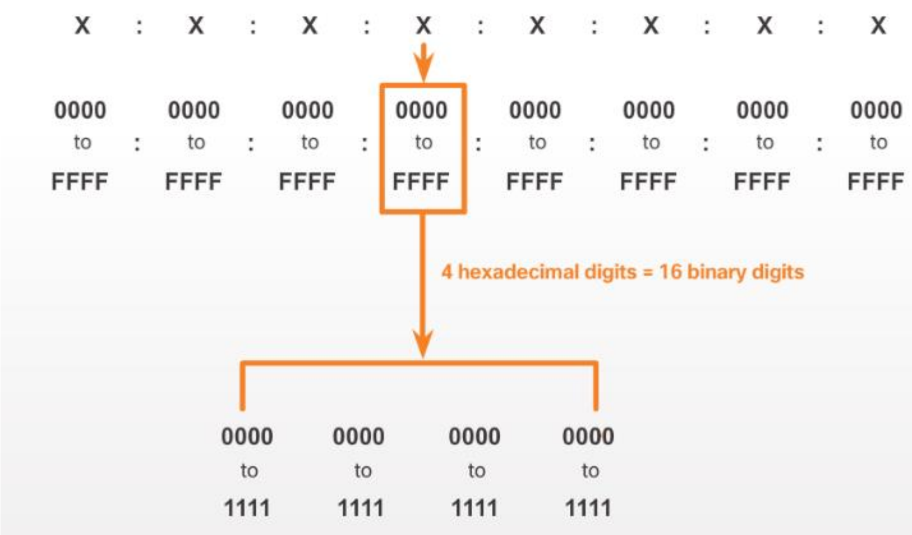
………………………………IPv6

- IPv6 versus IPv4:
  - Has a larger 128-bit address space
  - 340 undecillion addresses
  - Solves limitations with IPv4
  - Adds enhancement like address auto-configuration.
- Why IPv6 is needed:
  - Rapidly increasing Internet population
  - Depletion of IPv4
  - Issues with NAT
  - Internet of Things
- IPv6 Addresses:
  - 128 bits in length
  - Every 4 bits is represented by a single hexadecimal digit
  - Hextet - unofficial term referring to a segment of 16 bits or four hexadecimal values.



- In order to reduce or compress IPv6
  - First rule is to omit leading zeros in any hextet.

Preferred	2001:0DB8:0000:1111:0000:0000:0000:0200
No leading 0s	2001: DB8: 0:1111: 0: 0: 0: 200

- Rule 2 – Omit All 0 Segments
  - A double colon (::) can replace any single, contiguous string of one or more 16-bit segments (hextets) consisting of all 0s.

Preferred	2001:0DB8:0000:0000:ABCD:0000:0000:0100
No 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

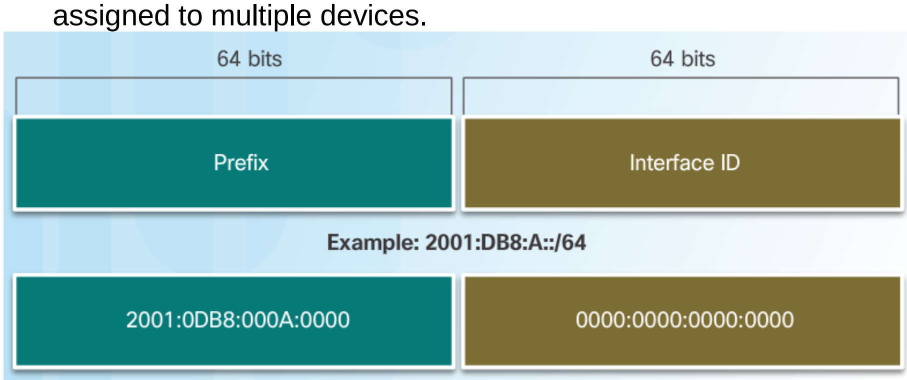
Only one :: may be used.

