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OSPFv3

How Does OSPF Work?

- OSPF is a link-state routing protocol, which is a routing protocol that makes its routing decisions based on the state of the links that connect source and destination devices.
- The interface information includes the IPv6 prefix on the interface, the type of network it is connected to, and the routers connected to that network.
- OSPF routers generate routing updates only when a change occurs in the network topology.
- When a link changes state, the device that detects the change creates an LSA and forwards it to the DR using FF02::6 multicast address who informs all devices within an area using FF02::5 multicast address. Each device then updates its Link State Database.

OSPFv2

- Advertises IPv4 routes.
- OSPF messages are sourced from the IPv4 address of the exit interface.
- Uses **224.0.0.6** as the DR/BDR multicast address and the **224.0.0.5** all OSPF router multicast address.
- Advertises networks using the **network** command in router configuration mode.
- Interfaces are indirectly enabled using the router configuration mode.

OSPFv3

- Advertises IPv6 routes.
- OSPF messages are sourced using the link-local address of the exit interface.
- Uses **FF02::6** as the DR/BDR multicast address and the **FF02::5** all OSPF router multicast address.
- The **ipv6 ospf *process-id* area *area-id*** *command* will enable the routing process and its associated configuration to be created but **network** statements are no longer used.
- Each interface must be enabled using the **ipv6 ospf *process-id* area *area-id*** in interface-configuration mode.

Link-state Advertisements

Type	Name	Description
1	Router LSA	Created by every router and flooded within a single area only. It describes the link state and costs of a router's links to the area. Sent to the DR in a NBMA.
2	Network LSA	Describes the link-state and cost information for all routers attached to the network. This LSA is an aggregation of all the link-state and cost information in the network. Only a designated router tracks this information and can generate a network LSA.
3	Summary LSA	Advertises internal networks to routers in other areas. Type 3 LSAs may represent a single network or a set of networks summarized into one advertisement. Only ABRs generate summary LSAs.
5	External LSA	Redistributes routes from another AS, usually from a different routing protocol into OSPFv3. A default route is propagated through the OSPF AS as an external network.

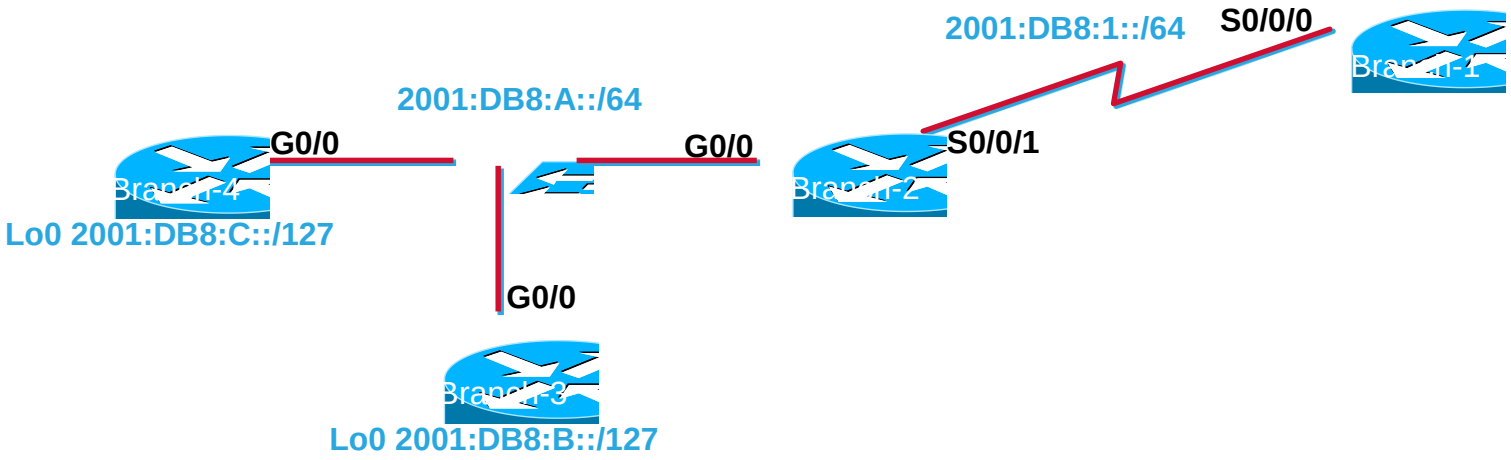
New Link-State Advertisements

- **LSA Type 8 (Link LSA)** – Only sent to other routers connected to the same link. Link LSAs provide the link-local address of the router to all other routers attached to the link, inform other routers attached to the link of a list of prefixes to associate with the link, and allow the router to assert a collection of Options bits to associate with the network LSA originated by the Designated Router on a NBMA link.
- **LSA Type 9 (Intra-Area Prefix LSA)** – A router can originate multiple intra-area-prefix LSAs for each router or transit network, each with a unique link-state ID. The link-state ID for each intra-area-prefix LSA describes its association to either the router LSA or the network LSA and contains prefixes for stub and transit networks.

