Chapter 12

Verify the OSPF Protocol and Neighbors

This chapter describes how to check whether the Open Shortest Path First protocol (OSPF) is configured correctly on a Juniper Networks router, the proper adjacencies are formed in a network, and the appropriate link-state advertisements (LSAs) are flooded throughout different parts of the OSPF autonomous system (AS). (See Table 32.)

Table 32: Checklist for Verifying the OSPF Protocol and Neighbors

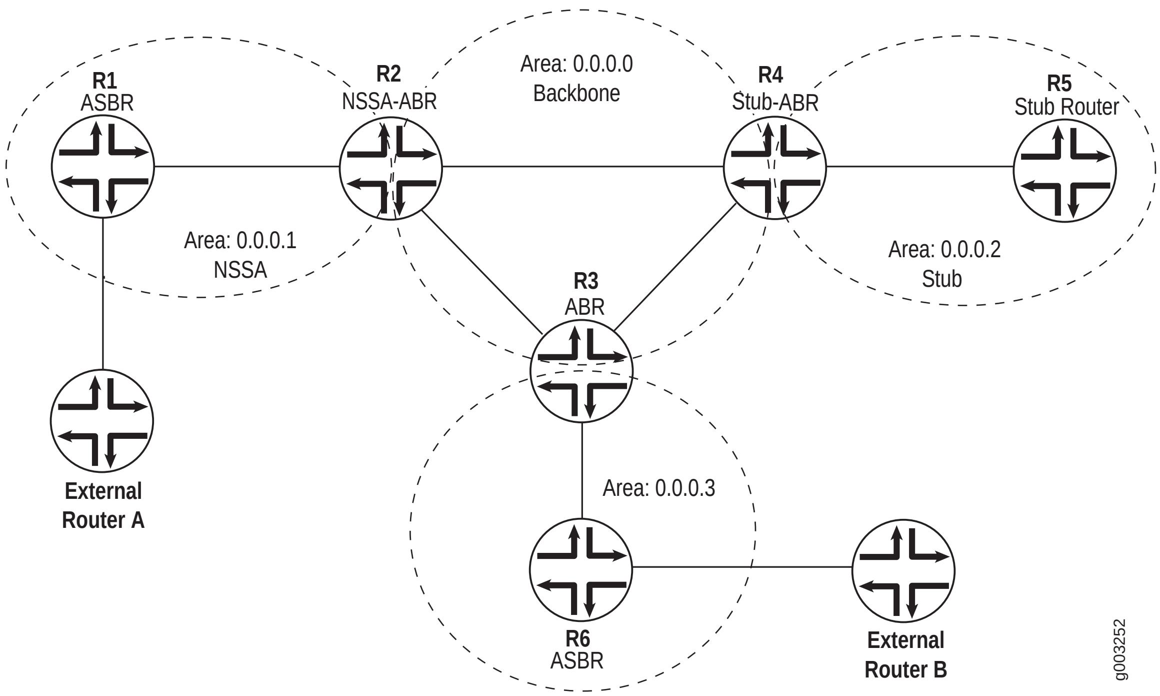
Verify the OSPF Protocol and Neighbors Tasks	Command or Action
Verify the OSPF Protocol on page 130	
1. Check OSPF on an ASBR on page 132	show configuration show ospf interface
2. Check OSPF on an ABR on page 135	show configuration show ospf interface
3. Check OSPF on a Stub Router on page 139	show configuration show ospf interface
Check OSPF Neighbors on page 141	
1. Verify OSPF Neighbors on page 142	show ospf neighbor
2. Examine the OSPF Link-State Database on page 144	show ospf database
3. Examine OSPF Routes on page 148	show route *destination-prefix* show ospf database
4. Examine the Forwarding Table on page 151	show route *destination-prefix* extensive show route forwarding-table destination *destination-prefix*
5. Examine Link-State Advertisements in Detail on page 152	
a. Examine a Type 1 Router LSA on page 152	show ospf database router extensive
b. Examine a Type 3 Summary LSA on page 153	show ospf database netsummary extensive
c. Examine a Type 4 ASBR Summary LSA on page 154	show ospf database asbrsummary extensive
d. Examine a Type 5 AS External LSA on page 155	show ospf database extern extensive
e. Examine Type 7 NSSA External LSA on page 156	show ospf database nssa extensive

Verify the OSPF Protocol

Purpose For OSPF to run on a router in your network, you must include the interfaces that run OSPF at the [edit protocols ospf] hierarchy level and, for those interfaces, the family inet statement must be included at the [edit interfaces *interface-name* unit *logical-unit-number*] hierarchy level.

Figure 10 illustrates an example an OSPF autonomous system (AS) consisting of multiple areas and different types of OSPF routers.

Figure 10: Multi-Area OSPF Network Topology



The AS in Figure 10 is organized hierarchically around a backbone area, 0.0.0.0. Portions of the network are designated as separate areas: 0.0.0.1, 0.0.0.2, and 0.0.0.3. The backbone is the connecting point for all other areas, and each area must attach to the backbone in at least one location. OSPF is based on the concept of a link-state database in which each OSPF router attempts to form adjacencies with its OSPF neighbor. Once the adjacencies are in place, each router generates and floods LSAs into the network. The LSAs are placed into the link-state database on each router where the shortest path first (SPF) algorithm is calculated to find the best path to each end node in the network.

All non-backbone areas (0.0.0.1, 0.0.0.2, and 0.0.0.3) contain routers internal to that area (R1, R5, and R6) as well as a single area border router (ABR) (R2, R3, and R4). Internal routers generate LSAs within their area. The ABR translates these internal LSAs into summary LSAs that represent the LSAs within its non-backbone area and floods the summary LSAs to the backbone. The ABR is also responsible for generating summary LSAs that represent the backbone LSAs and injecting them into its attached areas. Because the ABR belongs to more than one area, it maintains a separate topological database for each area to which it is connected.

In Figure 10, the ABRs belong to different non-backbone areas. R2 is in area 0.0.0.1, a not-so-stubby area (NSSA): R3 is in area 0.0.0.3: and R4 is in area 0.0.0.2, a stub area.

The NSSA (0.0.0.1) consists of two routers: R1 and R2. An NSSA allows external routes to be flooded within its area. These routes are then leaked to other areas within the AS. However, external routes learned from other areas within the AS do not enter the NSSA.

