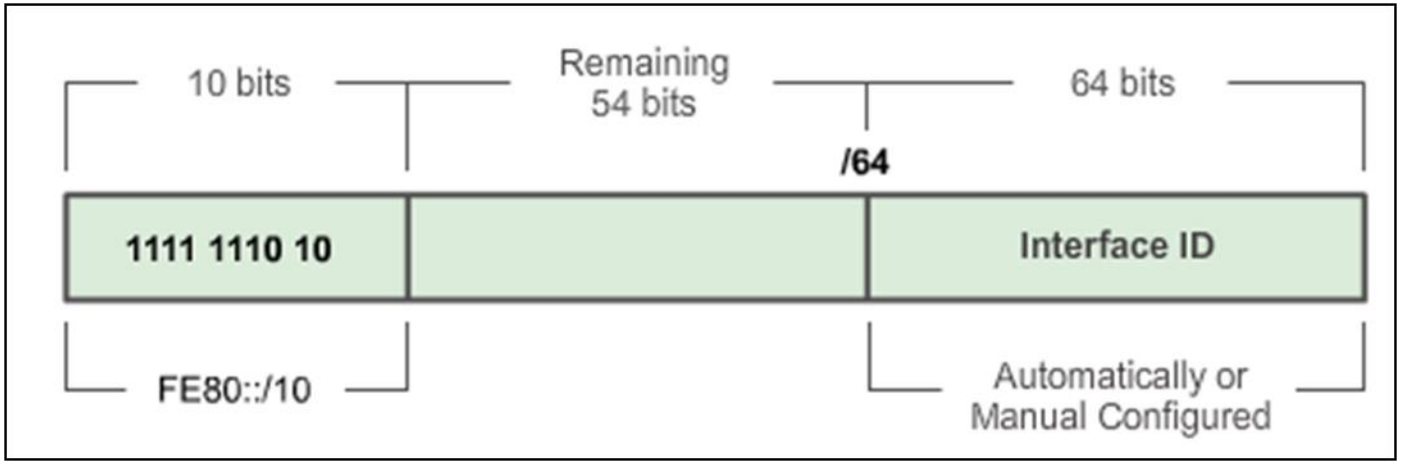
Global unicast



2.2 IPv6 addressing

Link-local

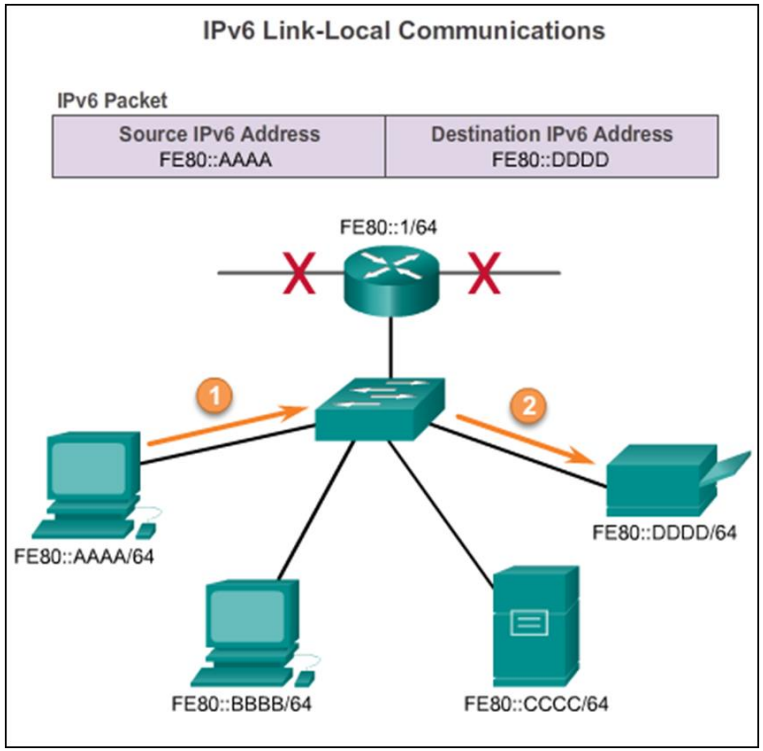
- Used to communicate with other devices on the same local link (subnet).
- Not routable.
- Every IPv6-enabled network interface is required to have a link-local address.
- Range FE80::/10.



2.2 IPv6 addressing

Link-local

- An IPv6-enabled device automatically generates its link-local address.
- The link-local address of the local router can be used for default gateway IPv6 address.
- Routers exchange dynamic routing protocol messages using link-local addresses.
- Routers' routing tables use the link-local address to identify the next-hop router when forwarding IPv6 packets.



Loopback

- Ping an IPv6 loopback address to test the configuration of TCP/IP on the local host.
- Cannot be assigned to a physical interface.
- All-0s except for the last bit, represented as ::1/128 or ::1.

Unspecified address

- All-0's address represented as ::/128 or ::
- Cannot be assigned to an interface.
- Only used as a source address.
- An unspecified address is used as a source address when:
  - The device does not yet have a permanent IPv6 address.
  - The source of the packet is irrelevant to the destination.

Unique local

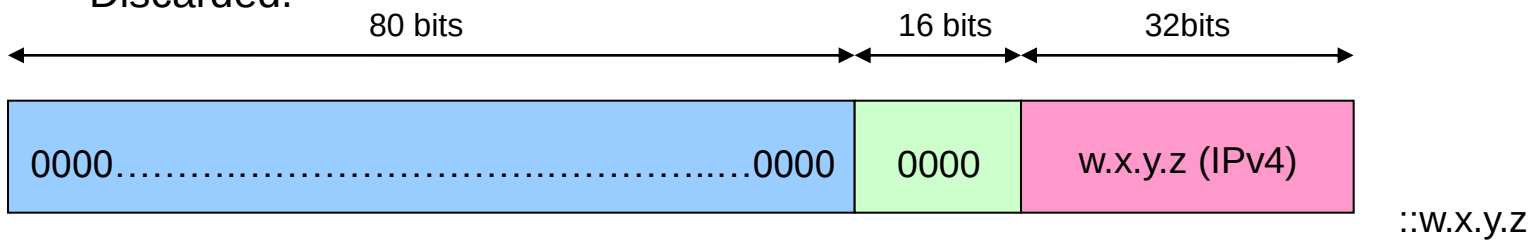
- Similar to private addresses for IPv4.
- Used for local addressing within a site or between a limited number of sites.
- Range FC00::/7.

2.2 IPv6 addressing

IPv4 embedded

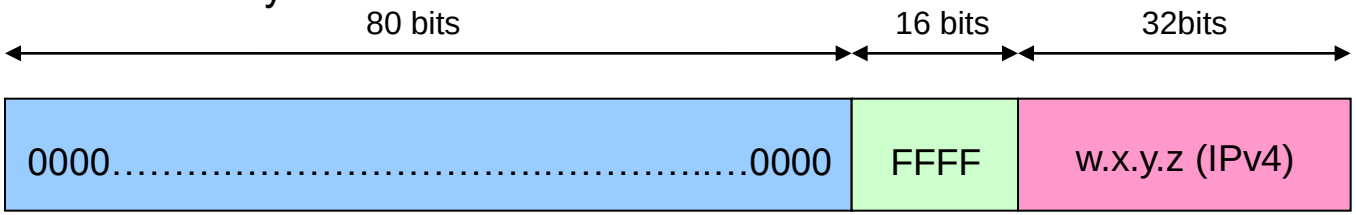
- Used to help transition from IPv4 to IPv6.
- Range ::/80.
- Two types:

1. IPv4-compatible IPv6 address.
   - Dual stack (IPv4-IPv6) devices.
   - Discarded.



::w.x.y.z

2. IPv4-mapped IPv6 address.
   - "IPv4-only" devices IP address.



::FFFF:w.x.y.z

Multicast addresses

- Range FF00::/8.
- There are two types of IPv6 multicast addresses:
  - Assigned multicast.
  - Solicited node multicast.

Assigned Multicast

Some common IPv6 assigned multicast groups:

FF02::1 All-nodes.

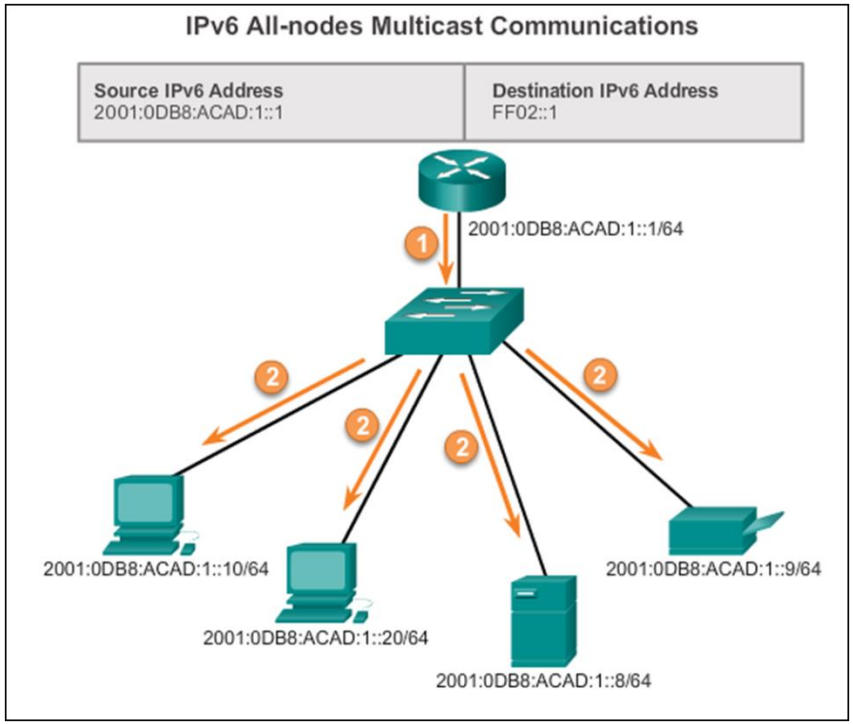
FF02::2 All-routers.

FF02::5 OSPF routers.

FF02::6 OSPF designated routers.

FF02::9 RIP routers.

FF02::1:2 DHCP agent.

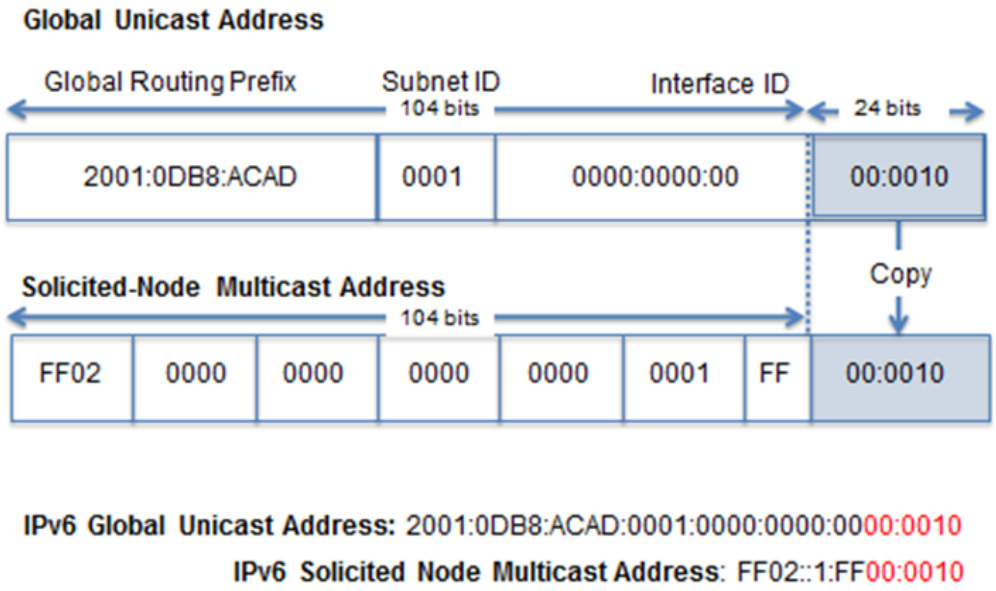


Solicited node

- Automatically created when the global unicast or link-local unicast addresses are assigned.
  - Multicast prefix

    FF02:0:0:0:0:1:FF00::/104.
  - The right-most 24 bits

    of its unicast or link-local address.



Solicited node

Solicited node addresses are used for:

- Address resolution.
  - Similar to ARP with IPv4.
  - It uses Neighbor Discovery Protocol (NDP).
- Detection of duplicated address.
  - It uses Duplicate Address Detection (DAD).

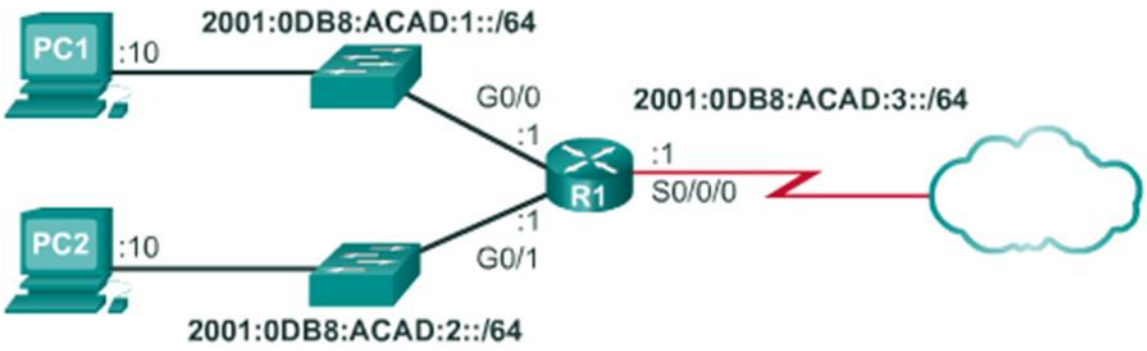
2.2 IPv6 addressing

Anycast addresses

- Can be asigned to several interfaces.
- Packets delivered to the closet interface (routing).
- Example: DNS, HTTP, servers.
- No specific range.
  - Global unicast range is used.