LSA Type 8 (Link LSA)

```
Branch-2# show ipv6 ospf database
            OSPF Router with ID (2.2.2.2) (Process ID 1)

                Router Link States (Area 0)

ADV Router      Age         Seq#       Fragment ID  Link count Bits
   2.2.2.2      127       0x80000002   0              1          B
   1.1.1.1      127       0x80000002   0              1

                Inter Area Prefix Link States (Area 0)
ADV Router      Age         Seq#            Metric Prefix
2.2.2.2         132       0x80000001 1      2001:DB8:A::/64

                Link (Type-8) Link States (Area 0)
ADV Router      Age         Seq#       Link ID    Interface
   2.2.2.2      127       0x80000002   4          Se0/0/1
   1.1.1.1      128       0x80000002   3          Se0/0/0

                Intra Area Prefix Link States (Area 0)
ADV Router      Age         Seq#       Link ID   Ref-lstype  Ref-LSID
   2.2.2.2      128       0x80000001   2         0x2001      0
   1.1.1.1      136       0x80000001   2         0x2001      0
                    OSPF Router with ID (2.2.2.2) (Process ID 1)
```

Configuration Requirements

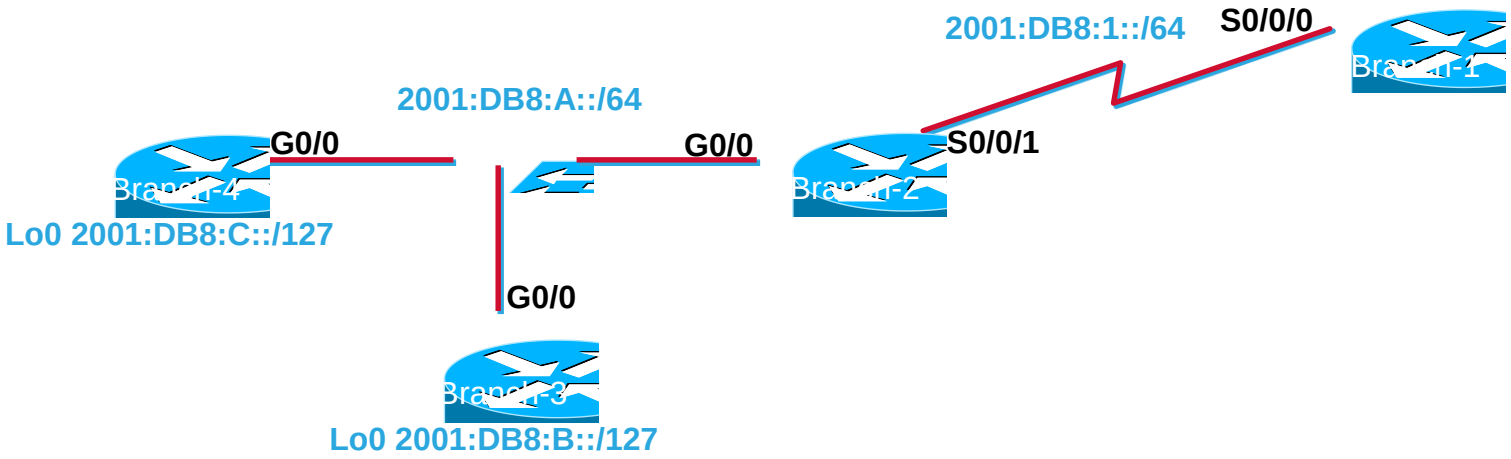


OSPFv3 configuration requirements:

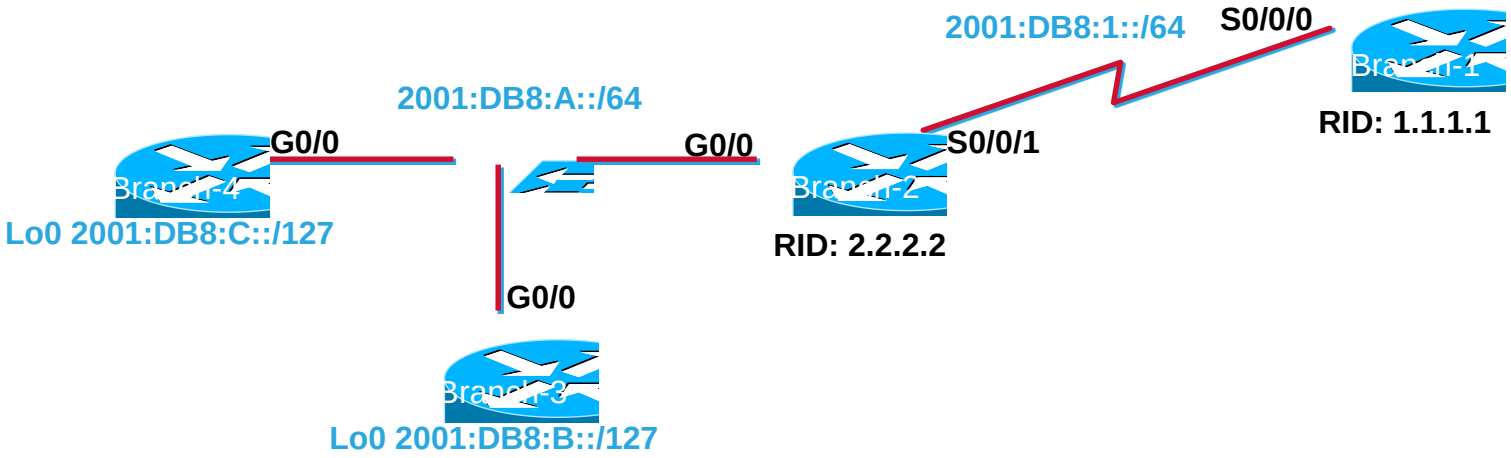
- Enable IPv6 unicast routing
- Enable the OSPFv3 routing process
- Enable OSPFv3 on the interface
- Configure passive interfaces

OSPFv3 Configuration

- IPv4 packet forwarding is enabled by default, whereas IPv6 packet forwarding is disabled by default.
- To enable IPv6 packet forwarding, use the **ipv6 unicast-routing** command in global configuration mode before enabling OSPF.
- Once IPv6 packet forwarding is enabled, we can now enable the IPv6 OSPF routing process.
- OSPFv3 continues to use an IPv4 32-bit address for the router ID. Because there are no IPv4 addresses configured on the routers, you are required to manually assign the router ID using the **router-id** command.



OSPFv3 Configuration

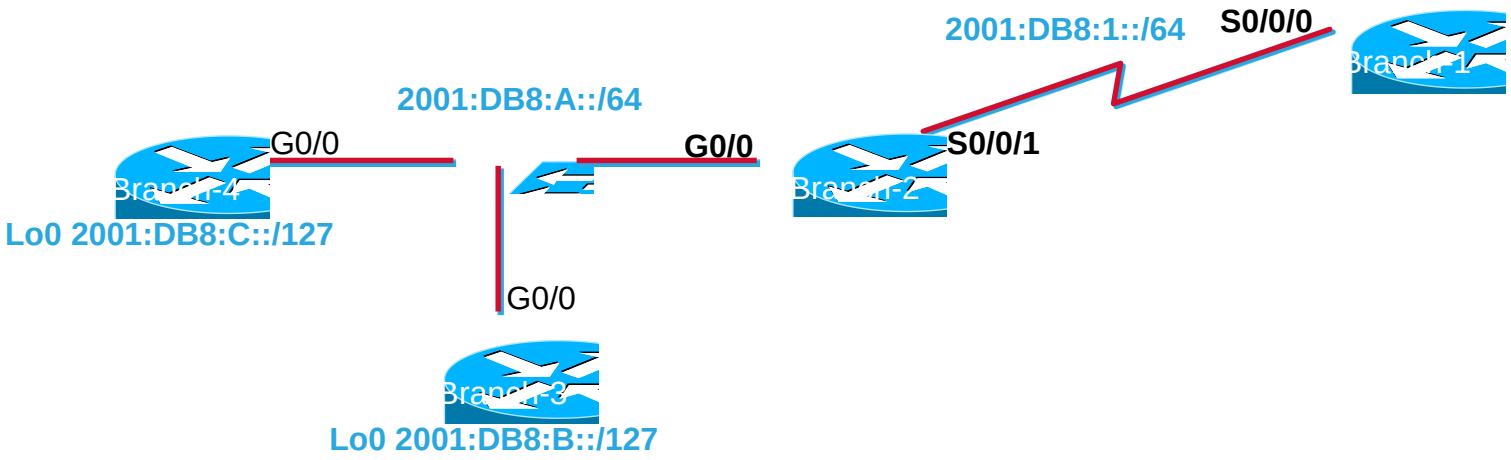



```
Branch-2(config)# ipv6 router ospf 1
% IPv6 routing not enabled
Branch-2(config)# ipv6 unicast-routing
Branch_2(config)# ipv6 router ospf 1
%OSPFv3-4-NORTRID: OSPFv3 process 1 could not pick a router-id,please
configure manually
Branch-2(config-rtr)# router-id 2.2.2.2
Branch-2(config-rtr)#
```