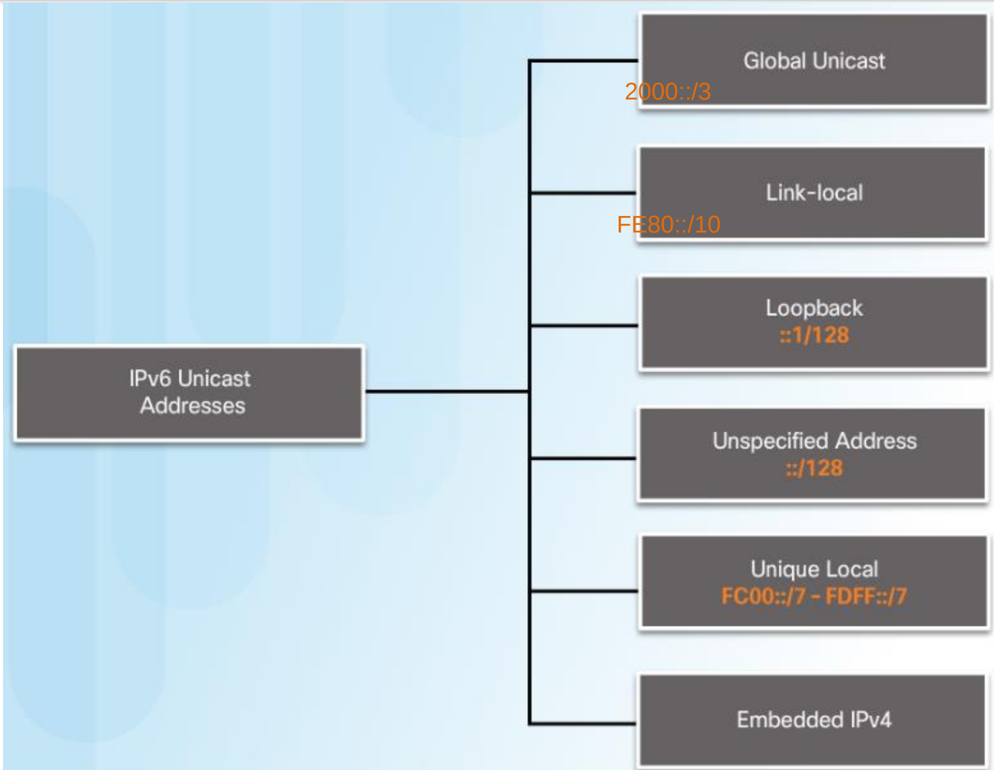
Preferred	0000:0000:0000:0000:0000:0000:0000:0000
No leading 0s	0: 0: 0: 0: 0: 0: 0: 0
Compressed	::

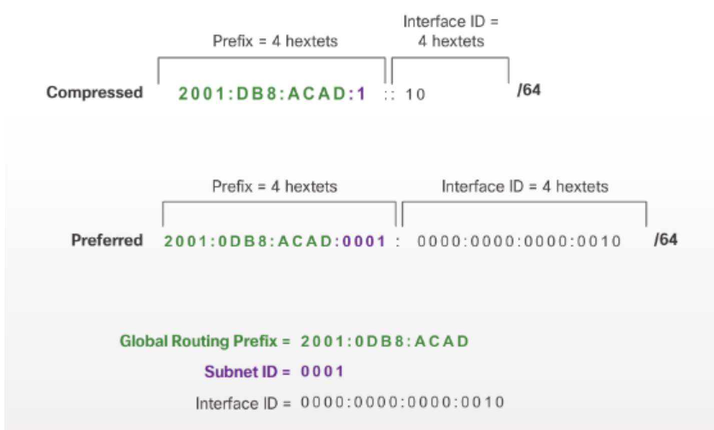
Preferred	FF02:0000:0000:0000:0000:0000:0000:0001
No leading 0s	FF02: 0: 0: 0: 0: 0: 0: 1
Compressed	FF02::1