2.2 IPv6 addressing

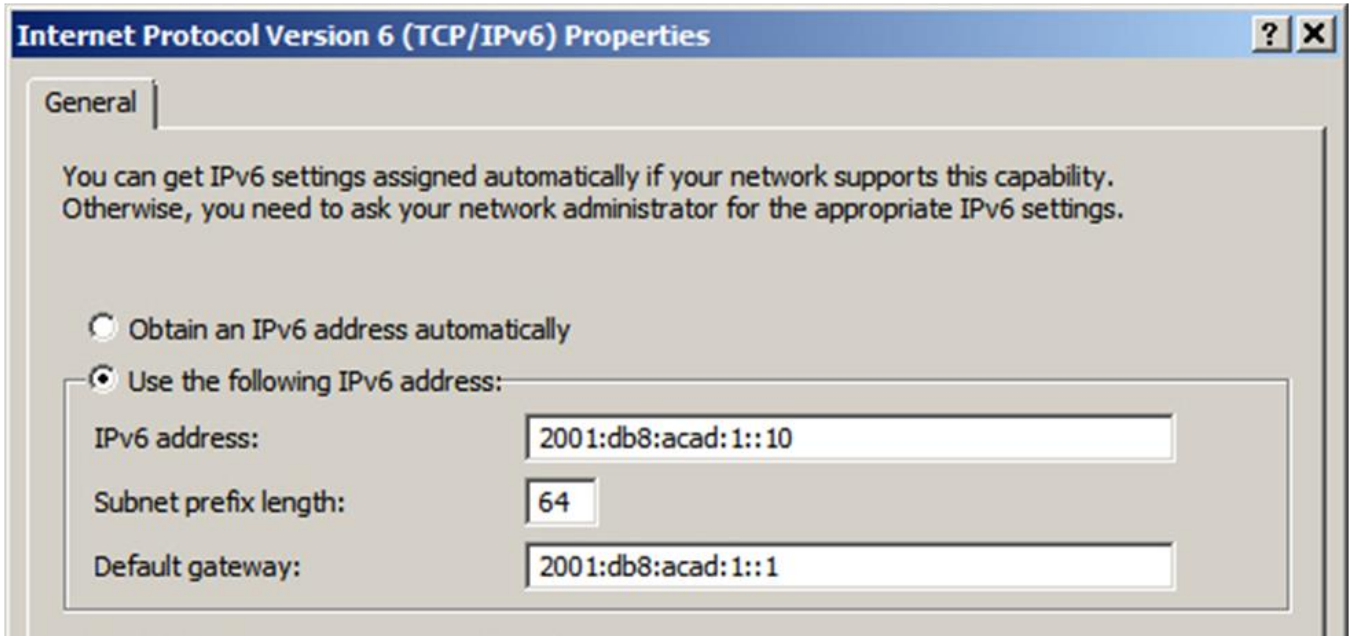
Global unicast: static configuration




```
R1(config)#interface gigabitethernet 0/0
R1(config-if)#ipv6 address 2001:db8:acad:1::1/64
R1(config-if)#no shutdown
R1(config-if)#exit
R1(config)#interface gigabitethernet 0/1
R1(config-if)#ipv6 address 2001:db8:acad:2::1/64
R1(config-if)#no shutdown
R1(config-if)#exit
R1(config)#interface serial 0/0/0
R1(config-if)#ipv6 address 2001:db8:acad:3::1/64
R1(config-if)#clock rate 56000
R1(config-if)#no shutdown
```

2.3 IPv6 configuration

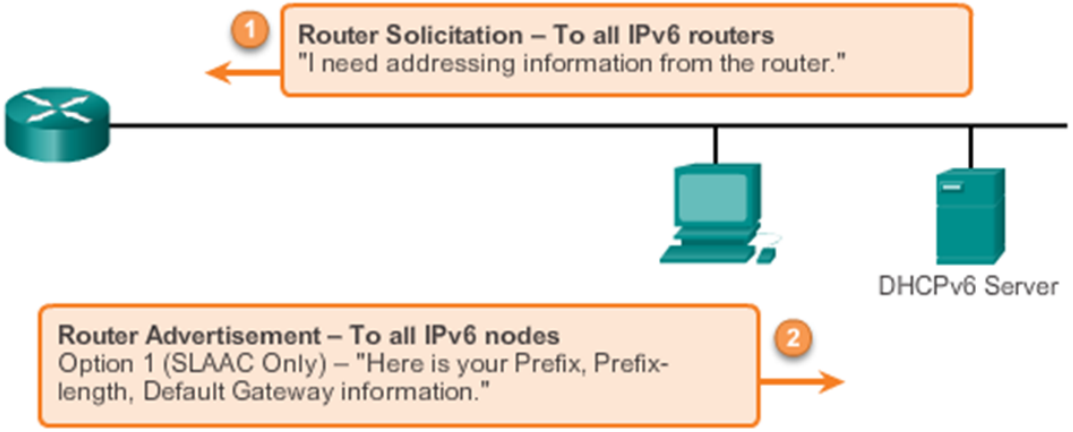
Global unicast: static configuration



2.3 IPv6 configuration

Global unicast: dynamic configuration using SLAAC

- SLAAC: Stateless Address Autoconfiguration.
- A device can obtain its prefix, prefix length and default gateway from an IPv6 router.
- No DHCPv6 server needed.
- Rely on ICMPv6 Router Advertisement (RA) messages.



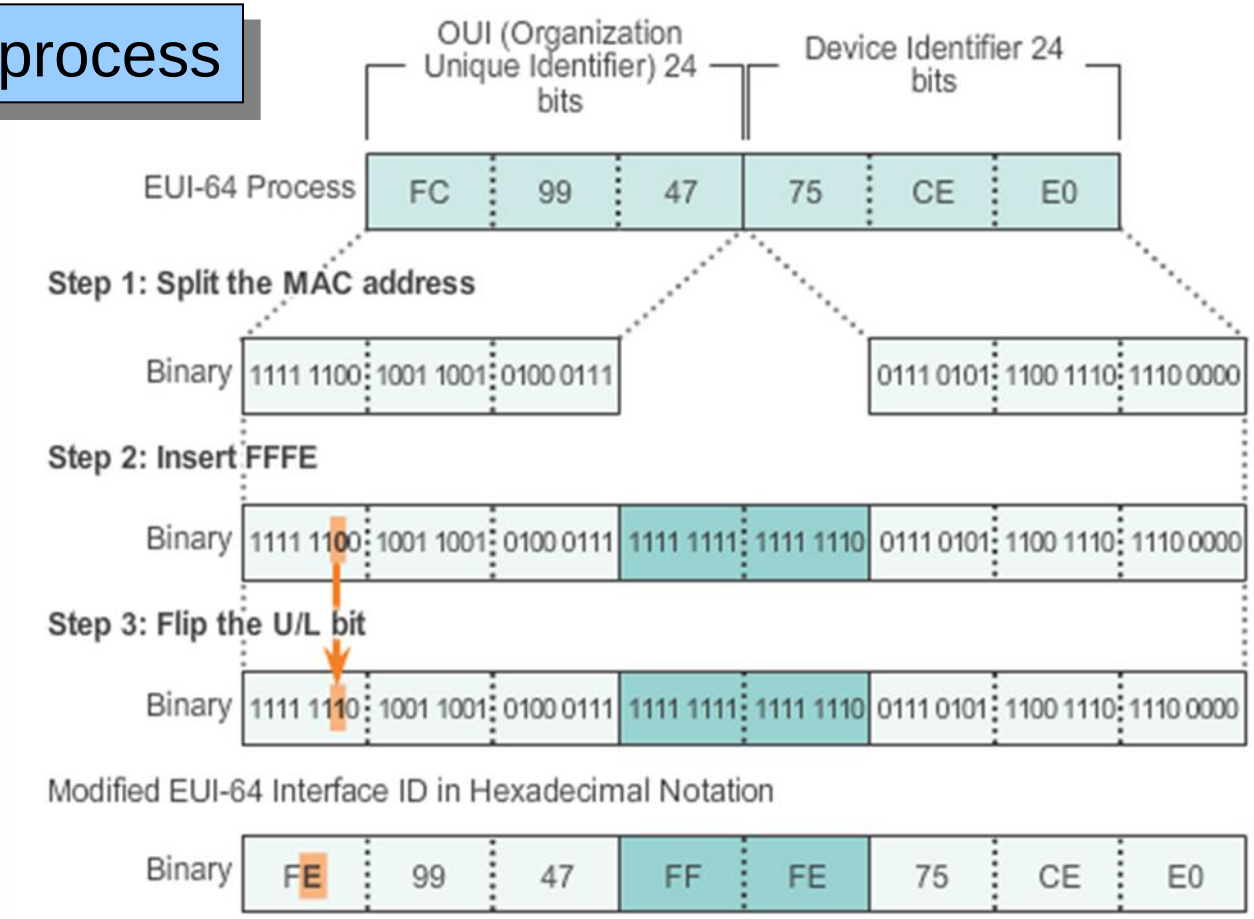
2.3 IPv6 configuration

Global unicast: dynamic configuration using SLAAC

- Routers send ICMPv6 RA messages using the link-local address as the source IPv6 address.
- RA message can contain one of the following three options:
  - SLAAC Only: Uses the information contained in the RA message.
  - SLAAC and DHCPv6: Uses the information contained in the RA message and get other information from the DHCPv6 server, for example, DNS.
  - DHCPv6 only: The device should not use the information in the RA (stateful DHCPv6).
- Interface ID: EUI-64 or random.
- A host may choose to ignore RA messages and obtain its IPv6 configuration from a DHCPv6 server.

2.3 IPv6 configuration

EUI-64 process



2.3 IPv6 configuration

Random interface ID

- Depending upon the operating system, a device can use a randomly generated Interface ID instead of using the EUI-64 process.
  - PC with Windows 10 and later uses a randomly generated Interface ID.
  - PC with Windows XP used EUI-64

2.3 IPv6 configuration

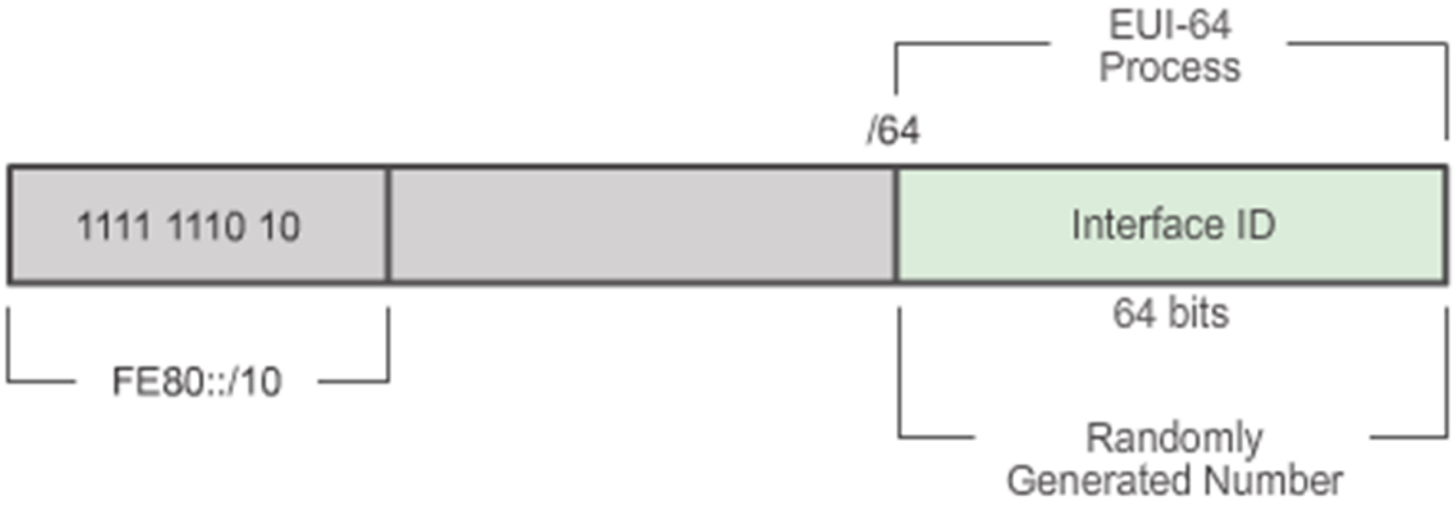
Link-local: static configuration

```
R1(config)#interface gigabitethernet 0/0
R1(config-if)#ipv6 address fe80::1 ?
  link-local  Use link-local address

R1(config-if)#ipv6 address fe80::1 link-local
R1(config-if)#exit
R1(config)#interface gigabitethernet 0/1
R1(config-if)#ipv6 address fe80::1 link-local
R1(config-if)#exit
R1(config)#interface serial 0/0/0
R1(config-if)#ipv6 address fe80::1 link-local
R1(config-if)#
```

2.3 IPv6 configuration

Link-local: dynamic configuration



2.3 IPv6 configuration

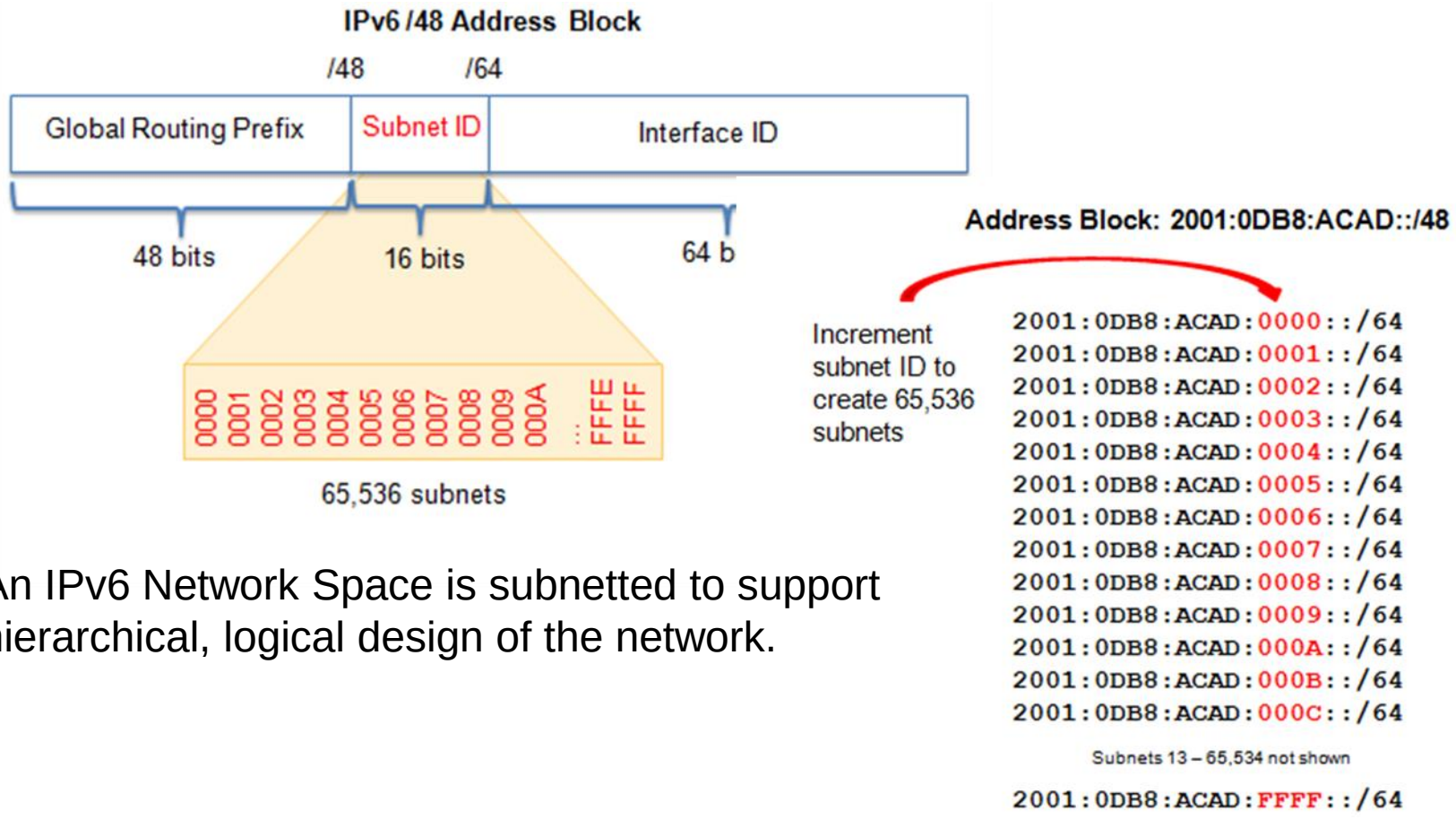
Link-local: dynamic configuration

```
R1#show interface gigabitethernet 0/0
GigabitEthernet0/0 is up, line protocol is up
  Hardware is CN Gigabit Ethernet, address is fc99.4775.c3e0
(bia fc99.4775.c3e0)
<Output Omitted>

R1#show ipv6 interface brief
GigabitEthernet0/0      [up/up]
    FE80::FE99:47FF:FE75:C3E0
    2001:DB8:ACAD:1::1
GigabitEthernet0/1      [up/up]
    FE80::FE99:47FF:FE75:C3E1
    2001:DB8:ACAD:2::1
Serial0/0/0             [up/up]
    FE80::FE99:47FF:FE75:C3E0
    2001:DB8:ACAD:3::1
```

2.4 IPv6 subnetting

IPv6 subnetting using the subnet ID



An IPv6 Network Space is subnetted to support hierarchical, logical design of the network.