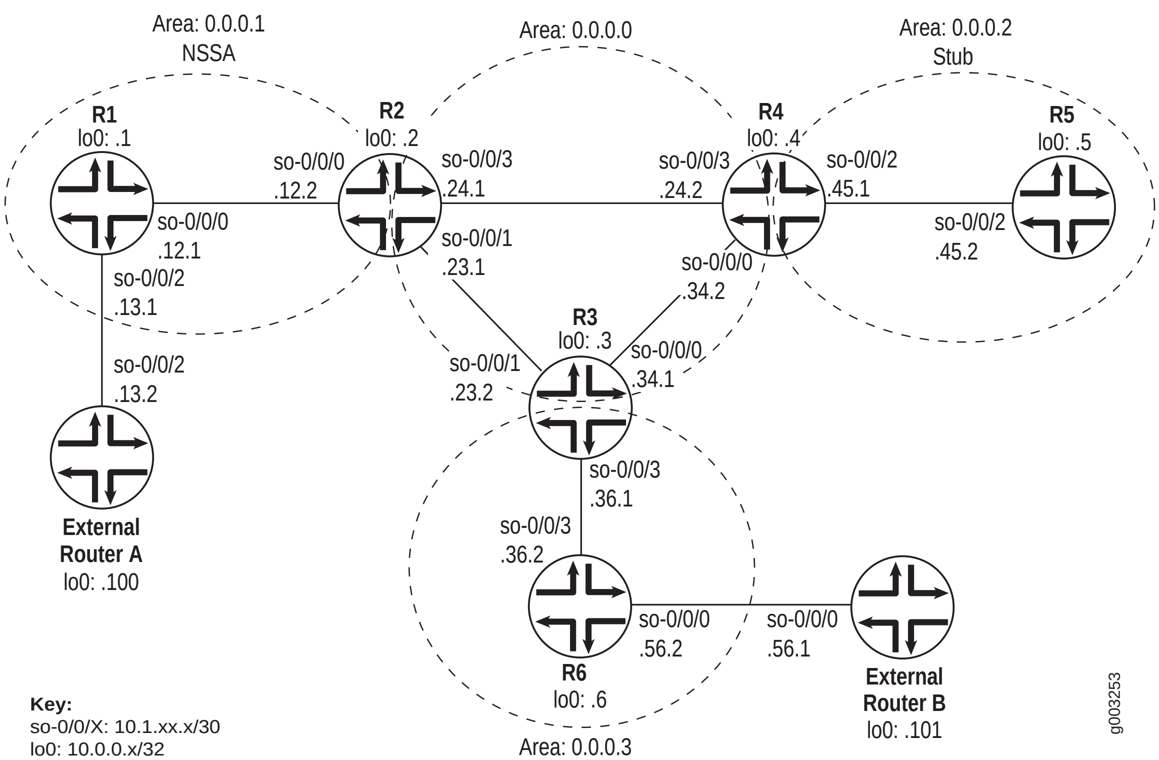
The stub area (0.0.0.2) consists of two routers: R4 and R5. A stub area does not allow external routes to be flooded within its area. A stub area is useful when much of the AS consists of external LSAs because it reduces the size of the topological database within the stub area and subsequently the amount of memory required by the routers in the area.

Area 0.0.0.3 is a non-backbone area consisting of two routers: R3 and R6.

External Routers A and B reside outside the AS. When an OSPF router exchanges routing information with routers in other ASs, that router is called an autonomous system boundary router (ASBR). The ASBRs shown in Figure 10 are R1 and R6.

Figure 11 provides interface and IP address information for the example OSPF network topology used for the procedures in this section.

Figure 11: OSPF Network Topology with Details



Steps To Take To verify that OSPF is configured correctly on routers in different areas of the network, follow these steps:

1. Check OSPF on an ASBR on page 132
2. Check OSPF on an ABR on page 135
3. Check OSPF on a Stub Router on page 139

Step 1: Check OSPF on an ASBR

Action To verify the OSPF configuration on an ASBR router in your network, enter the following JUNOS command-line interface (CLI) operational mode commands:

user@host> **show configuration**
user@host> **show ospf interface**

Sample Output The following sample output is for an OSPF configuration on R1, an ASBR router shown in Figure 11:

```
user@R1> show configuration
[...Output truncated...]
interfaces {
    so-0/0/0 {
        unit 0 {
            family inet {
                address 10.1.12.1/30;
            }
        }
    }
    so-0/0/2 {
        unit 0 {
            family inet {
                address 10.1.13.1/30;
            }
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 10.0.0.1/32;
            }
        }
    }
}
routing-options {
    static {
[...Output truncated...]
        route 10.0.0.100/32 next-hop 10.1.13.2;
    }
    router-id 10.0.0.1;
}
```

```
protocols {
    ospf {
        export export-to-ospf;
        area 0.0.0.1 {
            nssa;
            interface so-0/0/0.0;
            interface lo0.0 {
                passive;
            }
        }
    }
}
policy-options {
    policy-statement export-to-ospf {
        term external-router {
            from {
                route-filter 10.0.0.100/32 exact;
            }
            then accept;
        }
    }
}
```

```
user@R1> show ospf interface
Interface       State     Area            DR ID           BDR ID          Nbrs
lo0.0           DRother  0.0.0.1         0.0.0.0         0.0.0.0            0
so-0/0/0.0      PtToPt   0.0.0.1         0.0.0.0         0.0.0.0            1
```

The following sample output is for an OSPF configuration on R6, an ASBR router shown in Figure 11:

```
user@R6> show configuration
[...Output truncated...]
interfaces {
    so-0/0/0 {
        unit 0 {
            family inet {
                address 10.1.56.2/30;
            }
        }
    }
    so-0/0/3 {
        unit 0 {
            family inet {
                address 10.1.36.2/30;
            }
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 10.0.0.6/32;
            }
        }
    }
}
```

```
routing-options {
    static {
[...Output truncated...]
        route 10.0.0.101/32 next-hop 10.1.56.1;
    }
    router-id 10.0.0.6;
}
protocols {
    ospf {
        export export-to-ospf;
        area 0.0.0.3 {
            interface so-0/0/3.0;
            interface lo0.0 {
                passive;
            }
        }
    }
}
policy-options {
    policy-statement export-to-ospf {
        term external-router {
            from {
                route-filter 10.0.0.101/32 exact;
            }
            then accept;
        }
    }
}

user@R6> show ospf interface
Interface         State     Area            DR ID           BDR ID          Nbrs
lo0.0             DRother   0.0.0.3         0.0.0.0         0.0.0.0           0
so-0/0/3.0        PtToPt    0.0.0.3         0.0.0.0         0.0.0.0           1
```

What It Means The sample output shows a basic OSPF configuration at the [edit protocols ospf] and [edit interfaces] hierarchy levels on the R1 and R6 ASBR routers. In addition, both routers have an export policy, export-to-ospf, configured. The export policy allows external routes to be injected into the OSPF database and communicated throughout the AS.