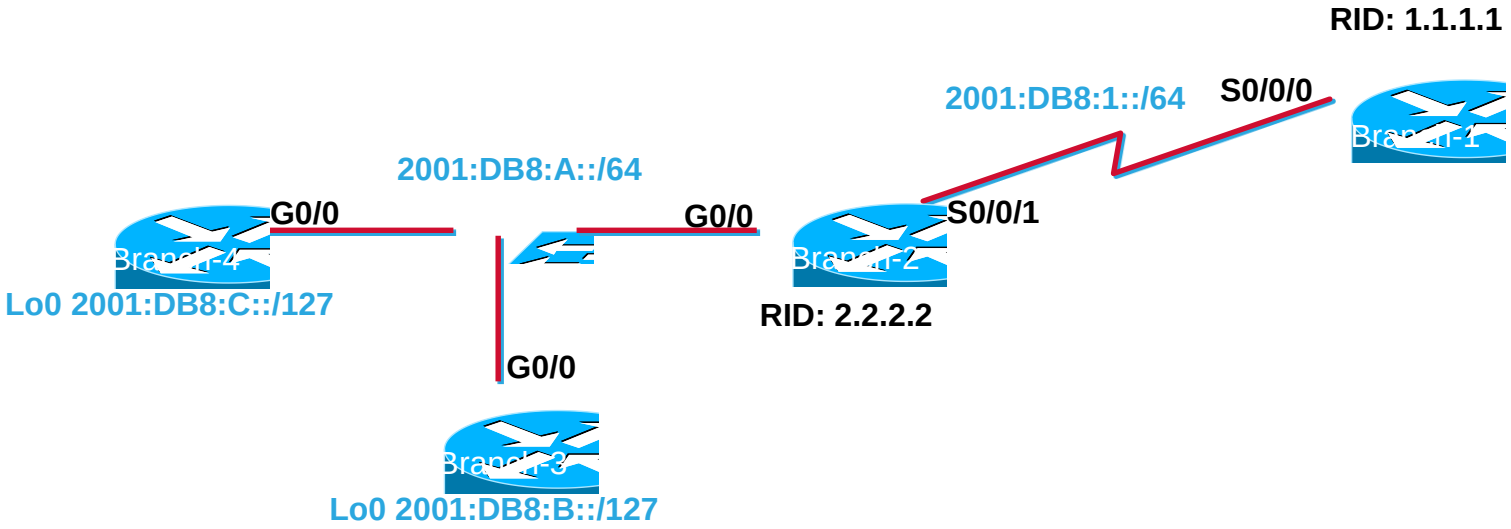
OSPFv3 Configuration

- Enabling OSPFv3 with **ipv6 ospf *process-id* area *area-id*** will enable the routing process and its associated configuration to be created.
- Unlike OSPFv2, you do not enter network statements. Each interface must be enabled using **ipv6 ospf *process-id* area *area-id*** in interface-configuration mode.

```
Branch-2(config)# int s0/0/1
Branch-2(config-if)# ipv6 ospf 1area 0
```

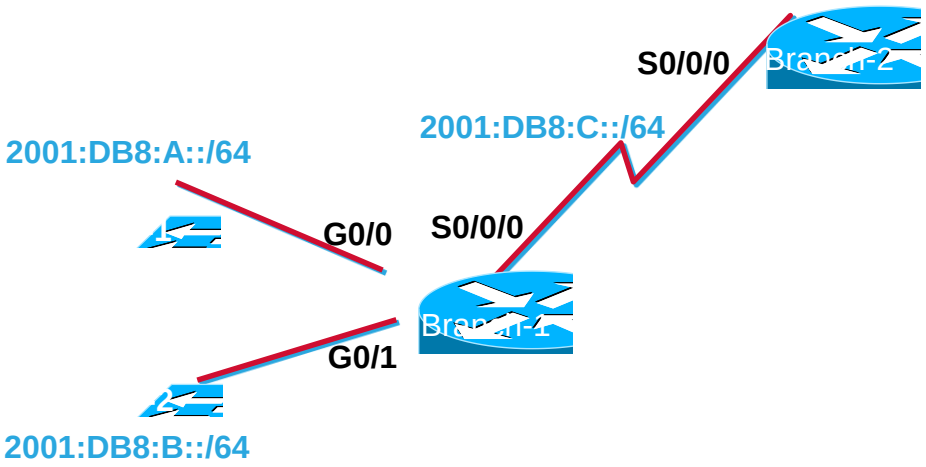


Configuration Example




```
Branch_2(config)# ipv6 router ospf 1
Branch_2(config-rtr)# router-id 2.2.2.2
Branch_2(config)# int s0/0/1
Branch_2(config-if)# ipv6 ospf 1 area 1
Branch_2(config-if)# int g0/0
Branch_2(config-if)# ipv6 ospf 1 area 0
00:26:56: %OSPFv3-5-ADJCHG: Process 1, Nbr 1.1.1.1 on Serial0/0/1 from LOADING
to FULL, Loading Done
Branch_2(config-if)#
```