2.4 IPv6 subnetting

IPv6 subnetting using the subnet ID

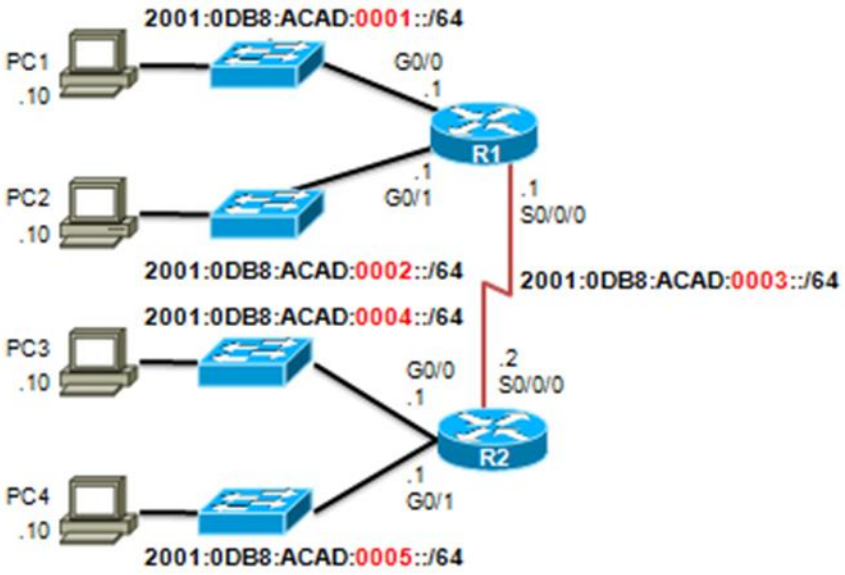
IPv6 Subnetting

Address Block: 2001:0DB8:ACAD::/48

5 subnets allocated from 65,536 available subnets

2001:0DB8:ACAD:0000::/64
2001:0DB8:ACAD:0001::/64
2001:0DB8:ACAD:0002::/64
2001:0DB8:ACAD:0003::/64
2001:0DB8:ACAD:0004::/64
2001:0DB8:ACAD:0005::/64
2001:0DB8:ACAD:0006::/64
2001:0DB8:ACAD:0007::/64
2001:0DB8:ACAD:0008::/64
⋮
2001:0DB8:ACAD:FFFF::/64

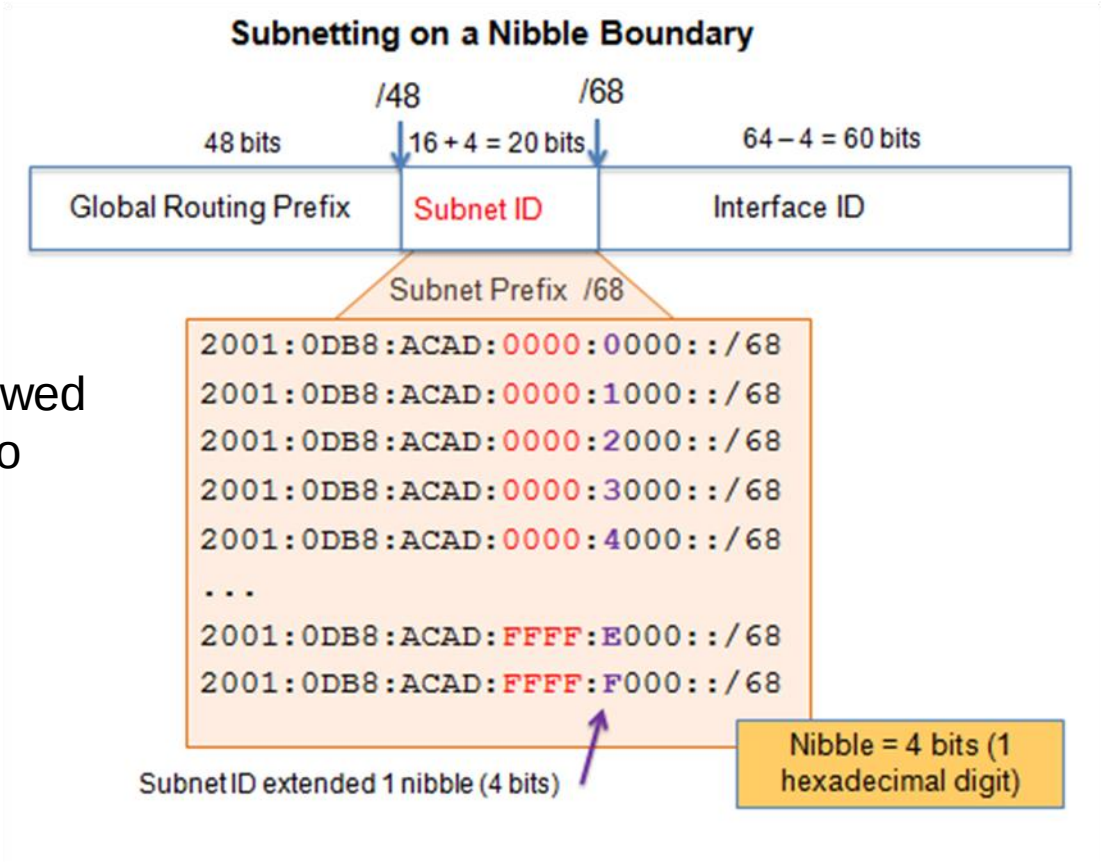
IPv6 Subnet Allocation



2.4 IPv6 subnetting

IPv6 subnetting into the interface ID

IPv6 bits can be borrowed from the interface ID to create additional IPv6 subnets.



2.5 IPv6 static routing

Static routes

- Standard IPv6 static route.
- Default IPv6 static route.
- Summary IPv6 static route.
- Floating IPv6 static route.

2.5 IPv6 static routing

Standard static IPv6 route

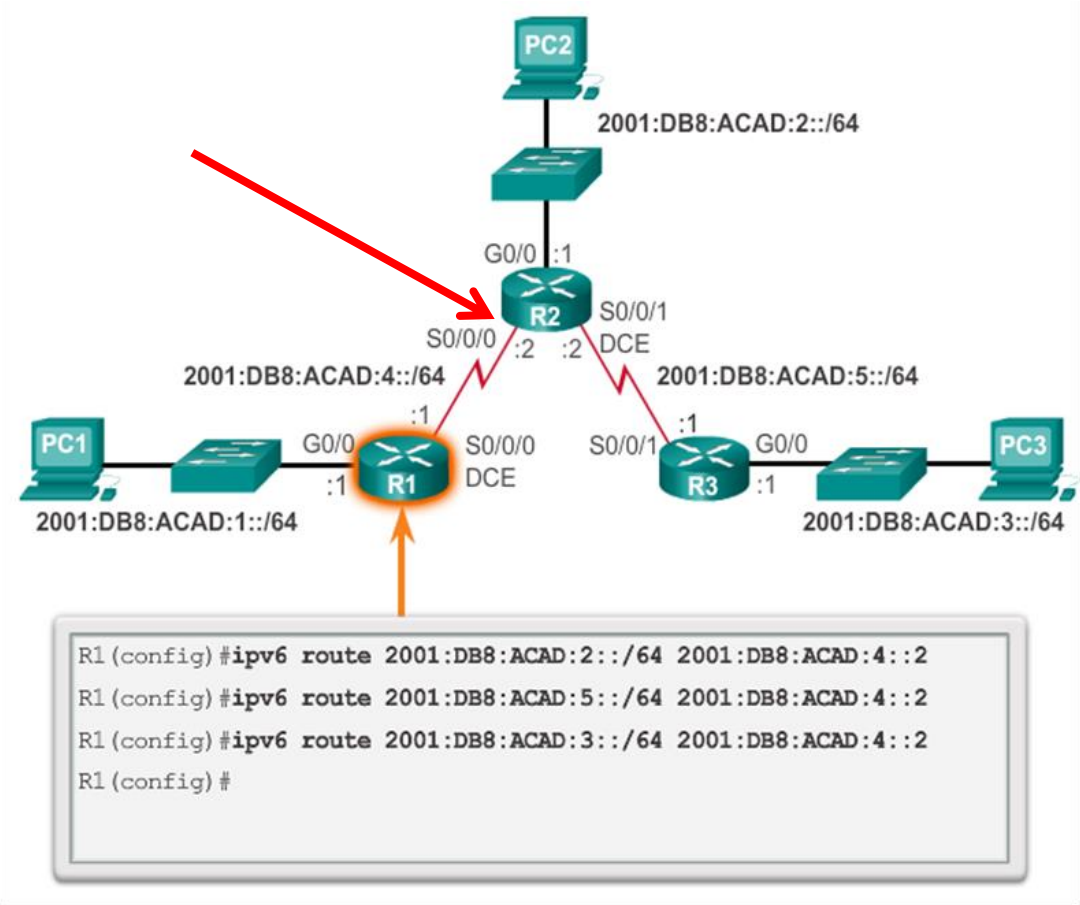
- Destination (address/prefix length) and next hop or exit interface

- Next-hop: IPv6 address.
- Exit interface (directly connected network): physical interface.
- Both next hop and exit interface (fully specified route).

```
Router(config)#ipv6 route ipv6-prefix/ipv6-mask
{ipv6-address | exit-intf}
```

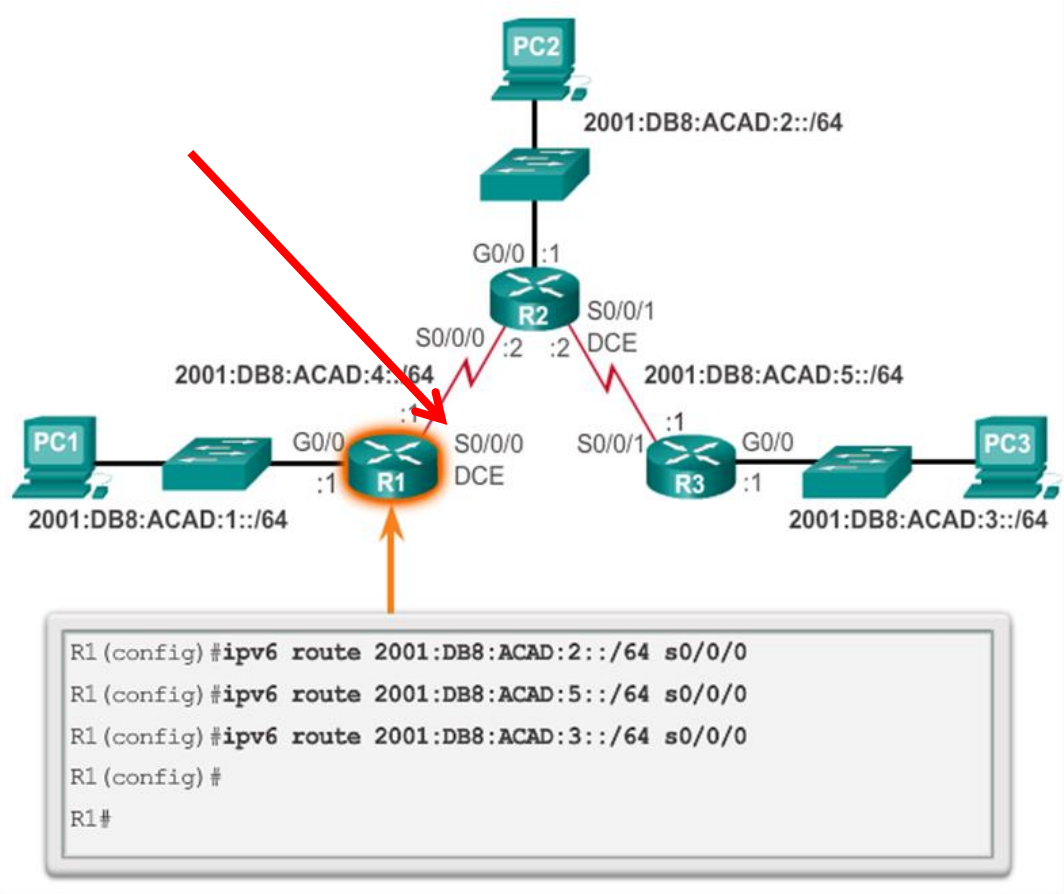
2.5 IPv6 static routing

Next-hop



2.5 IPv6 static routing

Exit interface



2.5 IPv6 static routing

Fully specified route

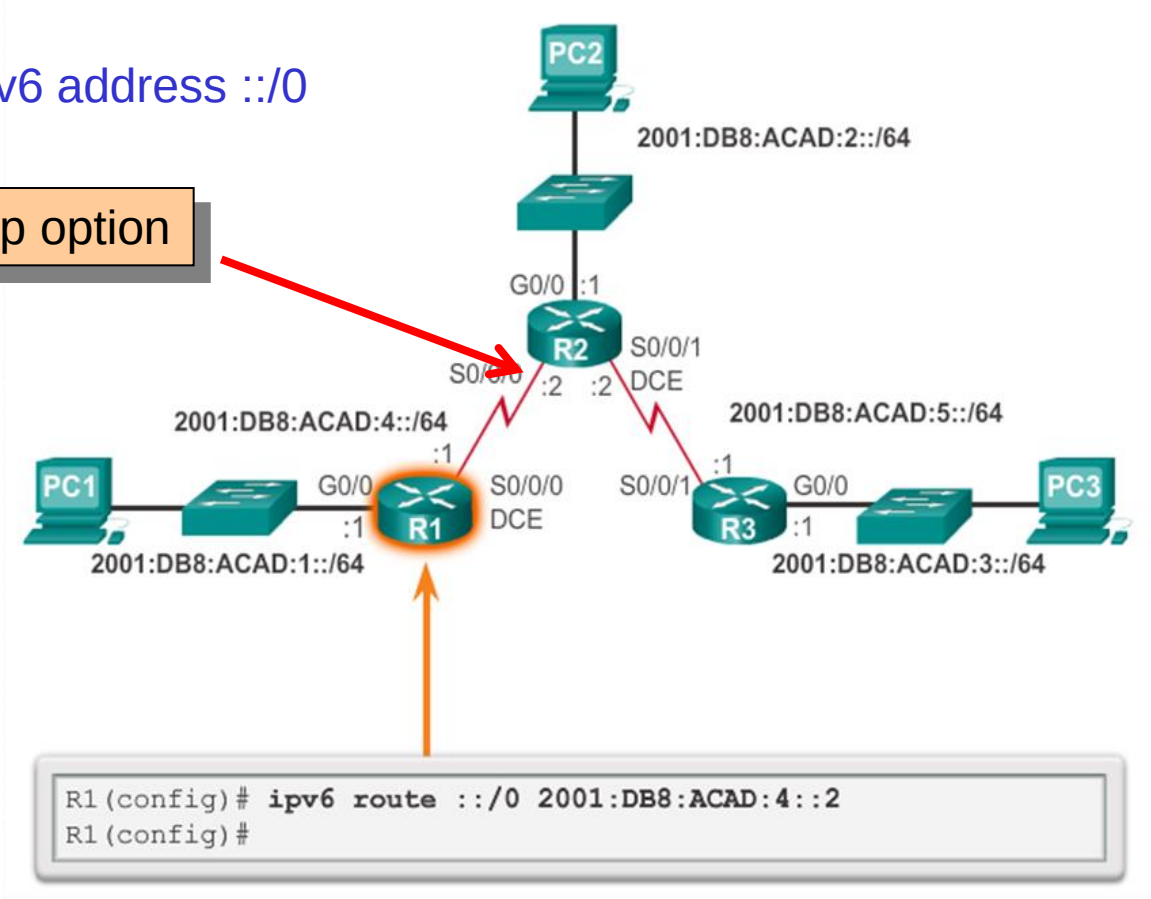

```
R1(config)# ipv6 route 2001:db8:acad:2::/64 fe80::2
% Interface has to be specified for a link-local nexthop
R1(config)# ipv6 route 2001:db8:acad:2::/64 s0/0/0 fe80::2
R1(config)#
```