R1 has two interfaces included at the [edit protocols ospf] hierarchy level: so-0/0/0 and the loopback interface (lo0). Both interfaces have the family inet statement included at the [edit interfaces] hierarchy level and are in area 0.0.0.1. Area 0.0.0.1 is attached to the backbone through R2, an ABR.

In addition, R1 has the nssa statement included at the [edit protocols ospf] hierarchy level indicating that it is an ASBR running in an NSSA. An NSSA allows external routes from outside the AS to be flooded within it. In this instance, the routes learned from external router B through the export policy export-to-ospf are injected into the R1 OSPF database and communicated throughout the AS. For more information on OSPF routes, see “Examine OSPF Routes” on page 148.

R6 has two interfaces included at the [edit protocols ospf] hierarchy level: so-0/0/3 and the loopback interface (lo0). Both interfaces have the family inet statement included at the [edit interfaces] hierarchy level and are in area 0.0.0.3. Area 0.0.0.3 is attached to the backbone through R3, an ABR. In addition, external router B is attached to R6 which has the export policy export-to-ospf configured. The export policy allows external routes to be injected into the R6 OSPF database and communicated throughout the AS.

Both routers (R1 and R6) have the router ID configured manually to avoid possible problems when the OSPF router ID (RID) changes: for example, when multiple loopback addresses are configured. The RID uniquely identifies the router within the OSPF network. It is transmitted within the LSAs used to populate the link-state database and calculate the shortest-path tree. In a link-state network, it is important that two routers do not share the same RID value, otherwise IP routing problems may occur.

An ASBR exchanges routing information with routers in other autonomous systems. ASBRs advertise externally learned routes throughout the AS. With the exception of routers in stub areas, any router in the AS—an internal router, an area border router, or a backbone router—can be an ASBR.

See the *JUNOS Routing Protocols Configuration Guide* for more information on configuring OSPF on a router.

Step 2: Check OSPF on an ABR

Action To verify the OSPF configuration on an ABR router in your network, enter the following JUNOS CLI operational mode commands:

user@host> **show configuration**
user@host> **show ospf interface**

Sample Output The following sample output is for an OSPF configuration on R2, an NSSA ABR shown in Figure 11:

```
user@R2> show configuration
[...Output truncated...]
interfaces {
    so-0/0/0 {
        unit 0 {
            family inet {
                address 10.1.12.2/30;
            }
        }
    }
    so-0/0/1 {
        unit 0 {
            family inet {
                address 10.1.23.1/30;
            }
        }
    }
    so-0/0/3 {
        unit 0 {
            family inet {
                address 10.1.24.1/30;
            }
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 10.0.0.2/32;
            }
        }
    }
```

```
}
routing-options {
    }
    router-id 10.0.0.2;
}
protocols {
    ospf {
        area 0.0.0.1 {
            nssa {
                default-lsa default-metric 10;
            }
            interface so-0/0/0.0;
        }
        area 0.0.0.0 {
            interface so-0/0/3.0;
            interface so-0/0/1.0;
            interface lo0.0 {
                passive;
            }
        }
    }
}
```

```
user@R2> show ospf interface
Interface        State     Area            DR ID           BDR ID          Nbrs
lo0.0            DRother  0.0.0.0         0.0.0.0         0.0.0.0            0
so-0/0/1.0       PtToPt   0.0.0.0         0.0.0.0         0.0.0.0            1
so-0/0/3.0       PtToPt   0.0.0.0         0.0.0.0         0.0.0.0            1
so-0/0/0.0       PtToPt   0.0.0.1         0.0.0.0         0.0.0.0            1
```

The following sample output is for an OSPF configuration on R3, an ABR shown in Figure 11:

```
user@R3> show configuration
interfaces {
    so-0/0/0 {
        unit 0 {
            family inet {
                address 10.1.34.1/30;
            }
        }
    }
    so-0/0/1 {
        unit 0 {
            family inet {
                address 10.1.23.2/30;
            }
        }
    }
    so-0/0/3 {
        unit 0 {
            family inet {
                address 10.1.36.1/30;
            }
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 10.0.0.3/32;
            }
        }
```

```
    }
}
routing-options {
    router-id 10.0.0.3;
}
protocols {
    ospf {
        area 0.0.0.0 {
            interface so-0/0/0.0;
            interface so-0/0/1.0;
            interface lo0.0 {
                passive;
            }
        }
        area 0.0.0.3 {
            interface so-0/0/3.0;
        }
    }
```

```
user@R3> show ospf interface
Interface       State     Area            DR ID           BDR ID          Nbrs
lo0.0           DRother  0.0.0.0         0.0.0.0         0.0.0.0            0
so-0/0/0.0      PtToPt   0.0.0.0         0.0.0.0         0.0.0.0            1
so-0/0/1.0      PtToPt   0.0.0.0         0.0.0.0         0.0.0.0            1
so-0/0/3.0      PtToPt   0.0.0.3         0.0.0.0         0.0.0.0            1
```