Three types of IPv6 addresses:

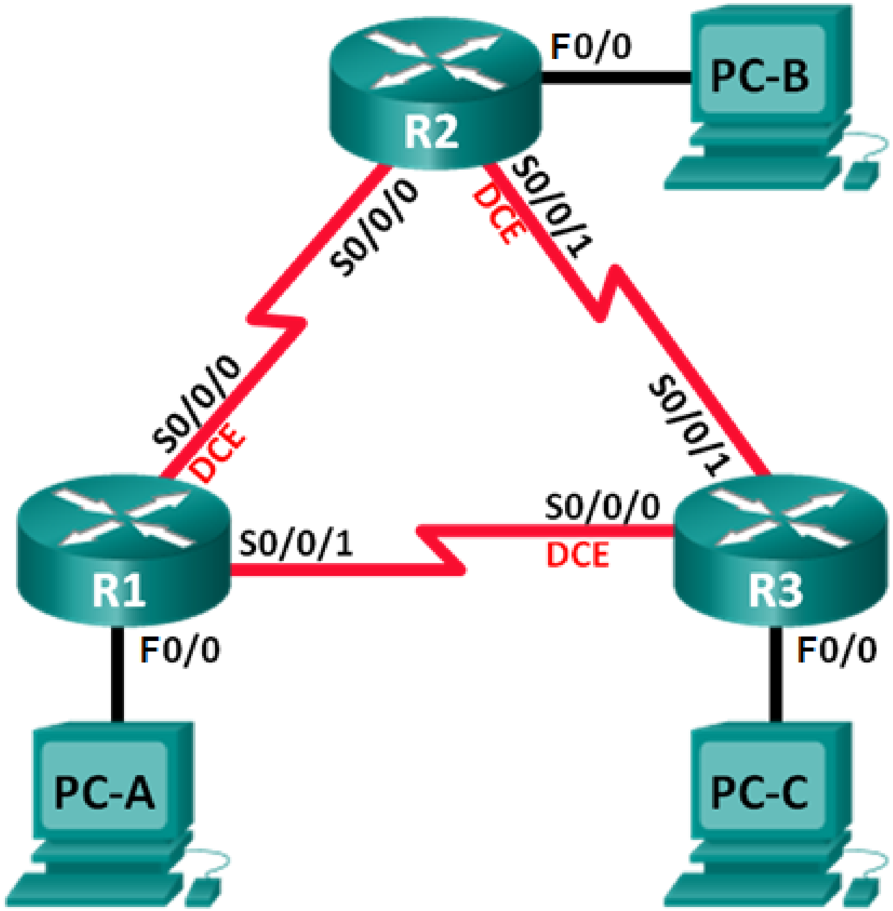
- **Unicast**- Single source IPv6 address.
- **Multicast** - An IPv6 multicast address is used to send a single IPv6 packet to multiple destinations.
- **Anycast** - An IPv6 anycast address is any IPv6 unicast address that can be assigned to multiple devices.




IPv6 Unicast Addresses
Global Unicast
2000::/3
Link-local
FE80::/10
Loopback
::1/128
Unspecified Address
::/128
Unique Local
FC00::/7 - FDFF::/7
Embedded IPv4


Prefix = 4 hextets
Interface ID = 4 hextets
Compressed
2001:DB8:ACAD:1 :: 10 /64
Prefix = 4 hextets
Interface ID = 4 hextets
Preferred
2001:0DB8:ACAD:0001 : 0000:0000:0000:0010 /64
Global Routing Prefix = 2001:0DB8:ACAD
Subnet ID = 0001
Interface ID = 0000:0000:0000:0010