2.5 IPv6 static routing

Default static IPv6 route

Network IPv6 address ::/0

Next-hop option

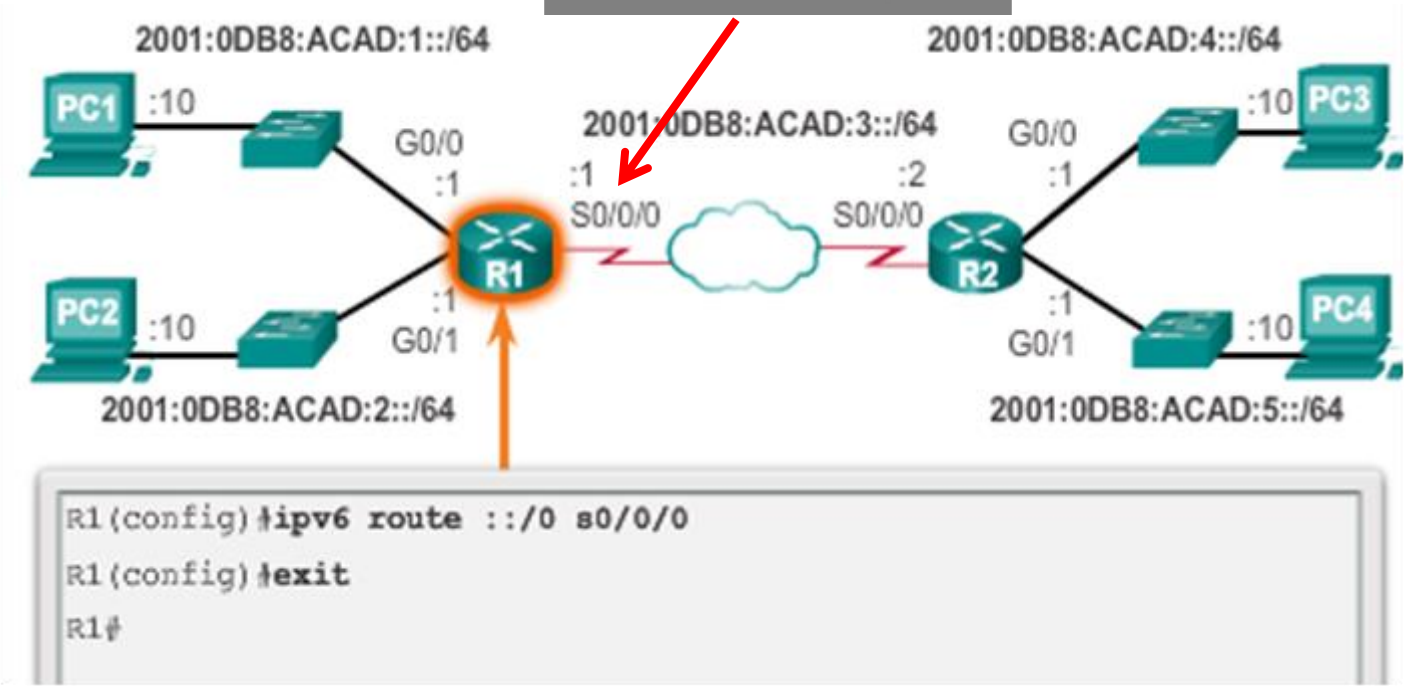


2.5 IPv6 static routing

Default static IPv6 route

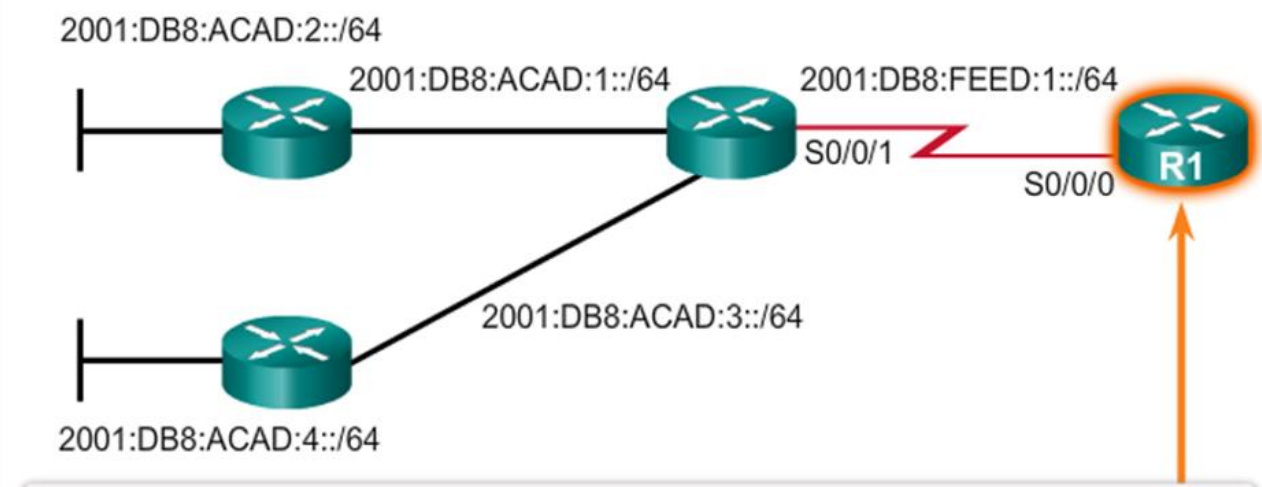
Network IPv6 address ::/0

Exit interface option



2.5 IPv6 static routing

IPv6 summary address




```
R1(config)# no ipv6 route 2001:DB8:ACAD:1::/64 2001:db8:feed:1::2
R1(config)# no ipv6 route 2001:DB8:ACAD:2::/64 2001:db8:feed:1::2
R1(config)# no ipv6 route 2001:DB8:ACAD:3::/64 2001:db8:feed:1::2
R1(config)# no ipv6 route 2001:DB8:ACAD:4::/64 2001:db8:feed:1::2
R1(config)#
R1(config)#
R1(config)# ipv6 route 2001:DB8:ACAD::/61 2001:db8:feed:1::2
R1(config)#
```

2.5 IPv6 static routing

Floating static route

- For backup
- Administrative distance: 1-254
- Command:

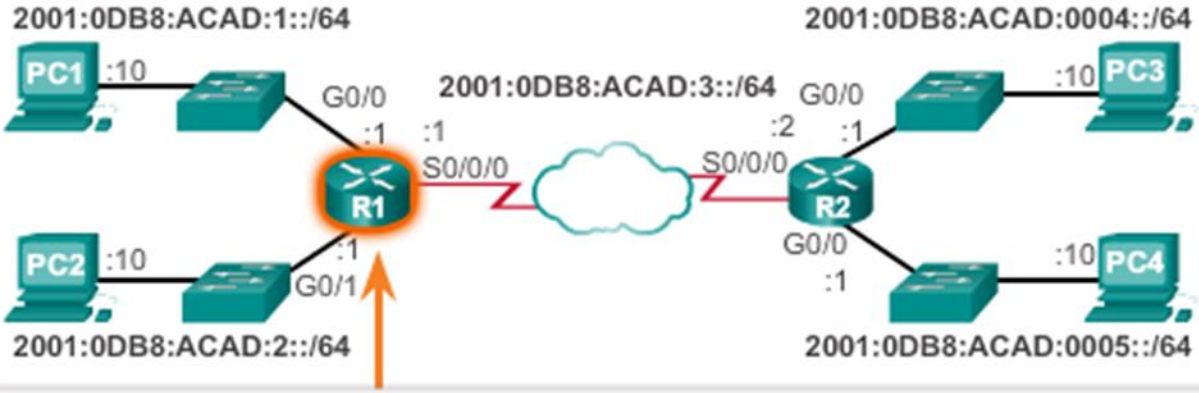
  ipv6 route address {*next-hop/exit interface*} *admin-dist*

- Example:

  Router(config)# ipv6 route 2016::10/64 2020::12 150

2.5 IPv6 static routing

Directed connected networks




```
R1#show ipv6 route
IPv6 Routing Table - default - 9 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE -
Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
C   2001:DB8:ACAD:1::/64 [0/0]
     via GigabitEthernet0/0, directly connected
L   2001:DB8:ACAD:1::1/128 [0/0]
     via GigabitEthernet0/0, receive
C   2001:DB8:ACAD:2::/64 [0/0]
     via GigabitEthernet0/1, directly connected
```

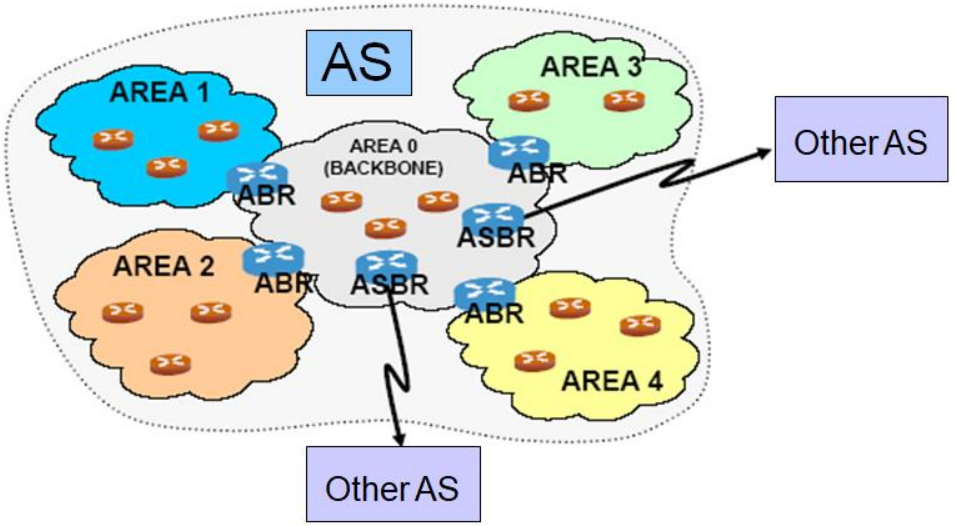
2.6 OSPFv3

OSPFv3 features

- Link-state protocol.
- SPF algorithm (Dijkstra).
- Metric based on BW.
- VLSM.
- Authentication.
- Load balancing.
- Multicast FF02::5

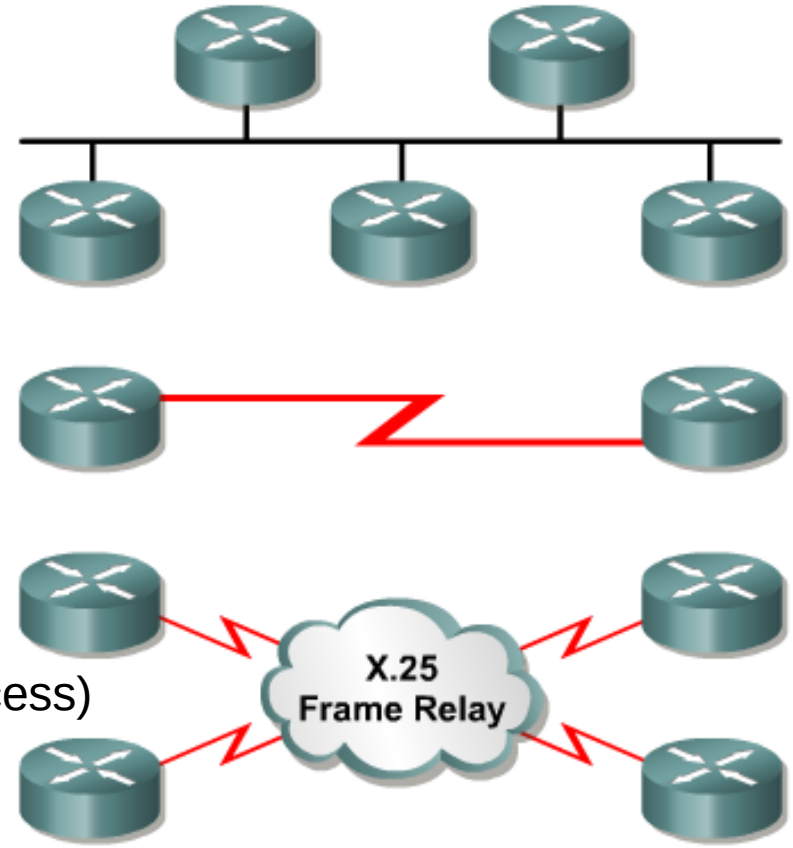
Network elements

- Network divided in Autonomous Systems (AS).
- AS divided in Areas.
  - All areas connected to Area 0 or Backbone.
- Types of rotuers:
  - IR (Interior Router)
  - ABR (Area Border Router)
  - ASBR (AS Border Routers)



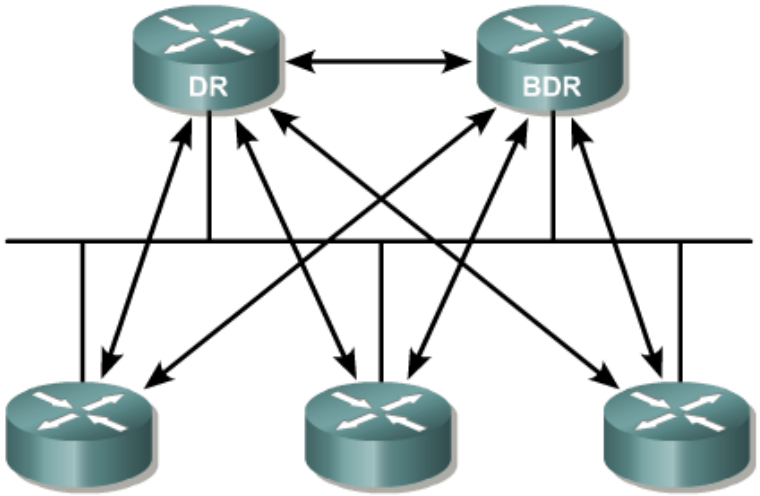
Network types

- BMA (Broadcast Multiaccess)
- Point to Point
- NBMA (Non Broadcast Multiaccess)



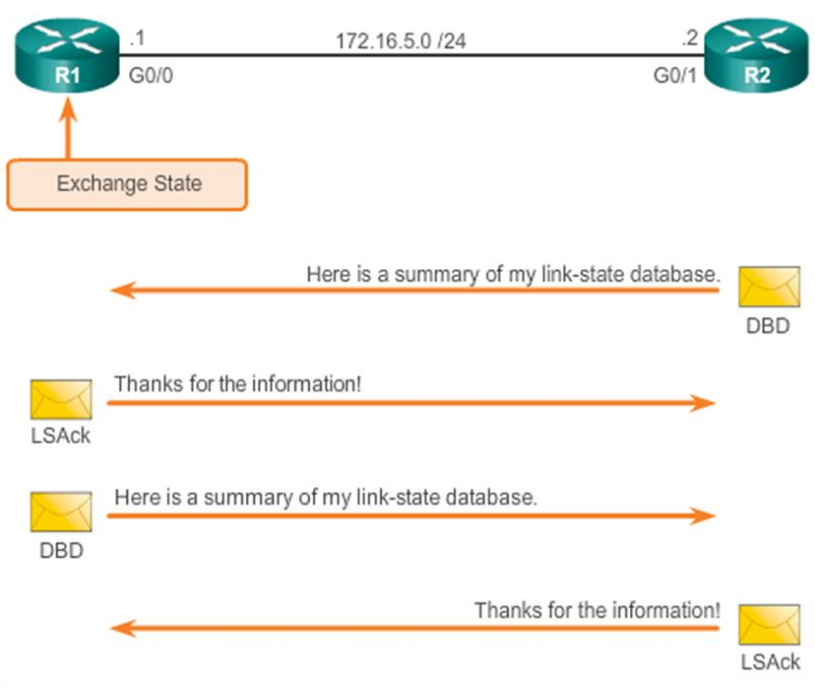
Types of OSPF packets

- 1. Hello
  - Discover OSPF neighbors and establish neighbor adjacencies.
  - Elect the Designated Router (DR) and Backup Designated Router (BDR) on multiaccess networks like Ethernet and Frame Relay.
  - Transmitted every 10 sec. (BMA and point to point) or 30 sec. (NBMA).