The following sample output is for an OSPF configuration on R4, an ABR shown in Figure 11:

```
user@R4> show configuration
[...Output truncated...]
interfaces {
    so-0/0/0 {
        unit 0 {
            family inet {
                address 10.1.34.2/30;
            }
        }
    }
    so-0/0/2 {
        unit 0 {
            family inet {
                address 10.1.45.1/30;
            }
        }
    }
    so-0/0/3 {
        unit 0 {
            family inet {
                address 10.1.24.2/30;
            }
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 10.0.0.4/32;
            }
        }
    }
}
routing-options {
```

```
    router-id 10.0.0.4;
}
protocols {
    ospf {
        area 0.0.0.0 {
            interface so-0/0/0.0;
            interface so-0/0/3.0;
            interface lo0.0 {
                passive;
            }
        }
        area 0.0.0.2 {
            stub default-metric 10;
            interface so-0/0/2.0;
        }
    }
}

user@R4> show ospf interface
Interface        State     Area            DR ID           BDR ID         Nbrs
lo0.0            DRother  0.0.0.0         0.0.0.0         0.0.0.0           0
so-0/0/0.0       PtToPt   0.0.0.0         0.0.0.0         0.0.0.0           1
so-0/0/3.0       PtToPt   0.0.0.0         0.0.0.0         0.0.0.0           1
so-0/0/2.0       PtToPt   0.0.0.2         0.0.0.0         0.0.0.0           1
```

What It Means The sample output shows a basic OSPF configuration at the [edit protocols ospf] and [edit interfaces] hierarchy levels on the R2, R3, and R4 ABR routers.

R2 has four interfaces included at the [edit protocols ospf] hierarchy level, and those interfaces have the family inet statement included at the [edit interfaces] hierarchy level. Three interfaces—so-0/0/1.0, so-0/0/3.0, and the loopback (lo0) interface—are in the backbone (0.0.0.0). One interface, so-0/0/0.0, is in the NSSA (0.0.0.1). Because R2 has one interface configured for an NSSA, external routes learned from outside the AS (through R1) are redistributed throughout the network. For more information on OSPF routes, see "Examine OSPF Routes" on page 148.

R3 has four interfaces included at the [edit protocols ospf] hierarchy level, and those interfaces have the family inet statement included at the [edit interfaces] hierarchy level. Three interfaces—so-0/0/0.0, so-0/0/1.0, and the loopback (lo0) interface—are in the backbone (0.0.0.0). One interface, so-0/0/3.0, is in a non-backbone area (0.0.0.3).

R4 has four interfaces included at the [edit protocols ospf] hierarchy level, and those interfaces have the family inet statement included at the [edit interfaces] hierarchy level. Two interfaces, so-0/0/0.0 and so-0/0/3.0, are in the backbone (0.0.0.0). One interface, so-0/0/2.0, is in the stub area (0.0.0.2). Because internal routers within a stub area do not receive external LSA information, they must rely on either direct static routes or a default route to get to external destinations. A default route can be statically configured on the internal router or learned from the stub ABR. To advertise a default LSA from the stub ABR, include the stub default-metric statement at the [edit protocols ospf area area-id] hierarchy level to activate the default route.

All routers (R2, R3, and R4) have the router ID configured manually to avoid possible problems when the OSPF router ID (RID) changes; for example, when multiple loopback addresses are configured. The RID uniquely identifies the router within the OSPF network. It is transmitted within the LSAs used to populate the link-state database and calculate the shortest-path tree. In a link-state network, it is important that two routers do not share the same RID value, otherwise IP routing problems may occur.

An ABR belongs to more than one area and maintains a separate topological database for each area to which it is connected. For more information on the OSPF database, see “Examine the OSPF Link-State Database” on page 144.

See the *JUNOS Routing Protocols Configuration Guide* for more information on configuring OSPF on a router.

Step 3: Check OSPF on a Stub Router

Action To verify the OSPF configuration on a stub router in your network, enter the following commands:

```
user@host> show configuration
user@host> show ospf interface
```

Sample Output The following sample output is for an OSPF configuration on R5, a stub router shown in Figure 11:

```
user@R5> show configuration
[...Output truncated...]
interfaces {
    so-0/0/2 {
        unit 0 {
            family inet {
                address 10.1.45.2/30;
            }
        }
    }
    lo0 {
        unit 0 {
            family inet {
                address 10.0.0.5/32;
            }
        }
    }
}
routing-options {
    router-id 10.0.0.5;
}
protocols {
    ospf {
        area 0.0.0.2 {
            stub;
            interface so-0/0/2.0;
            interface lo0.0 {
                passive;
            }
        }
    }
}
```

```
user@R5> show ospf interface
Interface         State     Area           DR ID           BDR ID       Nbrs
lo0.0             DRother  0.0.0.2        0.0.0.0         0.0.0.0         0
so-0/0/2.0        PtToPt   0.0.0.2        0.0.0.0         0.0.0.0         1
```

What It Means The sample output shows a basic OSPF configuration at the [edit protocols ospf] and [edit interfaces] hierarchy levels on R5, a stub router.

R5 has two interfaces included at the [edit protocols ospf] hierarchy level, and those interfaces have the family inet statement included at the [edit interfaces] hierarchy level. Both interfaces, so-0/0/2.0 and the loopback interface (lo0), are in the stub area (0.0.0.2).

R5 has the router ID configured manually to avoid possible problems when the OSPF router ID (RID) changes; for example, when multiple loopback addresses are configured. The RID uniquely identifies the router within the OSPF network. It is transmitted within the LSAs used to populate the link-state database and calculate the shortest-path tree. In a link-state network, it is important that two routers do not share the same RID value, otherwise IP routing problems may occur.

A stub area does not allow AS external advertisements to flood within that area. R5 relies on a default route (0.0.0.0/0) to reach destinations outside the AS. The default route can be statically configured on R5 or advertised by an ABR (R4). In this network, the default LSA is advertised by R4.