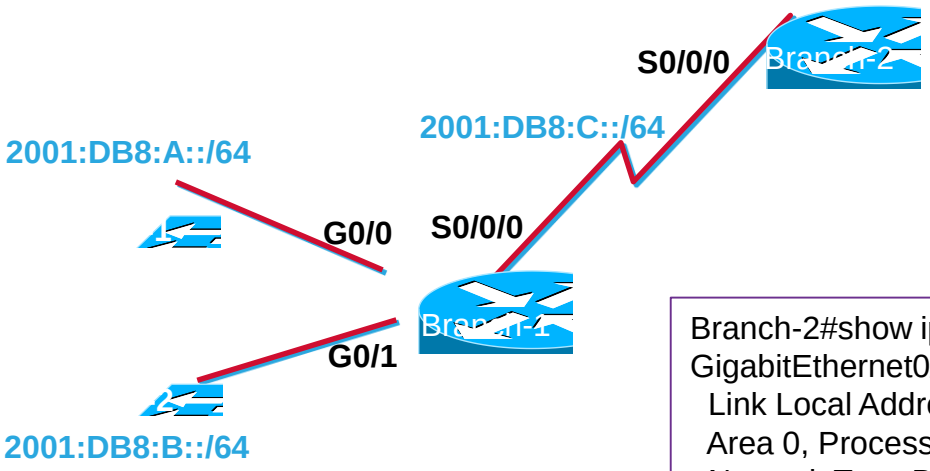
Passive Interface



- The purpose of the passive interface command is to suppress routing updates out of an interface. With regards to OSPF, it prevents the paranoid update and LSAs from being sent across LANs.
- The networks will still be advertised to neighboring routers but routing updates and LSAs will not be forwarded.

```
Branch-1(config)# ipv6 router ospf 1
Branch-1(config-rtr)# passive-interface g0/0
Branch-1(config-rtr)# passive-interface g0/1
```

Passive Interface

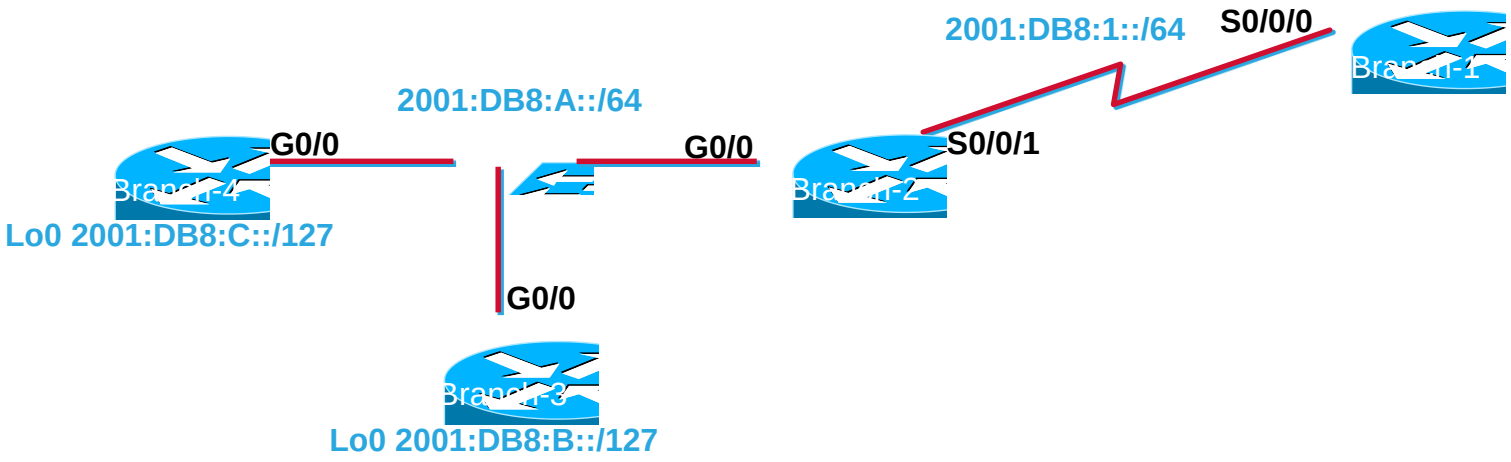



```
Branch-2#show ipv6 protocol
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "static
IPv6 Routing Protocol is "ospf 1"
  Interfaces (Area 0)
    GigabitEthernet0/0
    GigabitEthernet0/1
    Serial0/0/1
```

```
Branch-2#show ipv6 ospf interface g0/1
GigabitEthernet0/1 is up, line protocol is up
  Link Local Address FE80::202:17FF:FEC2:B902 , Interface ID 2
  Area 0, Process ID 1, Instance ID 0, Router ID 2.2.2.2
  Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 2.2.2.2, local address FE80::202:17FF:FEC2:B902
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    No Hellos (Passive interface)
  Index 3/3, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
```