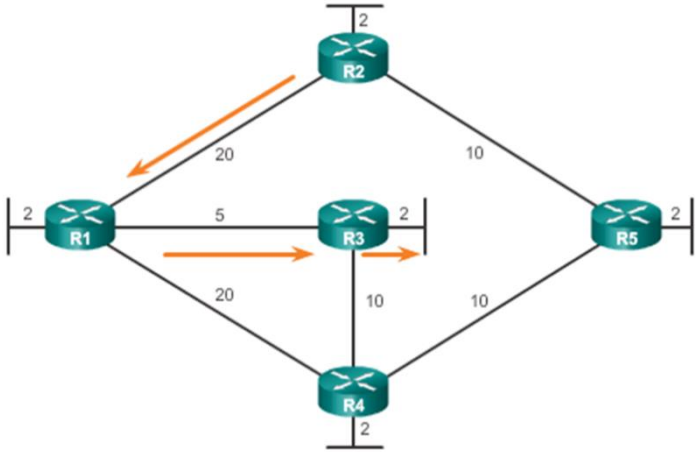
Types of OSPF packets

- 2. Database Description (DBD)
  - Checks for Database synchronization between routers.



Types of OSPF packets

- 3. Link-State Request (LSR)
  - Request specific link-state information.
- 4. Link-State Update (LSU)
  - Sends requested information.
  - Contains one or more Link-State Advertisements (LSA).
- 5. Link-State Acknowledgment (LSAck)

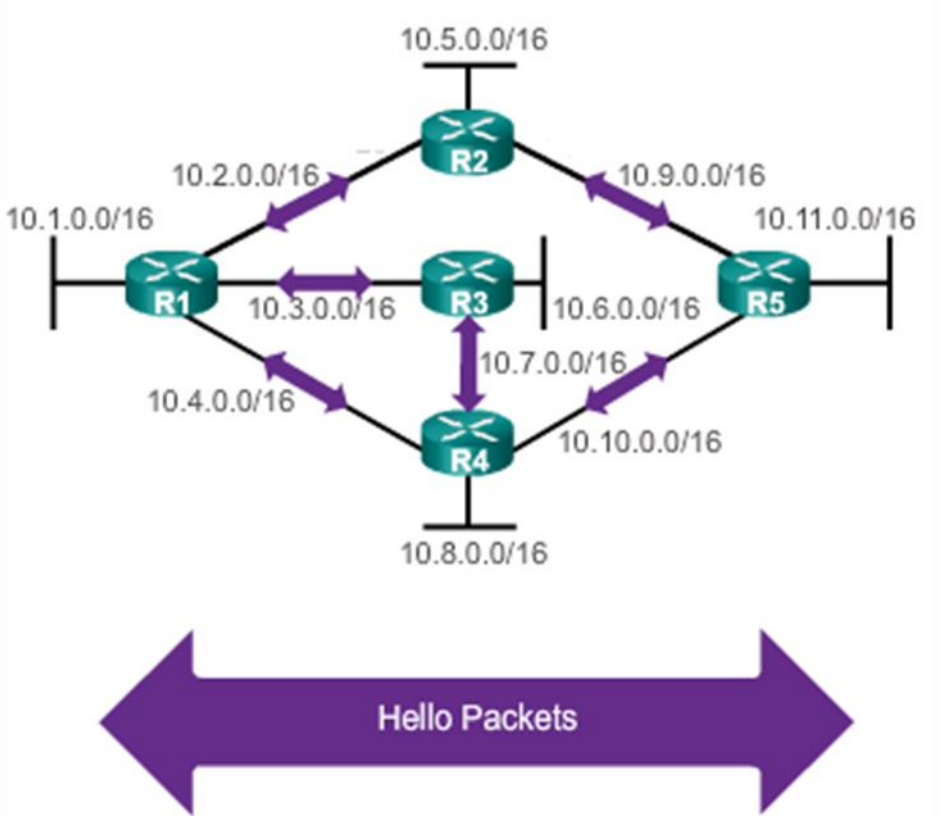


Types of LSAs

- Router link (RL)
  - Link-state information
  - Generated by IR.
- Network link (NL)
  - Summary of Link-state information after receiving RLs.
  - Generated by DR in multiaccess networks.
- Summary link (SL): generated by ABR.
  - Summary of information of some areas.
  - Generated by ABR.
- External link (EL): generated by ASBR.
  - Summary of information of some ASs.

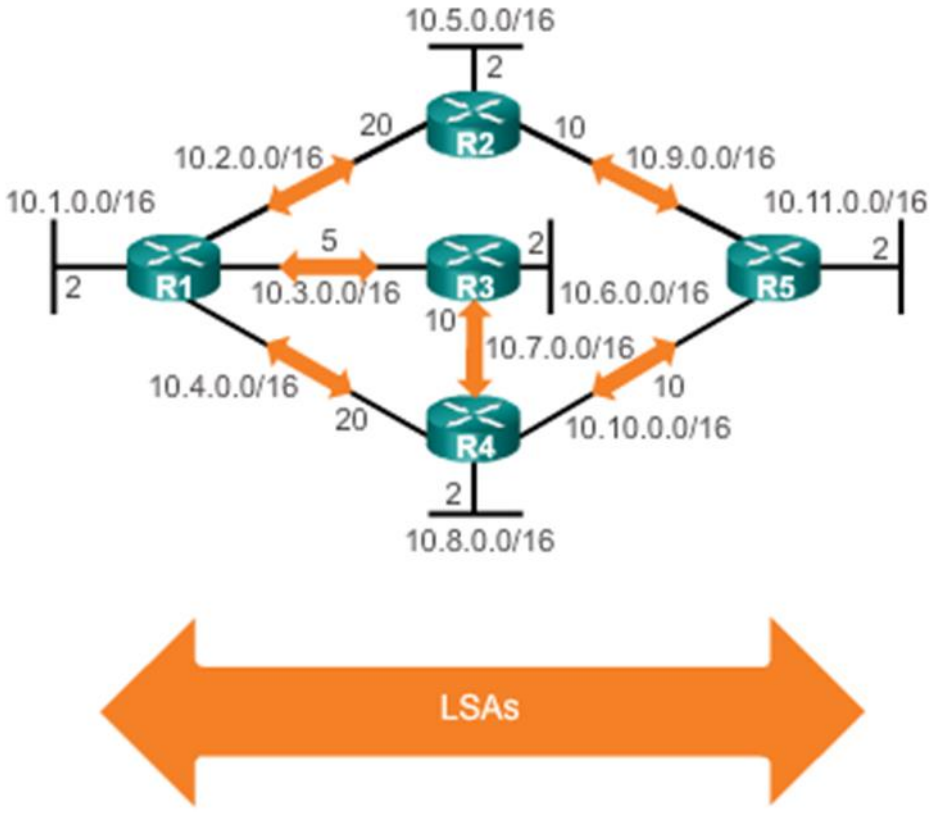
Step 1: Routers exchange of Hello packets

- Neigbor discovery and establishment of neighbor adjacencies.



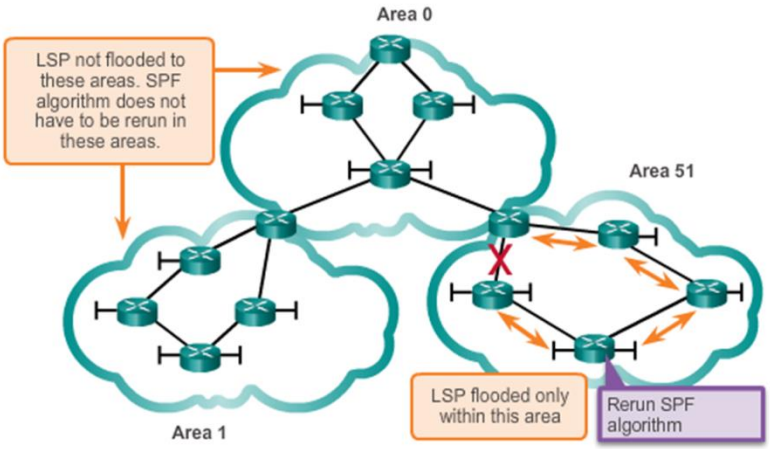
Step 2: Routers exchange LSAs

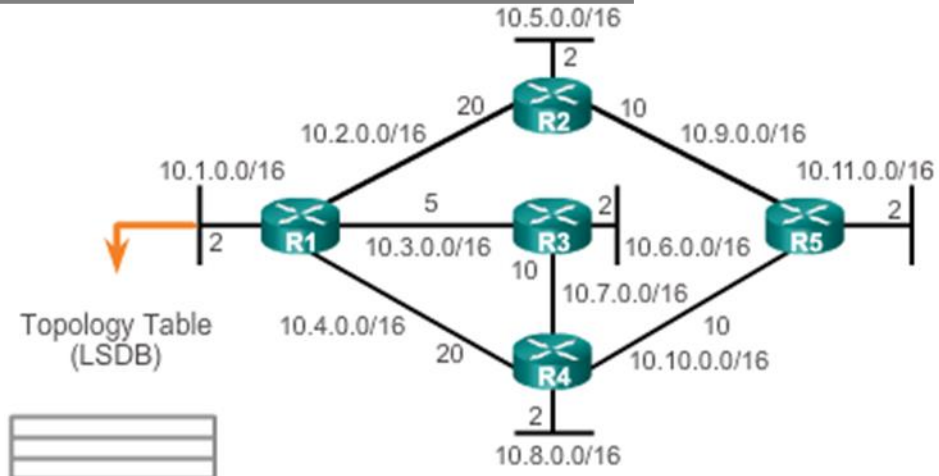
- LSAs contain port costs.
- Routers flood their LSAs to adjacent neighbors.
- Resend again LSAs untill all routers have all LSAs.



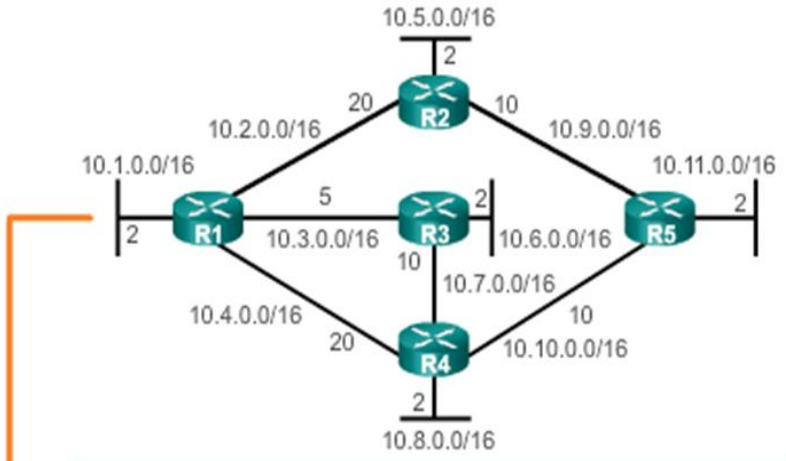
Step 3: Building the SPF Tree

- Routers build the topology based on recevied LSAs
- Execute SPF algorithm to create the SPF Tree.





Step 3: SPF Tree (cont.)



Destination	Shortest Path	Cost
10.5.0.0/16	R1 → R2	22
10.6.0.0/16	R1 → R3	7
10.7.0.0/16	R1 → R3	15
10.8.0.0/16	R1 → R3 → R4	17
10.9.0.0/16	R1 → R2	30
10.10.0.0/16	R1 → R3 → R4	25
10.11.0.0/16	R1 → R3 → R4 → R5	27

Step 4: Building the routing table

Destination	Shortest Path	Cost
10.5.0.0/16	R1 → R2	22
10.6.0.0/16	R1 → R3	7
10.7.0.0/16	R1 → R3	15
10.8.0.0/16	R1 → R3 → R4	17
10.9.0.0/16	R1 → R2	30
10.10.0.0/16	R1 → R3 → R4	25
10.11.0.0/16	R1 → R3→ R4→ R5	27

R1 Routing Table

Directly Connected Networks

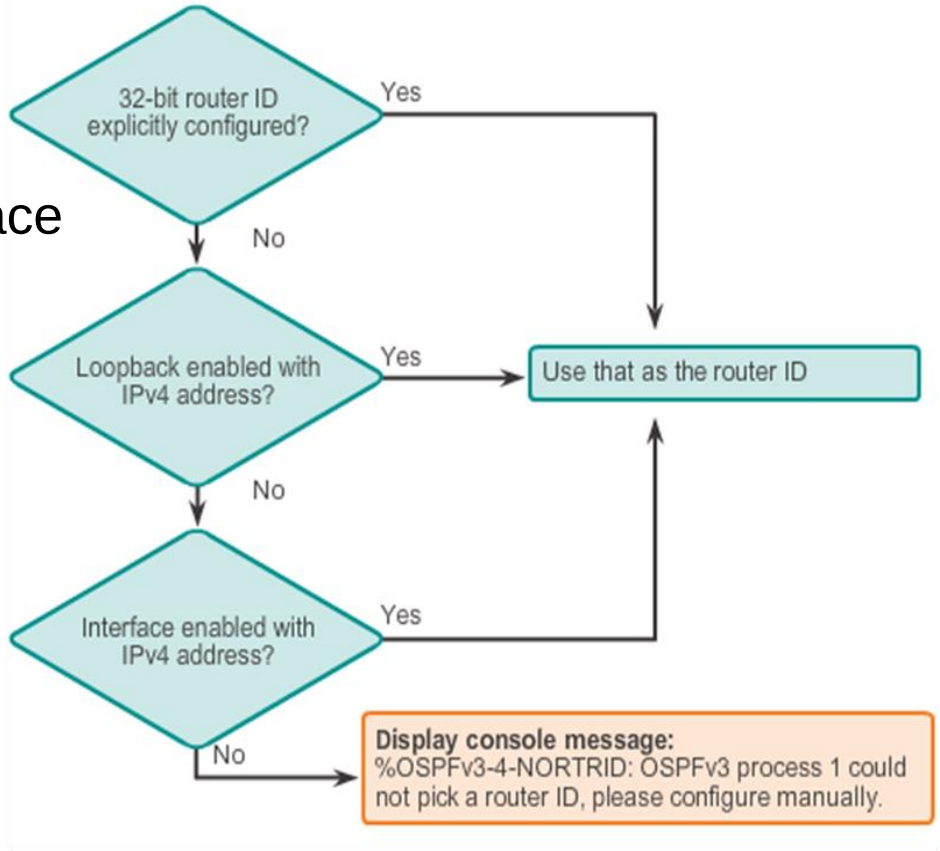
- 10.1.0.0/16 Directly Connected Network
- 10.2.0.0/16 Directly Connected Network
- 10.3.0.0/16 Directly Connected Network
- 10.4.0.0/16 Directly Connected Network