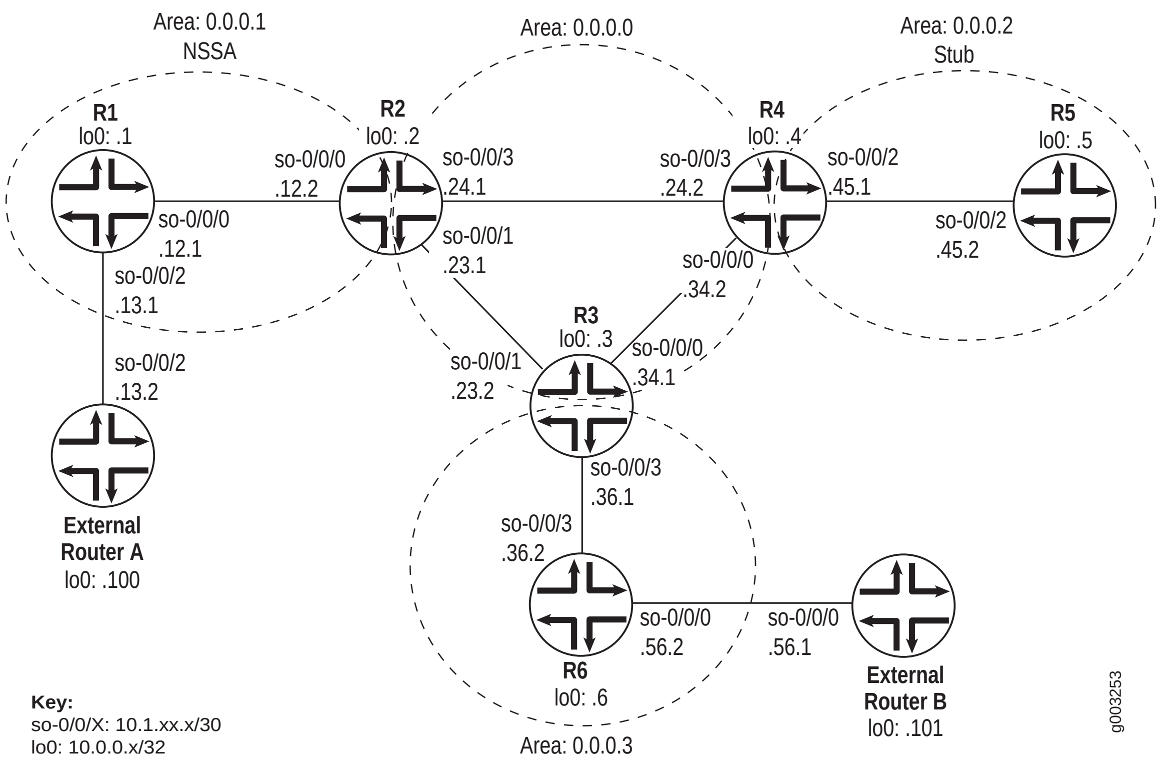
A stub area is useful if you want to reduce the size of the topological database and therefore the amount of memory required from the routers in the stub area. However, some restrictions apply to a stub area. You cannot create a virtual link through a stub area, and a stub area cannot contain an ASBR.

Check OSPF Neighbors

Purpose Assuming that all the routers are correctly configured for OSPF, you can verify which neighbors are adjacent and what type of LSAs are contained in the OSPF link-state database. In addition, you can examine the set of routes installed in the forwarding table to verify that the routing protocol process (rpd) has relayed the correct information into the forwarding table.

Figure 12 illustrates an example OSPF network topology used in this section.

Figure 12: OSPF Network Topology



The network consists of various types of routers that form adjacencies with neighboring OSPF routers. Once these adjacencies are in place, each router generates and floods LSAs into the network. The LSAs are placed into the link-state database on each router where the shortest path first (SPF) algorithm is calculated to find the best path to each router in the network. The network in Figure 12 should have the following adjacencies and LSA distribution:

- ABR routers R2, R3, and R4 should form adjacencies with routers in all areas to which they are connected (0.0.0.0, 0.0.0.1, 0.0.0.2, and 0.0.0.3). See "Check OSPF on an ABR" on page 135.

- Internal routers (R1, R5, and R6) should form adjacencies with routers inside their local area only. See "Check OSPF on a Stub Router" on page 139 and "Check OSPF on an ASBR" on page 132.

- Backbone area 0.0.0.0 should have Type 1, Type 3, Type 4, and Type 5 LSAs.

- NSSA area 0.0.0.1 should have Type 1, Type 3, and Type 7 LSAs.
- Stub area 0.0.0.2 should have Type 1 and Type 3 LSAs.
- Area 0.0.0.3 should have Type 1, Type 3, Type 4, and Type 5 LSAs.

Steps To Take To verify that routers are adjacent and have the correct exchange of LSAs, follow these steps:

1. Verify OSPF Neighbors on page 142
2. Examine the OSPF Link-State Database on page 144
3. Examine OSPF Routes on page 148
4. Examine the Forwarding Table on page 151
5. Examine Link-State Advertisements in Detail on page 152

Step 1: Verify OSPF Neighbors

Action To verify that routers are adjacent and able to exchange OSPF data, enter the following CLI operational mode command:

user@host> **show ospf neighbor**

Sample Output The following sample output shows the adjacencies that formed for all routers in Figure 12 on page 141:

```
user@R1> show ospf neighbor
  Address         Interface             State      ID               Pri  Dead
10.1.12.2        so-0/0/0.0             Full      10.0.0.2         128   36

user@R2> show ospf neighbor
  Address         Interface             State      ID               Pri  Dead
10.1.23.2        so-0/0/1.0             Full      10.0.0.3         128   32
10.1.24.2        so-0/0/3.0             Full      10.0.0.4         128   33
10.1.12.1        so-0/0/0.0             Full      10.0.0.1         128   33

user@R3> show ospf neighbor
  Address         Interface             State      ID               Pri  Dead
10.1.34.2        so-0/0/0.0             Full      10.0.0.4         128   36
10.1.23.1        so-0/0/1.0             Full      10.0.0.2         128   38
10.1.36.2        so-0/0/3.0             Full      10.0.0.6         128   33

user@R4> show ospf neighbor
  Address         Interface             State      ID               Pri  Dead
10.1.34.1        so-0/0/0.0             Full      10.0.0.3         128   31
10.1.24.1        so-0/0/3.0             Full      10.0.0.2         128   36
10.1.45.2        so-0/0/2.0             Full      10.0.0.5         128   39

user@R5> show ospf neighbor
  Address         Interface             State      ID               Pri  Dead
10.1.45.1        so-0/0/2.0             Full      10.0.0.4         128   35

user@R6> show ospf neighbor
  Address         Interface             State      ID               Pri  Dead
10.1.36.1        so-0/0/3.0             Full      10.0.0.3         128   31
```

What It Means The sample output shows that ABR routers R2, R3, and R4 have formed adjacencies with routers in all areas to which they are directly connected. Internal routers (R1, R5, and R6) have formed an adjacency with the other router inside their local area.