Topology


R2
F0/0
PC-B
S0/0/0
S0/0/1
DCE
S0/0/0
DCE
S0/0/1
R1
S0/0/1
S0/0/0
DCE
R3
F0/0
F0/0
PC-A
PC-C

Addressing Table

Device	Interface	IP Address	Default Gateway
R1	F0/0	2001:DB8:ACAD:A::1/64 FE80::1 link-local	N/A
	S0/0/0 (DCE)	2001:DB8:ACAD:12::1/64 FE80::1 link-local	N/A
	S0/0/1	2001:DB8:ACAD:13::1/64 FE80::1 link-local	N/A
R2	F0/0	2001:DB8:ACAD:B::1/64 FE80::2 link-local	N/A
	S0/0/0	2001:DB8:ACAD:12::2/64 FE80::2 link-local	N/A
	S0/0/1 (DCE)	2001:DB8:ACAD:23::2/64 FE80::2 link-local	N/A
R3	F0/0	2001:DB8:ACAD:C::1/64 FE80::3 link-local	N/A
	S0/0/0 (DCE)	2001:DB8:ACAD:13::3/64 FE80::3 link-local	N/A
	S0/0/1	2001:DB8:ACAD:23::3/64 FE80::3 link-local	N/A
PC-A	NIC	2001:DB8:ACAD:A::3/64	FE80::1
PC-B	NIC	2001:DB8:ACAD:B::3/64	FE80::2
PC-C	NIC	2001:DB8:ACAD:C::3/64	FE80::3

Background / Scenario

EIGRP for IPv6 has the same overall operation and features as EIGRP for IPv4. However, there are a few major differences between them:

- EIGRP for IPv6 is configured directly on the router interfaces.
- With EIGRP for IPv6, a router ID is required on each router or the routing process does not start.
- The EIGRP for IPv6 routing process uses a shutdown feature.

Required Resources

- 3 Routers
- 3 PCs
- Console cables to configure the Cisco IOS devices via the console ports
- Ethernet and serial cables as shown in the topology

Part 1: Build the Network and Verify Connectivity

In Part 1, you will set up the network topology and configure basic settings, such as the interface IP addresses, device access, and passwords.

Step 1: Cable the network as shown in the topology.

Step 2: Configure PC hosts.

Step 3: Initialize and reload the routers as necessary.

Step 4: Configure basic settings for each router.

a. Disable DNS lookup.

b. Configure IP addresses for the routers as listed in Addressing Table.

   Note: Configure the FE80::x link-local address and the unicast address for each router interface.

c. Configure the device name as shown in the topology.

d. Assign **pass** as the console and vty passwords.

e. Assign **pass** as the privileged EXEC password.

f. Configure **logging synchronous** to prevent console and vty messages from interrupting command entry.

g. Configure a message of the day.

h. Copy the running configuration to the startup configuration.

Step 5: Verify connectivity.

The routers should be able to ping one another, and each PC should be able to ping its default gateway. The PCs will not be able to ping other PCs until EIGRP routing is configured. Verify and troubleshoot if necessary.

Part 2: Configure EIGRP for IPv6 Routing

Step 1: Enable IPv6 routing on the routers.

```
R1(config)# ipv6 unicast-routing
```

Step 2: Assign a router ID to each router.

a. To begin the EIGRP for IPv6 routing configuration process, issue the **ipv6 router eigrp 1** command, where **1** is the AS number.

```
R1(config)# ipv6 router eigrp 1
```

b. EIGRP for IPv6 requires a 32-bit address for the router ID. Use the **eigrp router-id** command to configure the router ID in the router configuration mode.

```
R1(config)# ipv6 router eigrp 1
R1(config-rtr)# eigrp router-id 1.1.1.1

R2(config)# ipv6 router eigrp 1
R2(config-rtr)# eigrp router-id 2.2.2.2
```

```
R3(config)# ipv6 router eigrp 1
R3(config-rtr)# eigrp router-id 3.3.3.3
```

Step 3: Enable EIGRP for IPv6 routing on each router.