Remote Networks

- 10.5.0.0/16 via R2 serial 0/0/0,cost=22
- 10.6.0.0/16 via R3 serial 0/0/1,cost=7
- 10.7.0.0/16 via R3 serial 0/0/1,cost=15
- 10.8.0.0/16 via R3 serial 0/0/1,cost=17
- 10.9.0.0/16 via R2 serial 0/0/0,cost=30
- 10.10.0.0/16 via R3 serial 0/0/1,cost=25
- 10.11.0.0/16 via R3 serial 0/0/1,cost=27

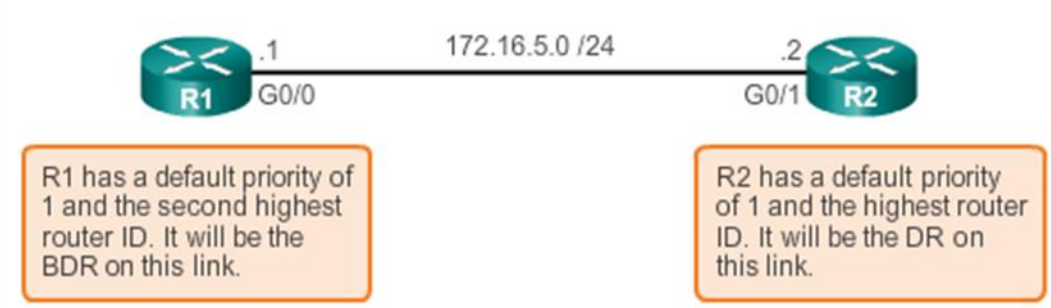
Router ID election

1. Command router-id
2. Highest IPv4 loopback interface
3. Highest IPv4 of an active physical interface



DR and BDR election

- DR:
  1. Router with highest interface priority (priority: 0-255, default 1)
  2. Router with highest router ID
- BDR:
  1. Router with next highest interface priority
  2. Router with next highest router ID



2.6 OSPFv3

OSPF cost

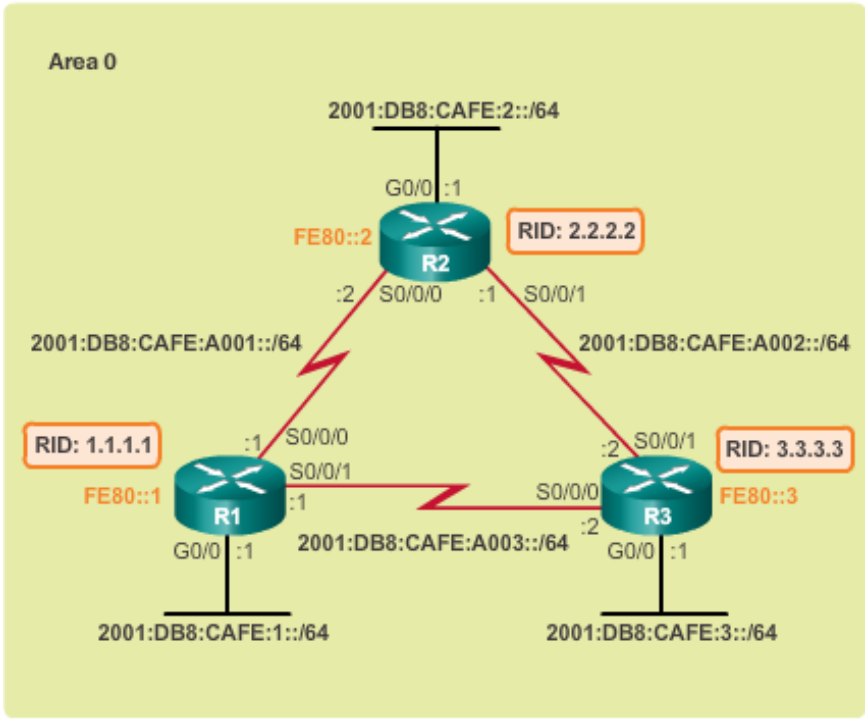
- Interface cost = 100.000.000 / [BW (bps)]

Medium	Cost
64 Kbps serial link	1562
128 Kbps serial link	781
T1 1.544 Mbs serial link	64
E1 2.048 Mbps serial link	48
Ethernet 10 Mbps	10
Fast Ethernet 100 Mbps	1
Gigabit Ethernet	1

2.6 OSPFv3

OSPF distance

- Distance calculation
  - Addition of exit interfaces costs from local router to network destination.



Router R1

Serial T1 (1.544 Mbps)

Giga Ethernet (1000 Mbps)

2001:DB8:CAFE:2::/64 [110/**65**] via FE80::2, Serial0/0/0

2001:DB8:CAFE:3::/64 [110/**65**] via FE80::3, Serial0/0/1

2001:DB8:CAFE:A002::/64 [110/**128**] via FE80::2, Serial0/0/0
via FE80::3, Serial0/0/1

Enabling OSPFv3

Enabling IPv6:

- Router(config)# **ipv6 unicast-routing**

Enabling OSPFv3:

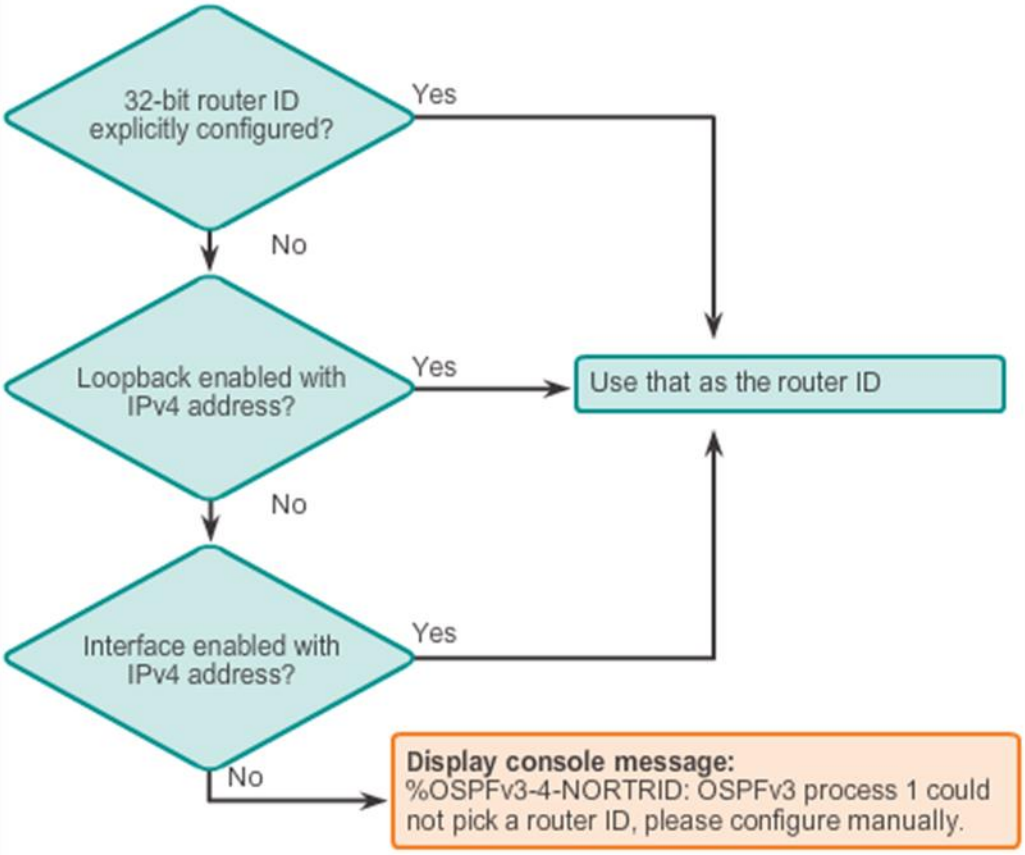
- Router(config)# **ipv6 router ospf** *process-ID*
  (process-ID: 1-65535)
  Router(config-rtr)#

Enabling OSPFv3 and IPv6 on an interface:

- Router(config)# **interface** *f0/0*
- Router(config-if)# **ipv6 enable**
- Router(config-if)# **ipv6 ospf** *10* **area** *0*

Configuring Router ID

- Router(config-rtr)# **router-id** *A.B.C.D*

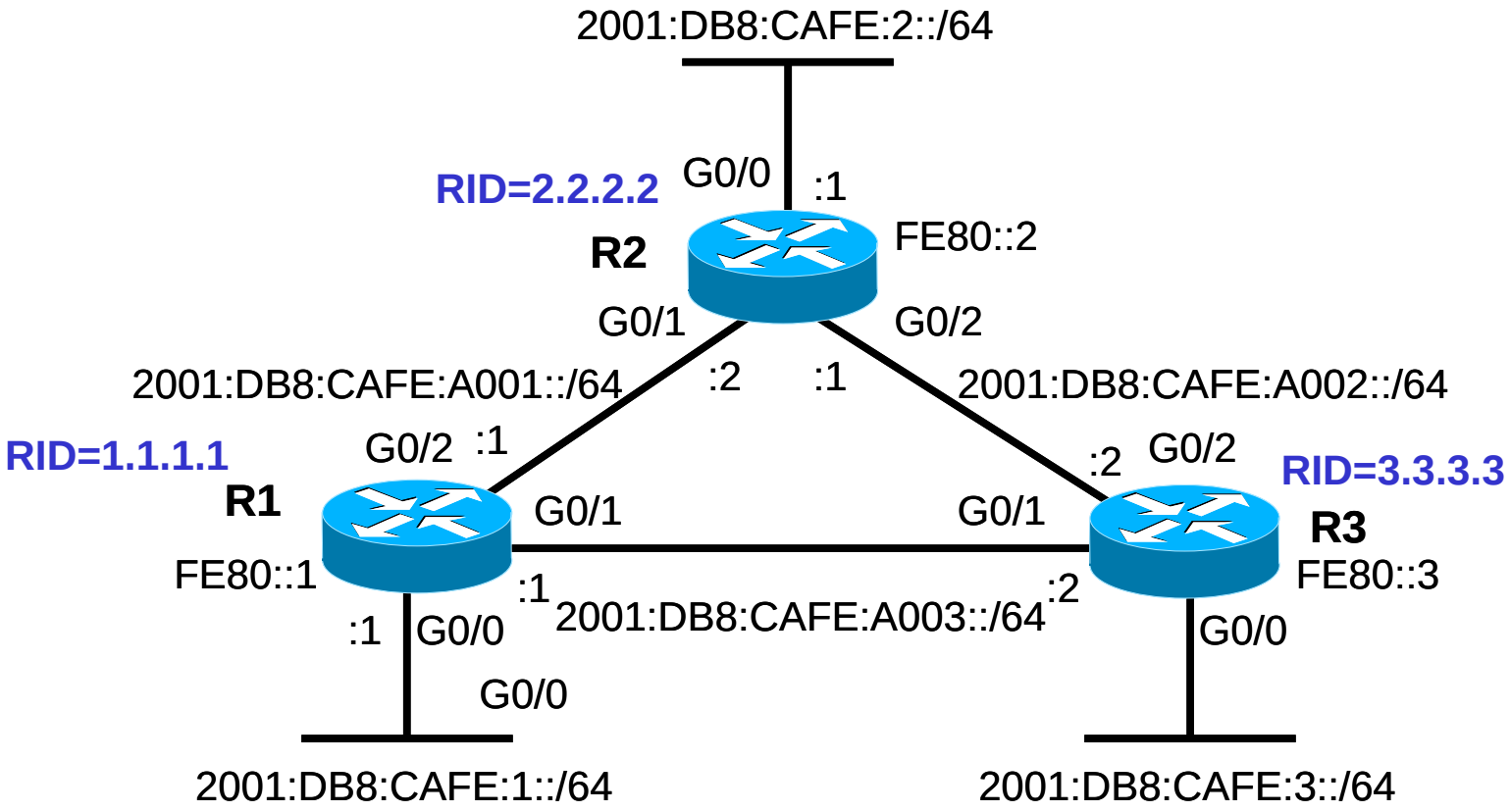


Configuring router priority

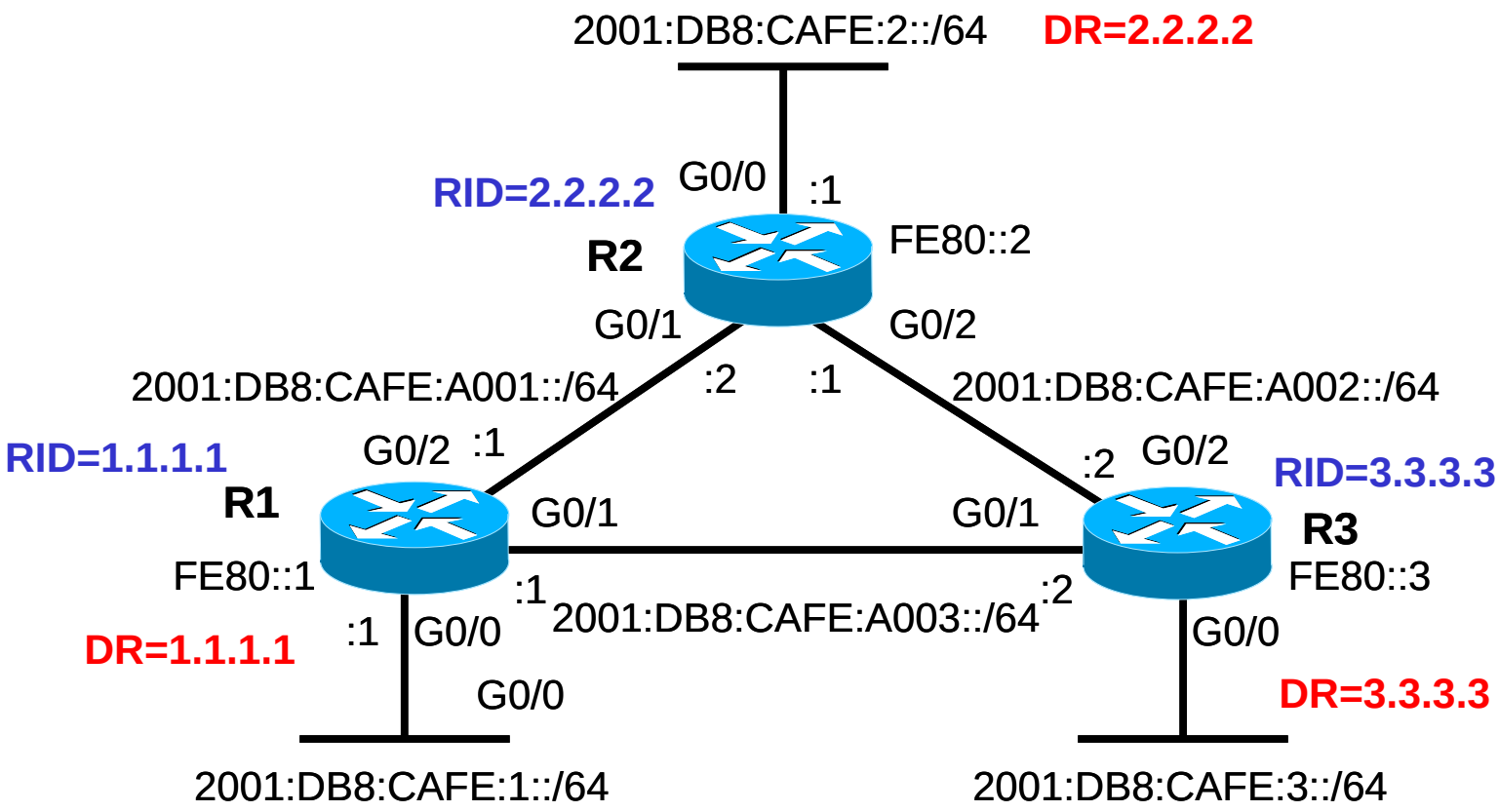
Router(config-if)# **ipv6 ospf priority** *number*

- [0-255]. By default 1.
- Priority 0 avoids a router to be selected as DR.