Passive interface does not appear in the **show ipv6 protocols** command. The **show ipv6 ospf** interface command verifies that passive interface was configured.

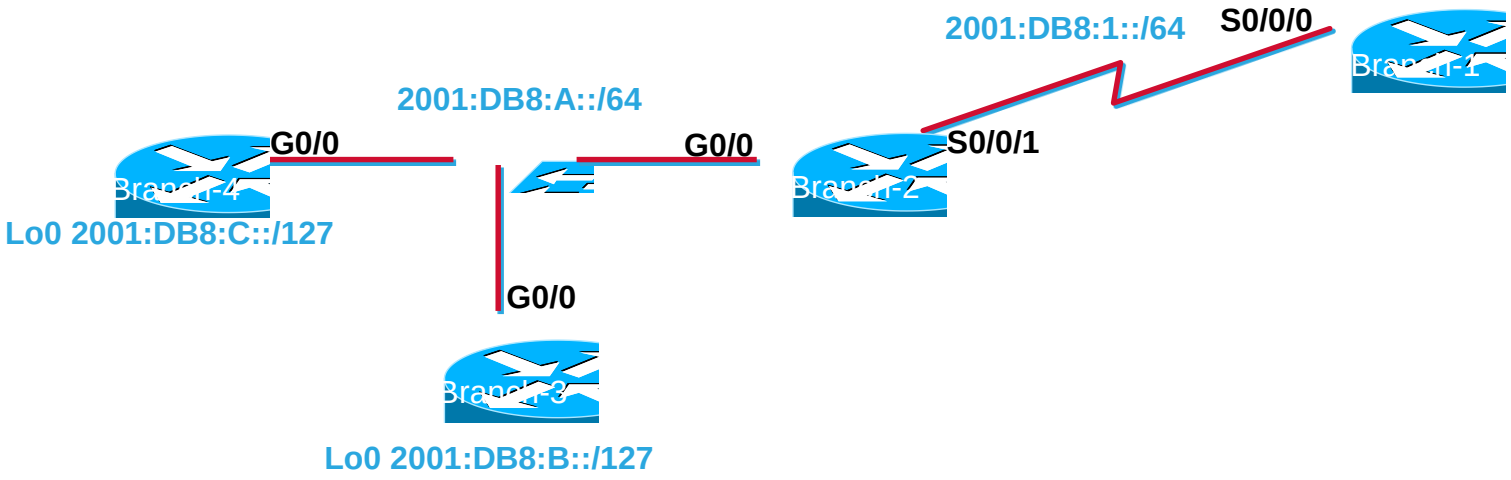
OSPFv3 Verification



There are various show commands that can be used to verify and display OSPFv3 configurations:

- Show ipv6 ospf neighbor
- Show ipv6 ospf database
- Show ipv6 route
- Show ipv6 protocols

OSPFv3 Verification



Branch-2#show ipv6 ospf neighbor

Neighbor ID	Pri	State	Dead Time	Interface ID	Interface
4.4.4.4	1	FULL/BDR	00:00:36	1	GigabitEthernet0/0
3.3.3.3	1	FULL/DROTHER	00:00:33	1	GigabitEthernet0/0
1.1.1.1	0	FULL/ -	00:00:37	3	Serial0/0/1

Neighbor's IPv6 ID

Priority

State

Expected time before Cisco IOS software will declare the neighbor dead.

Every interface is assigned an Interface ID, which uniquely identifies the interface with the router.

OSPFv3 Verification

```
Branch-1#show ipv6 route
 (Output Omitted)
IPv6 Routing Table - 4 entries
Codes: C - Connected, L – Local
O - OSPF intra, OI - OSPF inter, OE1 - OSPF
ext 1, OE2 - OSPF ext 2
C   2001:DB8:1::/64 [0/0]
     via ::, Serial0/0/0
L   2001:DB8:1::/128 [0/0]
     via ::, Serial0/0/0
O   2001:DB8:A::/64 [110/65]
     via FE80::2E0:8FFF:FE0A:5302, Serial0/0/0
L   FF00::/8 [0/0]
     via ::, Null0
Branch-1#
```

In Branch-1's routing table, it indicates that a route has been learned through OSPF and S0/0/0 is the exit interface to reach the address.