The IPv6 routing process is shut down by default. Issue the **no shutdown** command to enable EIGRP for IPv6 routing on all routers.

```
R1(config)# ipv6 router eigrp 1
R1(config-rtr)# no shutdown

R2(config)# ipv6 router eigrp 1
R2(config-rtr)# no shutdown

R3(config)# ipv6 router eigrp 1
R3(config-rtr)# no shutdown
```

Step 4: Configure EIGRP for IPv6 using AS 1 on the Serial and Gigabit Ethernet interfaces on the routers.

a. Issue the **ipv6 eigrp 1** command on the interfaces that participate in the EIGRP routing process. The AS number is 1 as assigned in Step 2. The configuration for R1 is displayed below as an example.

```
R1(config)# interface f0/0
R1(config-if)# ipv6 eigrp 1
R1(config-if)# interface s0/0/0
R1(config-if)# ipv6 eigrp 1
R1(config-if)# interface s0/0/1
R1(config-if)# ipv6 eigrp 1
```

b. Assign EIGRP participating interfaces on R2 and R3. You will see neighbor adjacency messages as interfaces are added to the EIGRP routing process. The messages on R1 are displayed below as an example.

```
R1(config-if)#
*Apr 12 00:25:49.183: %DUAL-5-NBRCHANGE: EIGRP-IPv6 1: Neighbor FE80::2 (Serial0/0/0)
is up: new adjacency
*Apr 12 00:26:15.583: %DUAL-5-NBRCHANGE: EIGRP-IPv6 1: Neighbor FE80::3 (Serial0/0/1)
is up: new adjacency
```

What address is used to indicate the neighbor in the adjacency messages? ____________________

Step 5: Verify end-to-end connectivity.

Part 3: Verify EIGRP for IPv6 Routing

Step 1: Examine the neighbor adjacencies.

On R1, issue the **show ipv6 eigrp neighbors** command to verify that the adjacency has been established with its neighboring routers. The link-local addresses of the neighboring routers are displayed in the adjacency table.

```
R1# show ipv6 eigrp neighbors
EIGRP-IPv6 Neighbors for AS(1)
```

```
H   Address                  Interface              Hold Uptime    SRTT    RTO   Q   Seq
                                                    (sec)          (ms)          Cnt Num
1   Link-local address:      Se0/0/1                  13 00:02:42     1    100   0   7
    FE80::3
0   Link-local address:      Se0/0/0                  13 00:03:09    12    100   0   9
    FE80::2
```

Step 2: Examine the IPv6 EIGRP routing table.

Use the **show ipv6 route eigrp** command to display IPv6 specific EIGRP routes on all the routers.

```
R1# show ipv6 route eigrp
<output omitted>
D   2001:DB8:ACAD:B::/64 [90/2172416]
     via FE80::2, Serial0/0/0
D   2001:DB8:ACAD:C::/64 [90/2172416]
     via FE80::3, Serial0/0/1
D   2001:DB8:ACAD:23::/64 [90/2681856]
     via FE80::2, Serial0/0/0
     via FE80::3, Serial0/0/1
```

Step 3: Examine the EIGRP topology.

```
R1# show ipv6 eigrp topology
<output omitted>
P 2001:DB8:ACAD:A::/64, 1 successors, FD is 28160
        via Connected, FastEthernet0/0
P 2001:DB8:ACAD:C::/64, 1 successors, FD is 2172416
        via FE80::3 (2172416/28160), Serial0/0/1
P 2001:DB8:ACAD:12::/64, 1 successors, FD is 2169856
        via Connected, Serial0/0/0
P 2001:DB8:ACAD:B::/64, 1 successors, FD is 2172416
        via FE80::2 (2172416/28160), Serial0/0/0
P 2001:DB8:ACAD:23::/64, 2 successors, FD is 2681856
        via FE80::2 (2681856/2169856), Serial0/0/0
        via FE80::3 (2681856/2169856), Serial0/0/1
P 2001:DB8:ACAD:13::/64, 1 successors, FD is 2169856
        via Connected, Serial0/0/1
```

Compare the highlighted entries to the routing table. What can you conclude from the comparison?