Adjacencies are formed after OSPF hello packets are sent and received by neighbors. Adjacencies determine the type of LSAs sent and received, and what topological database updates are sent. When adjacencies are established, pairs of adjacent routers synchronize their topological databases.

Table 33 lists and describes the fields in the show ospf neighbor command.

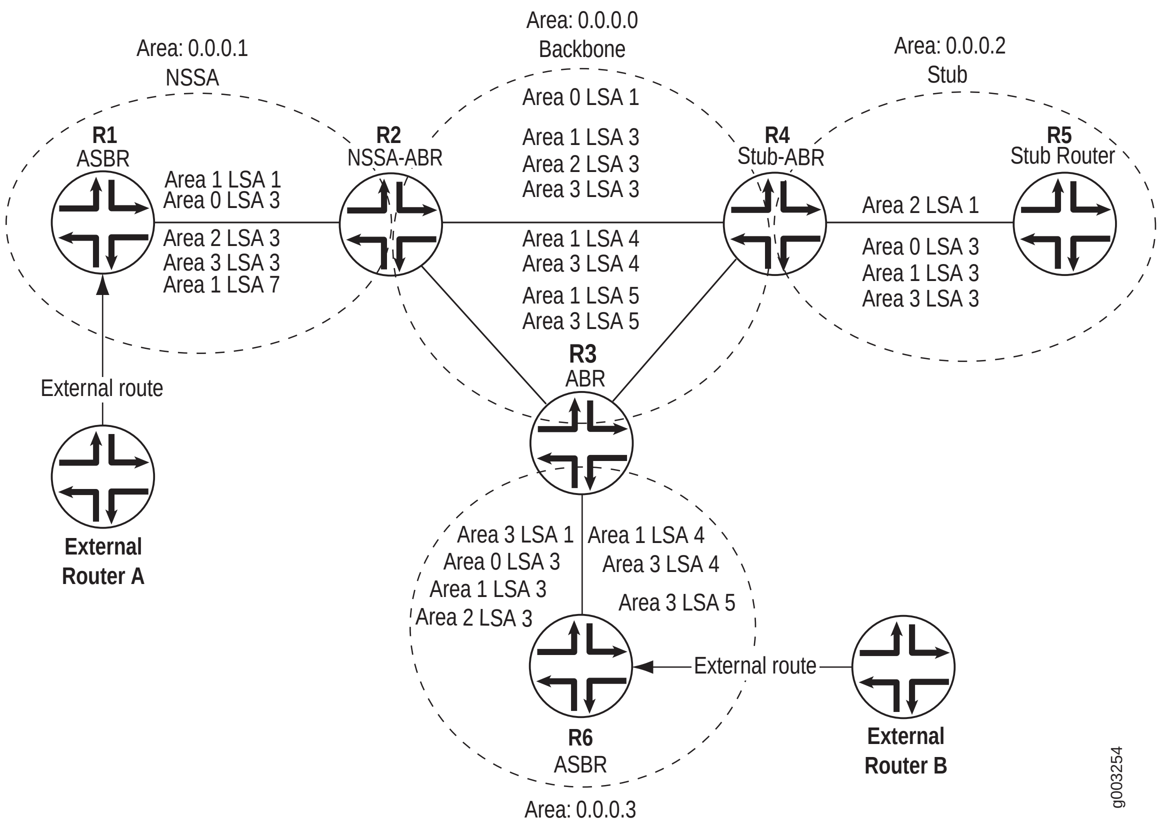
Table 33: Output Fields for the show ospf neighbor Command

Field	Description
Address	Address of the neighbor.
Interface	Interface through which the neighbor is reachable.
State	State of the neighbor. It can be Attempt, Down, Exchange, ExStart, Full, Init, Loading, or 2 Way.
ID	Router ID of the neighbor.
Pri	Priority of the neighbor to become the designated router. Only used on broadcast networks during designated router elections. By default, set to 128, indicating the highest priority and the most likely router to be elected designated router.
Dead	Number of seconds until the neighbor becomes unreachable.

Step 2: Examine the OSPF Link-State Database

Purpose You can determine if the correct types of LSAs are sent and received throughout the OSPF network by examining the entire OSPF link-state database. Figure 13 illustrates the flooding scope of LSAs generated and flooded in the example OSPF network.

Figure 13: LSA Flooding Scopes



This network should have the following distribution of LSAs:

- Backbone area 0.0.0.0 should have Type 1, Type 3, Type 4, and Type 5 LSAs.
- NSSA area 0.0.0.1 should have Type 1, Type 3, and Type 7 LSAs.
- Stub area 0.0.0.2 should have Type 1 and Type 3 LSAs.
- Area 0.0.0.3 should have Type 1, Type 3, Type 4, and Type 5 LSAs.

Because all routers in this network have SONET interfaces configured for Point-to-Point (PPP) encapsulation, all OSPF adjacencies are point-to-point, which results in Type 2 network LSAs not appearing in this network or being described in the following sections. Type 2 network LSAs are only advertised by a designated router, which is only present on broadcast or non-broadcast multiaccess (NBMA) networks.

Action To determine if the correct LSAs appear in the different areas of the OSPF AS, enter the following CLI operational mode command:

user@host> **show ospf database**

Sample Output

```
user@R2> show ospf database

    OSPF link state database, area 0.0.0.0
 Type       ID               Adv Rtr          Seq      Age  Opt  Cksum  Len
Router   *10.0.0.2        10.0.0.2         0x80000049  1555  0x2  0xd72a  84
Router    10.0.0.3        10.0.0.3         0x80000038  1395  0x2  0xef0e  84
Router    10.0.0.4        10.0.0.4         0x80000041   914  0x2  0x46a9  84
Summary  *10.0.0.1        10.0.0.2         0x80000047  1855  0x2  0xf509  28
Summary   10.0.0.5        10.0.0.4         0x8000003c  2114  0x2  0xd72c  28
Summary   10.0.0.6        10.0.0.3         0x80000033  1995  0x2  0xe527  28
Summary  *10.1.12.0       10.0.0.2         0x80000047   786  0x2  0x5d98  28
Summary   10.1.36.0       10.0.0.3         0x80000035  2426  0x2  0x727c  28
Summary   10.1.45.0       10.0.0.4         0x8000003d  1021  0x2  0xf8e3  28
ASBRSum  *10.0.0.1        10.0.0.2         0x80000046   355  0x2  0xe915  28
ASBRSum   10.0.0.6        10.0.0.3         0x80000032  1526  0x2  0xd933  28

    OSPF link state database, area 0.0.0.1
 Type       ID               Adv Rtr          Seq      Age  Opt  Cksum  Len
Router    10.0.0.1        10.0.0.1         0x80000058   858  0x0  0x5c26  60
Router   *10.0.0.2        10.0.0.2         0x80000048  1986  0x0  0xecbd  48
Summary  *10.0.0.2        10.0.0.2         0x80000039  1686  0x0  0x1cf2  28
Summary  *10.0.0.3        10.0.0.2         0x80000038  2286  0x0  0x1eef  28
Summary  *10.0.0.4        10.0.0.2         0x80000038   955  0x0  0x14f8  28
Summary  *10.0.0.5        10.0.0.2         0x80000038   186  0x0  0x14f6  28
Summary  *10.0.0.6        10.0.0.2         0x80000038  2155  0x0  0xaff   28
Summary  *10.1.23.0       10.0.0.2         0x80000046   655  0x0  0x4e9   28
Summary  *10.1.24.0       10.0.0.2         0x80000046   486  0x0  0xf8f3  28
Summary  *10.1.34.0       10.0.0.2         0x80000039  1255  0x0  0xae40  28
Summary  *10.1.36.0       10.0.0.2         0x80000039    55  0x0  0x9854  28
Summary  *10.1.45.0       10.0.0.2         0x80000039  1086  0x0  0x35ae  28
NSSA     *0.0.0.0         10.0.0.2         0x80000044  2455  0x0  0xd821  36
NSSA      10.0.0.100      10.0.0.1         0x80000051  2916  0x8  0x797c  36
    OSPF AS SCOPE link state database
 Type       ID               Adv Rtr          Seq      Age  Opt  Cksum  Len
Extern   *10.0.0.100      10.0.0.2         0x8000005e  1386  0x2  0xcf20  36
Extern    10.0.0.101      10.0.0.6         0x8000002b   333  0x2  0x9791  36

user@R3> show ospf database

    OSPF link state database, area 0.0.0.0
 Type       ID               Adv Rtr          Seq      Age  Opt  Cksum  Len
Router    10.0.0.2        10.0.0.2         0x80000049  1668  0x2  0xd72a  84
Router   *10.0.0.3        10.0.0.3         0x80000038  1506  0x2  0xef0e  84
Router    10.0.0.4        10.0.0.4         0x80000041  1027  0x2  0x46a9  84
Summary   10.0.0.1        10.0.0.2         0x80000047  1968  0x2  0xf509  28
Summary   10.0.0.5        10.0.0.4         0x8000003c  2227  0x2  0xd72c  28
Summary  *10.0.0.6        10.0.0.3         0x80000033  2106  0x2  0xe527  28
Summary   10.1.12.0       10.0.0.2         0x80000047   900  0x2  0x5d98  28
Summary  *10.1.36.0       10.0.0.3         0x80000036     6  0x2  0x707d  28
Summary   10.1.45.0       10.0.0.4         0x8000003d  1134  0x2  0xf8e3  28
ASBRSum   10.0.0.1        10.0.0.2         0x80000046   468  0x2  0xe915  28
ASBRSum  *10.0.0.6        10.0.0.3         0x80000032  1638  0x2  0xd933  28

    OSPF link state database, area 0.0.0.3
 Type       ID               Adv Rtr          Seq      Age  Opt  Cksum  Len
Router   *10.0.0.3        10.0.0.3         0x80000036  2406  0x2  0x3452  48
Router    10.0.0.6        10.0.0.6         0x8000002f   445  0x2  0x1850  60
```

```
Summary *10.0.0.1         10.0.0.3         0x80000036   906  0x2  0x1cf1  28
Summary *10.0.0.2         10.0.0.3         0x80000036   738  0x2  0x806   28
Summary *10.0.0.3         10.0.0.3         0x80000033  1806  0x2  0xf917  28
Summary *10.0.0.4         10.0.0.3         0x80000033  1038  0x2  0xf915  28
Summary *10.0.0.5         10.0.0.3         0x80000033   306  0x2  0xf913  28
Summary *10.1.12.0        10.0.0.3         0x80000036   606  0x2  0x8381  28
Summary *10.1.23.0        10.0.0.3         0x80000036   438  0x2  0xfffa  28
Summary *10.1.24.0        10.0.0.3         0x80000036  1338  0x2  0xfef9  28
Summary *10.1.34.0        10.0.0.3         0x80000036   138  0x2  0x8669  28
Summary *10.1.45.0        10.0.0.3         0x80000033  1206  0x2  0x1dc9  28
ASBRSum *10.0.0.1         10.0.0.3         0x80000035  2238  0x2  0x10fd  28
ASBRSum *10.0.0.2         10.0.0.3         0x80000035  1938  0x2  0xfb12  28
    OSPF AS SCOPE link state database
 Type       ID               Adv Rtr           Seq      Age  Opt  Cksum  Len
Extern   10.0.0.100       10.0.0.2         0x8000005e  1500  0x2  0xcf20  36
Extern   10.0.0.101       10.0.0.6         0x8000002b   445  0x2  0x9791  36

user@R4> show ospf database

    OSPF link state database, area 0.0.0.0
 Type       ID               Adv Rtr           Seq      Age  Opt  Cksum  Len
Router   10.0.0.2         10.0.0.2         0x80000049  1711  0x2  0xd72a  84
Router   10.0.0.3         10.0.0.3         0x80000038  1550  0x2  0xef0e  84
Router  *10.0.0.4         10.0.0.4         0x80000041  1068  0x2  0x46a9  84
Summary  10.0.0.1         10.0.0.2         0x80000047  2011  0x2  0xf509  28
Summary *10.0.0.5         10.0.0.4         0x8000003c  2268  0x2  0xd72c  28
Summary  10.0.0.6         10.0.0.3         0x80000033  2150  0x2  0xe527  28
Summary  10.1.12.0        10.0.0.2         0x80000047   942  0x2  0x5d98  28
Summary  10.1.36.0        10.0.0.3         0x80000036    50  0x2  0x707d  28
Summary *10.1.45.0        10.0.0.4         0x8000003d  1175  0x2  0xf8e3  28
ASBRSum  10.0.0.1         10.0.0.2         0x80000046   511  0x2  0xe915  28
ASBRSum  10.0.0.6         10.0.0.3         0x80000032  1681  0x2  0xd933  28

    OSPF link state database, area 0.0.0.2
 Type       ID               Adv Rtr           Seq      Age  Opt  Cksum  Len
Router  *10.0.0.4         10.0.0.4         0x8000003f   875  0x0  0x5913  48
Router   10.0.0.5         10.0.0.5         0x8000002e  1263  0x0  0x5a03  60
Summary *0.0.0.0          10.0.0.4         0x80000019   768  0x0  0x4be3  28
Summary *10.0.0.1         10.0.0.4         0x80000040   575  0x0  0x20e4  28
Summary *10.0.0.2         10.0.0.4         0x80000040   468  0x0  0xcf8   28
Summary *10.0.0.3         10.0.0.4         0x8000003f   275  0x0  0x401   28
Summary *10.0.0.4         10.0.0.4         0x8000003d   168  0x0  0xf313  28
Summary *10.0.0.6         10.0.0.4         0x8000003d  2075  0x0  0xf30f  28
Summary *10.1.12.0        10.0.0.4         0x8000003f  1968  0x0  0x8973  28
Summary *10.1.23.0        10.0.0.4         0x8000003f  1775  0x0  0x10e1  28
Summary *10.1.24.0        10.0.0.4         0x8000003d  1668  0x0  0xfef4  28
Summary *10.1.34.0        10.0.0.4         0x8000003d  1475  0x0  0x9059  28
Summary *10.1.36.0        10.0.0.4         0x8000003d  1368  0x0  0x8462  28
    OSPF AS SCOPE link state database
 Type       ID               Adv Rtr           Seq      Age  Opt  Cksum  Len
Extern   10.0.0.100       10.0.0.2         0x8000005e  1542  0x2  0xcf20  36
Extern   10.0.0.101       10.0.0.6         0x8000002b   488  0x2  0x9791  36
```