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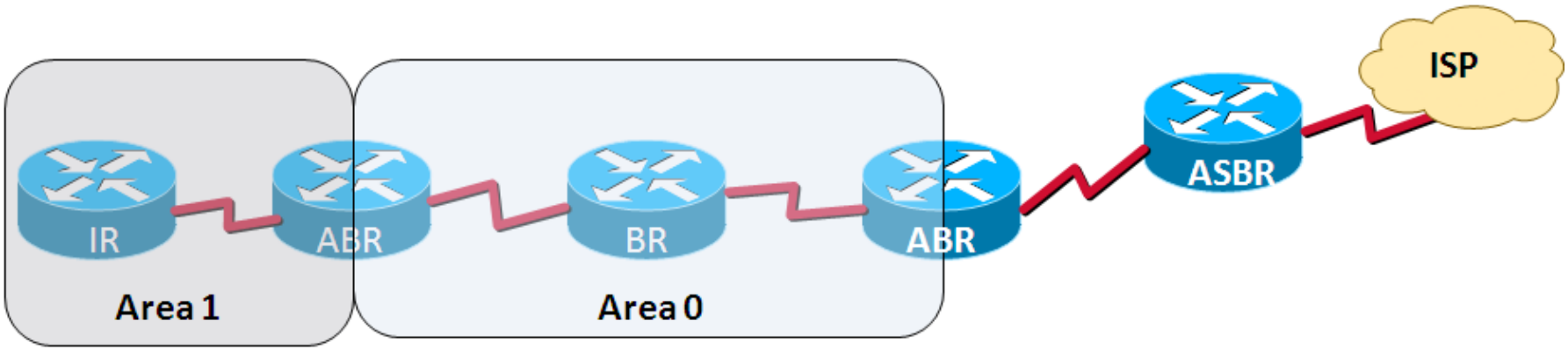
Multi-area OSPFv3

Multi-area OSPFv3

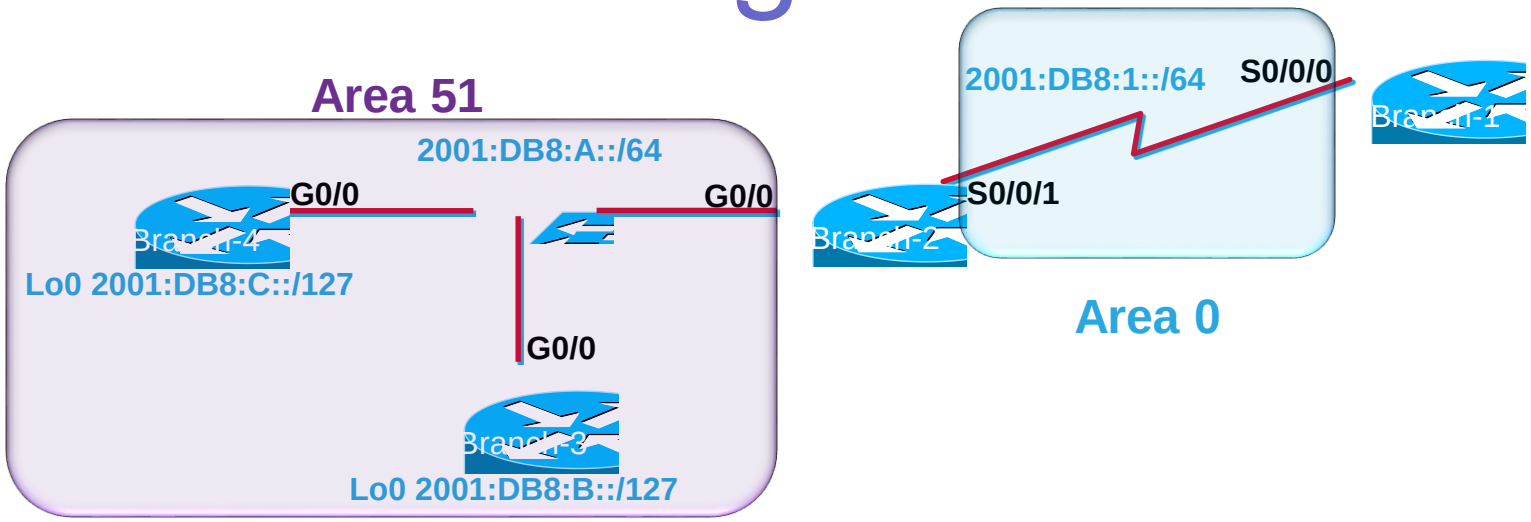
- **Backbone area (Area 0)** – OSPF has special restrictions when multiple areas are involved. If more than one area is configured, one of these areas has be to be area 0. All areas have to be physically connected to the backbone. The reasoning behind this is that OSPF expects all areas to inject routing information into the backbone and in turn the backbone will disseminate that information into other areas.
- **Regular (non-backbone) area** – Connects users and resources. Regular areas are usually set up along functional or geographical groupings. By default, a regular area does not allow traffic from another area to use its links to reach other areas. All traffic from other areas must cross through area 0.