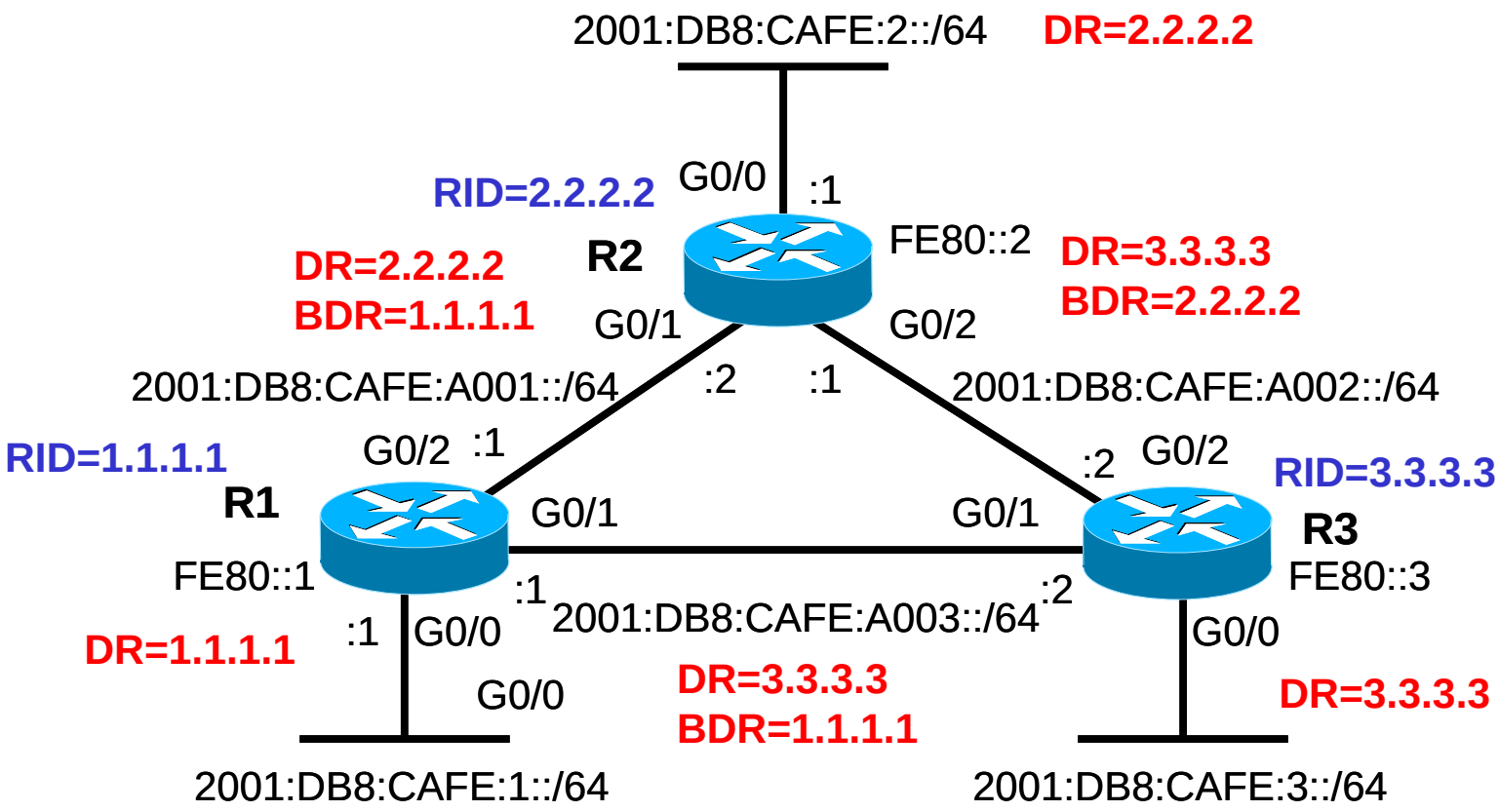
Example: DR and BDR election



Example: DR and BDR election



Example: DR and BDR election



Configuring interface cost

Modifying reference bandwidth (optional):

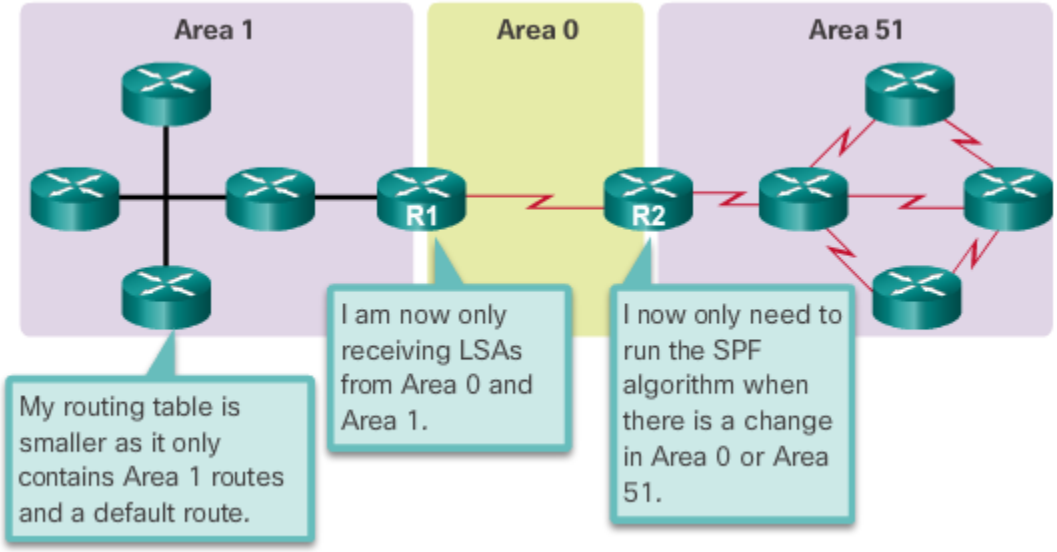
- Router(config-rtr)# **auto-cost reference-bandwidth** *BW_Mpbs*

Modifying interface cost:

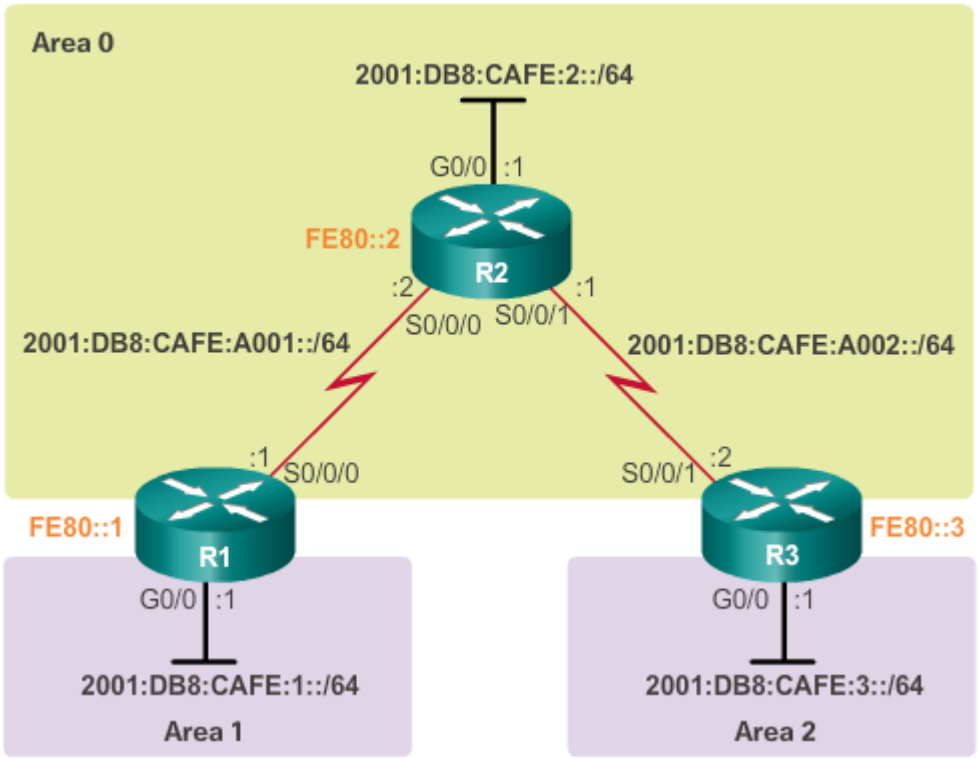
- Router(config-if)# **bandwidth** *kbps*
- Router(config-if)# **ipv6 ospf cost** *number*
  (cost number: 1-65535)

Multiarea OSPF

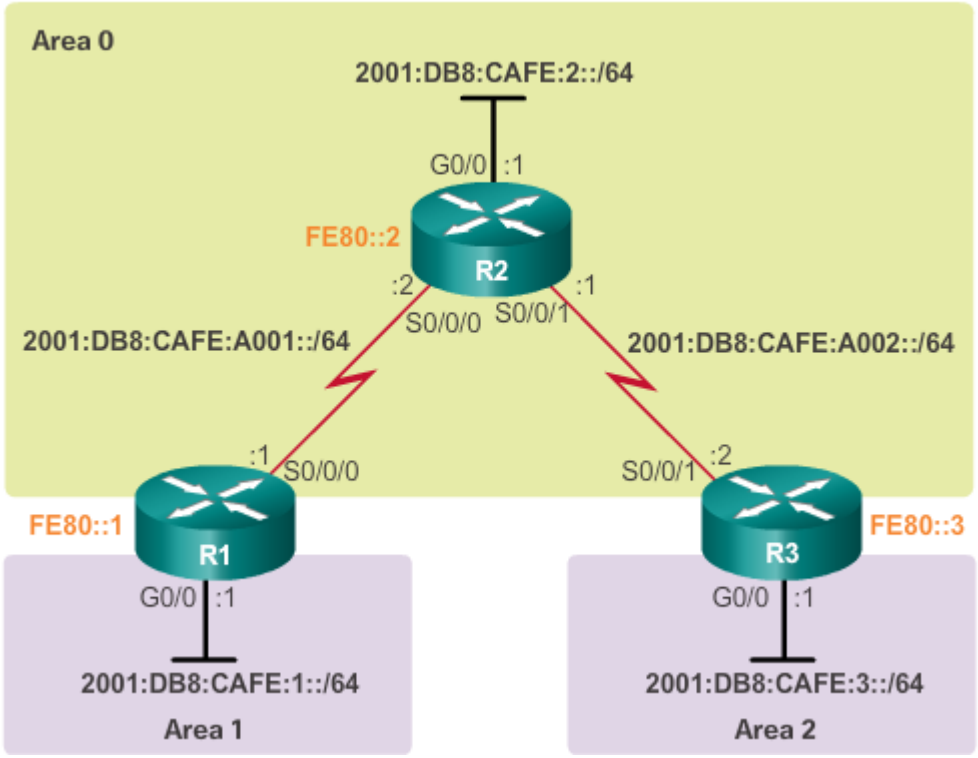
- Large networks.
- Reduce processing and memory overhead.
  - Smaller routing tables.
  - Reduced link-state update overhead.
  - Reduced frequency of SPF calculations.



Multiarea OSPF



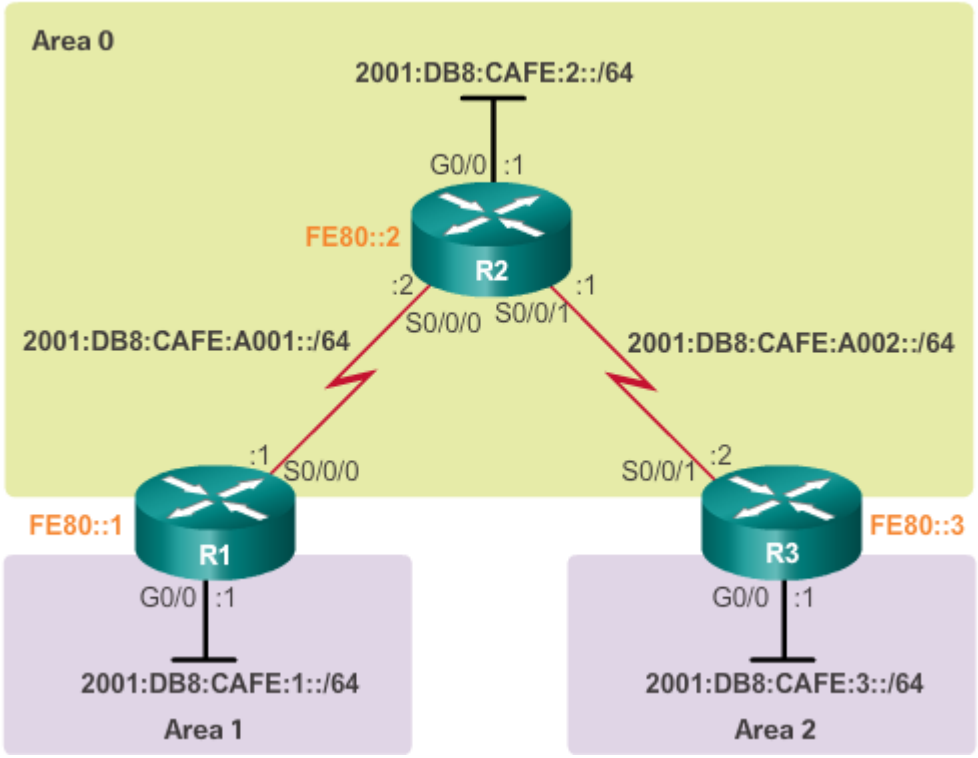
Multiarea OSPF




```
R1(config)# ipv6 router ospf 10
R1(config-rtr)# router-id 1.1.1.1
R1(config-rtr)# exit
R1(config)#
R1(config)# interface GigabitEthernet 0/0
R1(config-if)# ipv6 ospf 10 area 1
R1(config-if)#
R1(config-if)# interface Serial0/0/0
R1(config-if)# ipv6 ospf 10 area 0
R1(config-if)# end
R1#
```