____

____

____

Step 4: Verify the parameters and current state of the active IPv6 routing protocol processes.

Issue the **show ipv6 protocols** command to verify the configured parameter. From the output, EIGRP is the configured IPv6 routing protocol with 1.1.1.1 as the router ID for R1. This routing protocol is associated with autonomous system 1 with three active interfaces: F0/0, S0/0/0, and S0/0/1.

```
R1# show ipv6 protocols
IPv6 Routing Protocol is "connected"
```

```
IPv6 Routing Protocol is "ND"
IPv6 Routing Protocol is "eigrp 1"
EIGRP-IPv6 Protocol for AS(1)
  Metric weight K1=1, K2=0, K3=1, K4=0, K5=0
  NSF-aware route hold timer is 240
  Router-ID: 1.1.1.1
  Topology : 0 (base)
    Active Timer: 3 min
    Distance: internal 90 external 170
    Maximum path: 16
    Maximum hopcount 100
    Maximum metric variance 1

  Interfaces:
    FastEthernet0/0
    Serial0/0/0
    Serial0/0/1
  Redistribution:
    None
```

Part 4: Configure and Verify Passive Interfaces

A passive interface does not allow outgoing and incoming routing updates over the configured interface. The **passive-interface** *interface* command causes the router to stop sending and receiving Hello packets over an interface.

Step 1: Configure interface F0/0 as passive on R1 and R2.

```
R1(config)# ipv6 router eigrp 1
R1(config-rtr)# passive-interface f0/0

R2(config)# ipv6 router eigrp 1
R2(config-rtr)# passive-interface f0/0
```

Step 2: Verify the passive interface configuration.

Issue the **show ipv6 protocols** command on R1 and verify that F0/0 has been configured as passive.

```
R1# show ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "ND"
IPv6 Routing Protocol is "eigrp 1"
EIGRP-IPv6 Protocol for AS(1)
  Metric weight K1=1, K2=0, K3=1, K4=0, K5=0
  NSF-aware route hold timer is 240
  Router-ID: 1.1.1.1
  Topology : 0 (base)
    Active Timer: 3 min
    Distance: internal 90 external 170
    Maximum path: 16
    Maximum hopcount 100
```

```
    Maximum metric variance 1

  Interfaces:
    Serial0/0/0
    Serial0/0/1
    FastEthernet0/0 (passive)
  Redistribution:
    None
```

Step 3: Configure the F0/0 passive interface on R3.

If a few interfaces are configured as passive, use the **passive-interface default** command to configure all the interfaces on the router as passive. Use the **no passive-interface** *interface* command to allow EIGRP Hello messages in and out of the router interface.

a. Configure all interfaces as passive on R3.

```
R3(config)# ipv6 router eigrp 1
R3(config-rtr)# passive-interface default
R3(config-rtr)#
*Apr 13 00:07:03.267: %DUAL-5-NBRCHANGE: EIGRP-IPv6 1: Neighbor FE80::1 (Serial0/0/0)
is down: interface passive
*Apr 13 00:07:03.267: %DUAL-5-NBRCHANGE: EIGRP-IPv6 1: Neighbor FE80::2 (Serial0/0/1)
is down: interface passive
```

b. After you have issued the **passive-interface default** command, R3 no longer participates in the routing process. What command can you use to verify it?

____

c. What command can you use to display the passive interfaces on R3?

____

d. Configure the serial interfaces to participate in the routing process.

```
R3(config)# ipv6 router eigrp 1
R3(config-rtr)# no passive-interface s0/0/0
R3(config-rtr)# no passive-interface s0/0/1
```

e. The neighbor relationships have been established again with R1 and R2. Verify that only F0/0 has been configured as passive.