OSPF Router Types

- There are 4 types of OSPF routers.
  - **Internal Router (IR)** – A router that has every interface in the same area.
  - **Area Border Router (ABR)** – A router that has an interface in multiple areas and generates summary LSAs. It connects one or more areas to the main backbone network.
  - **Autonomous System Border Router (ASBR)** – A router that is connected to more than one routing protocol or has at least one interface outside of OSPF. Used to distribute routes received from other, external LSAs throughout its own autonomous system.
  - **Backbone Router (BR)** – A router that is connected to the backbone area.



OSPFv3 Multi-area Configuration




```
Branch-2(config)#int s0/0/1
Branch-2(config-if)#ipv6 ospf 1 area 0
Branch-2(config-if)#int g0/0
Branch-2(config-if)#ipv6 ospf 1 area 51
00:11:25: %OSPFv3-5-ADJCHG: Process 1, Nbr 1.1.1.1 on Serial0/0/1 from LOADING to FULL, Loading Done

Branch-2(config-if)#
00:11:27: %OSPFv3-5-ADJCHG: Process 1, Nbr 3.3.3.3 on GigabitEthernet0/0 from LOADING to FULL, Loading Done

00:11:30: %OSPF-5-ADJCHG: Process 1, Nbr 4.4.4.4 on GigabitEthernet0/0 from FULL to DOWN, Neighbor Down: Dead timer expired

00:11:30: %OSPFv3-5-ADJCHG: Process 1, Nbr 4.4.4.4 on GigabitEthernet0/0 from FULL to DOWN, Neighbor Down: Interface down or detached
```

OSPFv3 Multi-area Verification

```
Branch-2# show ipv6 ospf database

OSPF Router with ID (2.2.2.2) (Process ID 1)

 Router Link States (Area 0)

ADV Router      Age         Seq#       Fragment ID  Link count Bits
   2.2.2.2      291         0x80000003       0          1         B
   1.1.1.1      292         0x80000003       0          1

            Inter Area Prefix Link States (Area 0)
ADV Router      Age         Seq#       Metric       Prefix
   2.2.2.2      296         0x80000002    1      2001:DB8:A::/64

            Link (Type-8) Link States (Area 0)
ADV Router      Age         Seq#       Link ID    Interface
   2.2.2.2      291         0x80000003    4       Se0/0/1
   1.1.1.1      293         0x80000003    3       Se0/0/0

            Intra Area Prefix Link States (Area 0)
ADV Router      Age         Seq#       Link ID    Ref-lstype  Ref-LSID
   2.2.2.2      292         0x80000002    2       0x2001      0
   1.1.1.1      300         0x80000002    2       0x2001      0
        OSPF Router with ID (2.2.2.2) (Process ID 1)
```

```
 Router Link States (Area 51)

ADV Router      Age         Seq#       Fragment ID  Link count Bits
   2.2.2.2      261         0x80000004       0          1         B
   3.3.3.3      262         0x80000003       0          1

            Net Link States (Area 51)
ADV Router      Age         Seq#       Link ID (DR)  Rtr count
   3.3.3.3      262         0x80000002       1            2

            Inter Area Prefix Link States (Area 51)
ADV Router      Age         Seq#       Metric       Prefix
   2.2.2.2      286         0x80000002    64     2001:DB8:1::/64

            Link (Type-8) Link States (Area 51)
ADV Router      Age         Seq#       Link ID    Interface
   2.2.2.2      271         0x80000003    1       Gi0/0
   3.3.3.3      262         0x80000003    1       Gi0/0

            Intra Area Prefix Link States (Area 51)
ADV Router      Age         Seq#       Link ID    Ref-lstype  Ref-LSID
   2.2.2.2      300         0x80000002    2       0x2001      0
   3.3.3.3      300         0x80000003    2       0x2001      0
   3.3.3.3      262         0x80000004    1       0x2002      1
Branch-2#
```

Thank you.

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