2.6 OSPFv3

Multiarea OSPF

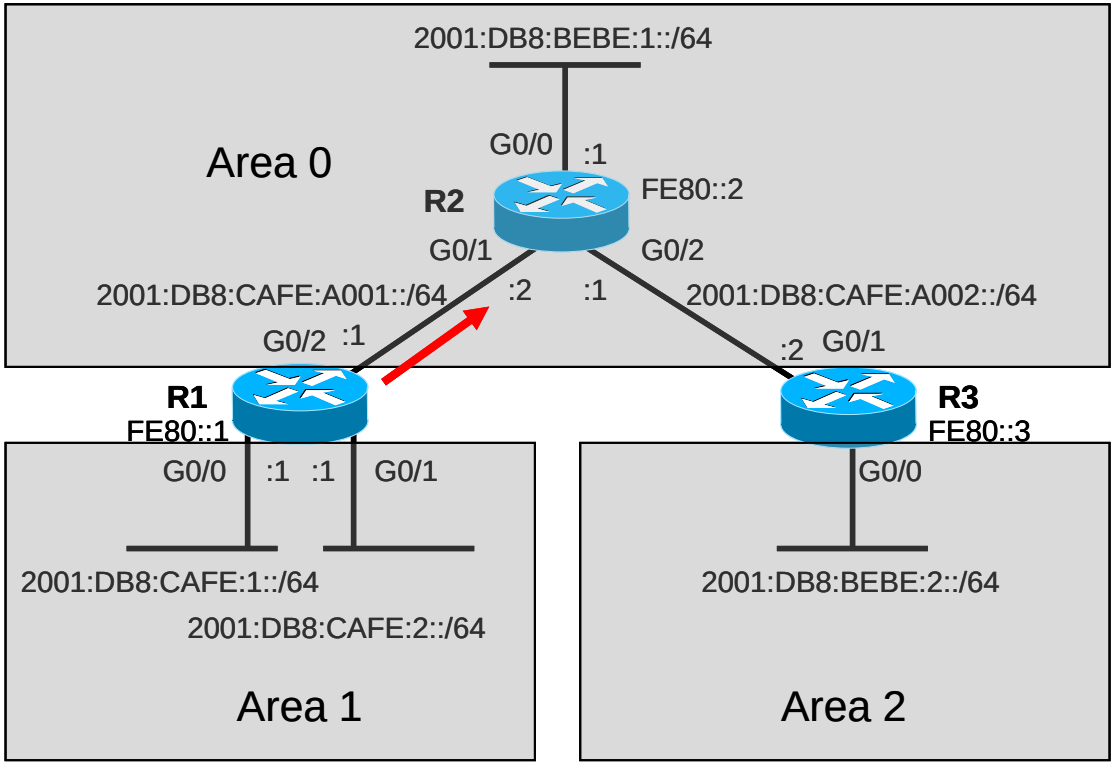



```
R1(config)# ipv6 router ospf 10
R1(config-rtr)# router-id 1.1.1.1
R1(config-rtr)# exit
R1(config)#
R1(config)# interface GigabitEthernet 0/0
R1(config-if)# ipv6 ospf 10 area 1
R1(config-if)#
R1(config-if)# interface Serial0/0/0
R1(config-if)# ipv6 ospf 10 area 0
R1(config-if)# end
R1#
```

```
R1# show ipv6 route ospf
IPv6 Routing Table - default - 8 entries
Codes: C - Connected, L - Local, S - Static, U - Per-us
route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS sum
       EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND P
Destination
       NDr - Redirect, O - OSPF Intra, OI - OSPF Inter,
       ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1, ON2 - O
O   2001:DB8:CAFE:2::/64 [110/648]
     via FE80::2, Serial0/0/0
OI  2001:DB8:CAFE:3::/64 [110/1295]
     via FE80::2, Serial0/0/0
O   2001:DB8:CAFE:A002::/64 [110/1294]
     via FE80::2, Serial0/0/0
```

2.6 OSPFv3

Summarization



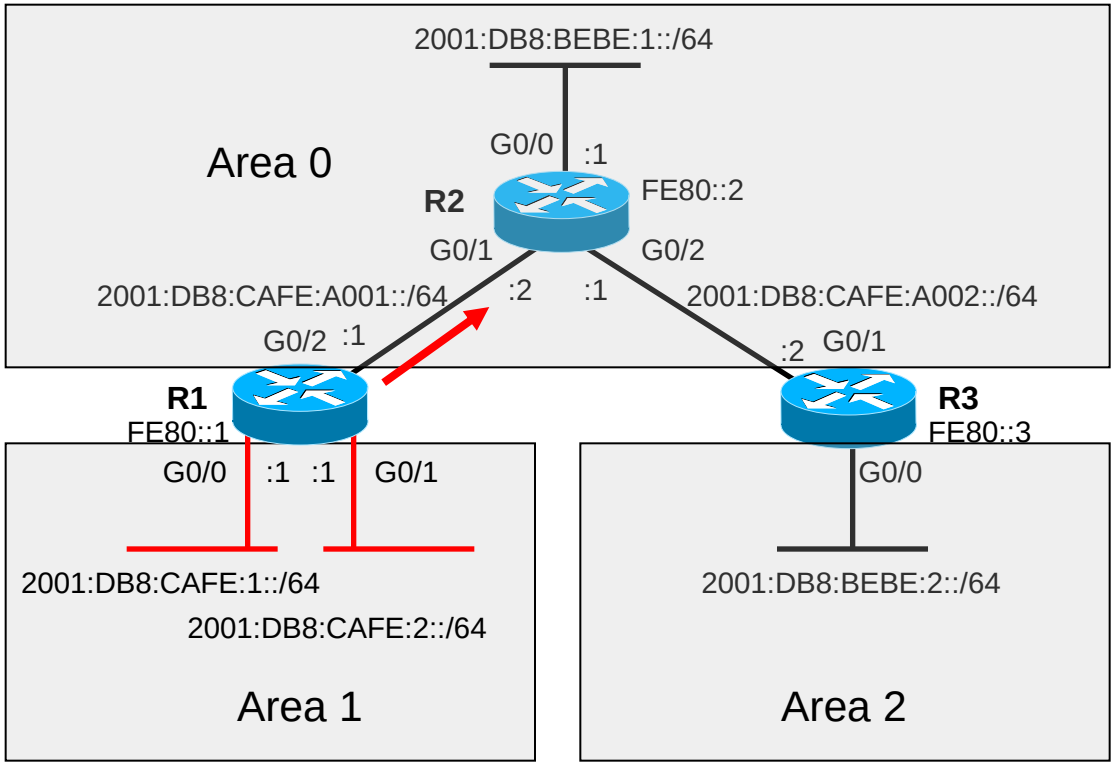
Router(confg-rtr)# **area** *area-id* **range** *prefix/prefix-length*

R1(confg-rtr)# **area** 1 **range** *2001:DB8:CAFE::/62*

2.6 OSPFv3

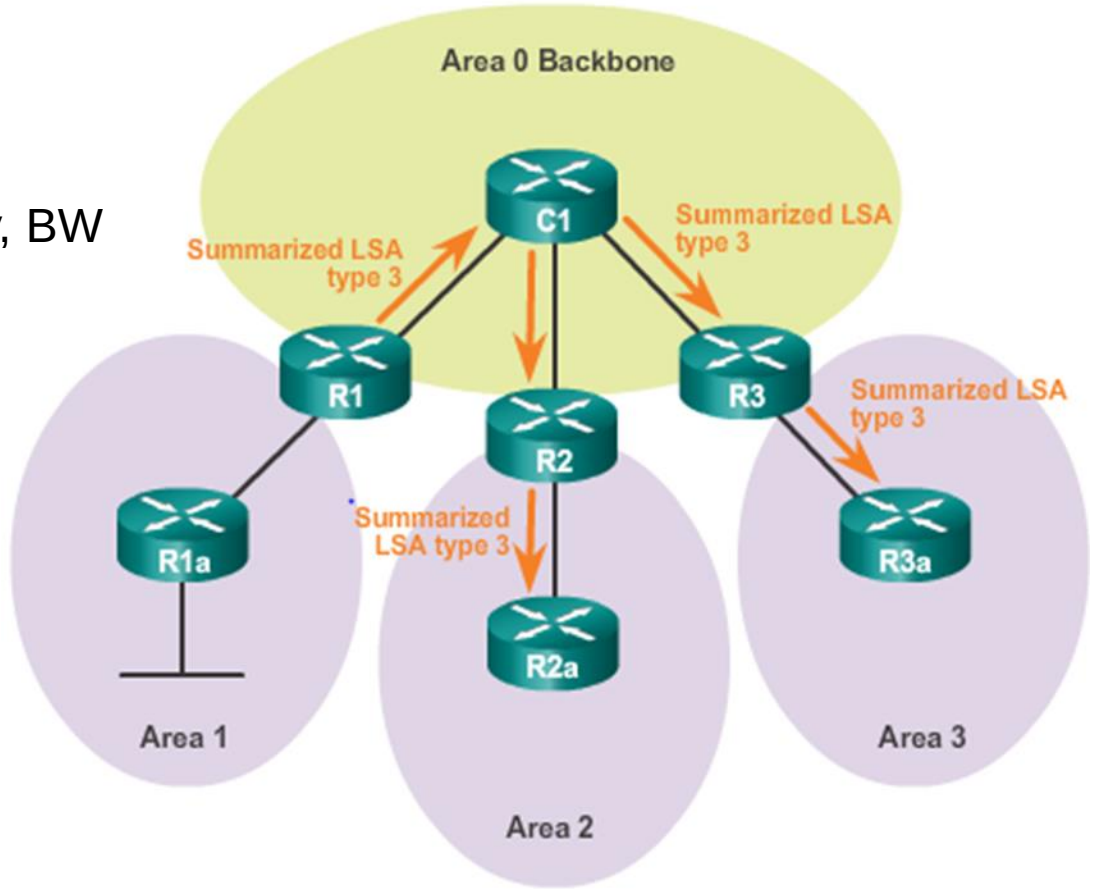
Summarization

- Only in ABR and ASBR.
- Interarea route summarization:
  - Manually configured in ABR.
  - An ABR can only summarize routes that are within the areas connected to the ABR.



Summarization

- Smaller routing tables.
- Less LSA flooding.
  - Less CPU, memory, BW consumption.



2.7 RIPng

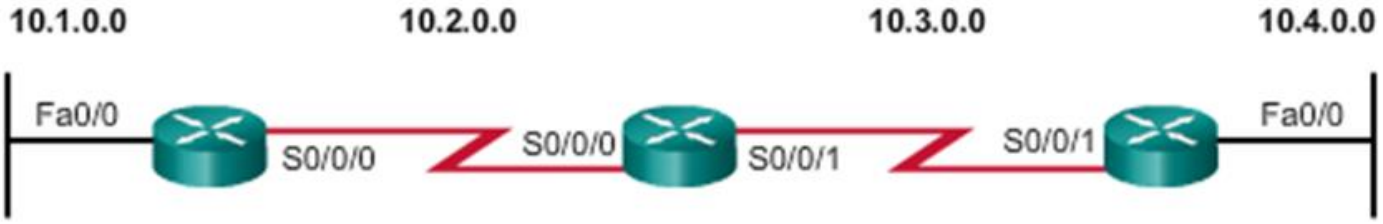
RIPng features

- Distance vector protocol.
- Bellman-Ford algorithm.
- Metric: number of hops.
- VLSM.
- Authentication.
- Load balancing.
- Multicast FF02::9
- UDP 521.

2.7 RIPng

Exchanging routing information

1. Directly connected networks detected



Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0

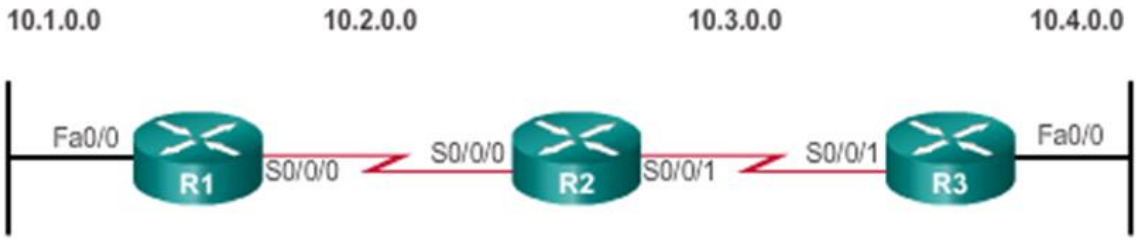
Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0

Network	Interface	Hop
10.3.0.0	S0/0/1	0
10.4.0.0	Fa0/0	0

2.7 RIPng

Exchanging routing information

2. Initial exchange



Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/0	1

Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0
10.1.0.0	S0/0/0	1
10.4.0.0	S0/0/1	1

Network	Interface	Hop
10.3.0.0	S0/0/0	0
10.4.0.0	Fa0/0	0
10.2.0.0	S0/0/1	1

2.7 RIPng

Exchanging routing information

3. Next updates

Network	Interface	Hop
10.1.0.0	Fa0/0	0
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/0	1
10.4.0.0	S0/0/0	2

Network	Interface	Hop
10.2.0.0	S0/0/0	0
10.3.0.0	S0/0/1	0
10.1.0.0	S0/0/0	1
10.4.0.0	S0/0/1	1

Network	Interface	Hop
10.3.0.0	S0/0/1	0
10.4.0.0	Fa0/0	0
10.2.0.0	S0/0/1	1
10.1.0.0	S0/0/1	2

2.7 RIPng

Timers

- Routing-update timer.
  - Global.
  - 30 seconds.
  - Send routing information.

- Routing-timeout timer.
  - Specific for each entry.
  - 180 seconds.
  - Valid information. If expired, infinite distance.
  - Reset when update is received.

2.7 RIPng

Timers

- Route-flush or garbage-collection timer.
  - Specific for each entry.
  - Starts when an entry is unreachable (update or timeout).
  - 120 or 240 seconds.
  - When expired, entry is removed from routing table.

2.7 RIPng

Timers

- Hold-down timer.
  - Specific for each entry.
  - Starts when received an update from a neighbor with unreachable network.
  - 180 seconds.
    - Case 1: received an update from same neigbor: reachable network. Update table.
    - Case 2: received an update from another neighbor: reachable network with less distance than originally. Update table.
    - Case 3: received an update from another neighbor: reachable network wih more distance than originally. Ignore.

2.7 RIPng

RIP improvements

1. Split horizon.
   - Router A is going to send un update to its neighbor B.
   - If B is the next hop for network destination D, then router A will not send information to B about destination D.
2. Poisoned reverse.
   - When an interface is disconnected, the router will send an update with infinite distance.
3. Triggered updates.
   - When there is a change, the router will send immediately an update.

2.7 RIPng

Enabling RIPng

Enabling IPv6:

- Router(config)# **ipv6 unicast-routing**

Enabling RIPng:

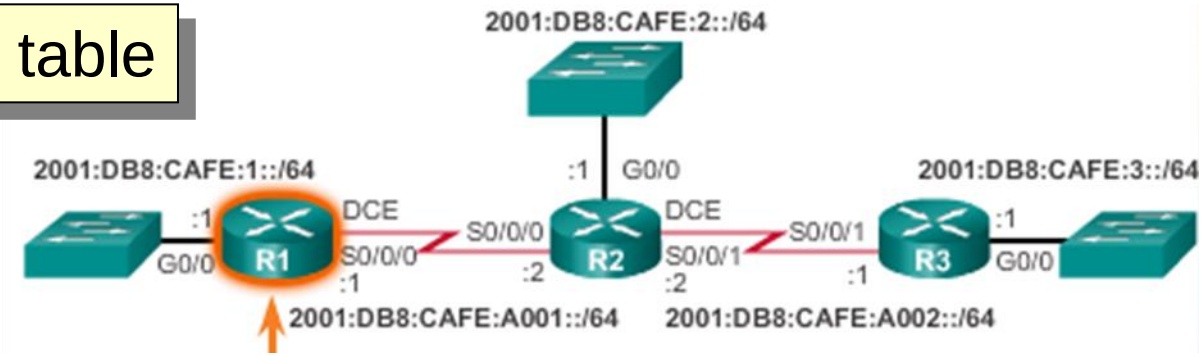
- Router(config)# **ipv6 router rip** *domain-name*

Enabling RIPng and IPv6 on an interface:

- Router(config)# **interface** *f0/0*
- Router(config-if)# **ipv6 enable**
- Router(config-if)# **ipv6 rip** *IRST* **enable**

2.7 RIPng

Routing table



Command show ipv6 route.

```
C   2001:DB8:CAFE:1::/64 [0/0]
     via GigabitEthernet0/0, directly connected
L   2001:DB8:CAFE:1::1/128 [0/0]
     via GigabitEthernet0/0, receive
R   2001:DB8:CAFE:2::/64 [120/2]
     via FE80::FE99:47FF:FE71:78A0, Serial0/0/0
R   2001:DB8:CAFE:3::/64 [120/3]
     via FE80::FE99:47FF:FE71:78A0, Serial0/0/0
C   2001:DB8:CAFE:A001::/64 [0/0]
     via Serial0/0/0, directly connected
L   2001:DB8:CAFE:A001::1/128 [0/0]
     via Serial0/0/0, receive
R   2001:DB8:CAFE:A002::/64 [120/2]
```