What It Means The sample output shows that all the ABRs have the correct distribution of LSAs. Area 0.0.0.0 for all routers has Type 1 router, Type 3 summary, and Type 4 ASBR summary LSAs. Each ABR has an OSPF AS scope link-state database that includes Type 5 external LSAs.

Note that Type 2 network LSAs are not found in this topology because both broadcast or NMBA network types are not present.

NSSA area 0.0.0.1, in the output for R2, has Type 1 router, Type 3 summary, and Type 7 NSSA LSAs. Stub area 0.0.0.2, in the output for R4, has Type 1 router and Type 3 summary LSAs. Non-backbone area 0.0.0.3, in the output for R3, has Type 1 router, Type 3 summary, Type 4 ASBR, and Type 5 external LSAs.

All areas have a Type 1 router LSA because the Type 1 LSA is generated for each router that has interfaces in that area. Because this LSA has an area flooding scope, it remains within its own particular area and is not seen in other areas. For example, in the link-state database for area 0.0.0.2, there are two router LSAs: one for R4 and one for R5.

The ABR for that area places the routing information contained within the Type 1 LSA into a Type 3 summary or Type 4 ASBR summary LSA and forwards it across the area boundary. Whether the area receives a Type 3 or Type 4 summary LSA depends on whether the area is a stub area. Type 3 summary LSAs appear in all areas, but Type 4 LSAs only appear in non-stub areas as indicated in the link-state databases for areas 0.0.0.1, 0.0.0.2, and 0.0.0.3.

Each ABR router has a Type 5 AS external LSA used to advertise any networks external to the OSPF AS. This LSA is flooded by the ABRs to each non-stub router in the entire AS. For example, within area 0.0.0.0, Type 5 LSAs exist for areas 0.0.0.1 and 0.0.0.3. Both of these areas are connected to routers (external router A and external router B) from other ASs, which results in the injection of external routes into the OSPF AS. However, there are no Type 5 LSAs in stub areas 0.0.0.1 and 0.0.0.2.

A Type 7 NSSA external LSA appears in NSSA area 0.0.0.1 and is used within the NSSA to advertise an external router. This LSA is flooded to each router in the NSSA and is not sent to other adjacent areas. For example, only area 0.0.0.1 has a Type 7 LSA. Because a Type 7 LSA does not traverse area boundaries, the ABR in the NSSA (R2) translates the Type 7 LSA into a Type 5 LSA that is forwarded to all areas (with the exception of stub areas).

The sample output shows that each router has two databases, indicating that it is an ABR between the backbone and a non-backbone, stub, or NSSA area. All of the addresses preceded by an asterisk (*) are LSAs that originated with the router from which the output was taken.

Step 3: Examine OSPF Routes

Purpose You can determine if the LSAs that appear in the link-state database of a router are correct by examining the route to the destination. In this step, three routes are examined. The first example shows the route from R5 to external router A, the second shows the route from R6 to external router A, and the third shows the route from R4 to R6.

Action To examine a route in an OSPF AS, enter one or all of the following CLI commands:

```
user@host> show route destination-prefix
user@host> show ospf database
```

Sample Output 1 The following sample output shows the path from R5 to external router A:

```
user@R5> show route 10.0.0.100

inet.0: 23 destinations, 25 routes (23 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

0.0.0.0/0          *[OSPF/10] 01:58:42, metric 11
                    > via so-0/0/2.0

user@R5> show ospf database

    OSPF link state database, area 0.0.0.2
 Type       ID               Adv Rtr           Seq      Age  Opt  Cksum  Len
Router   10.0.0.4        10.0.0.4         0x8000002b   140  0x0  0x81fe  48
Router  *10.0.0.5        10.0.0.5         0x8000001f   526  0x0  0x78f3  60
Summary  0.0.0.0         10.0.0.4         0x80000005    32  0x0  0x73cf  28
Summary  10.0.0.1        10.0.0.4         0x8000002b  2132  0x0  0x4acf  28
Summary  10.0.0.2        10.0.0.4         0x8000002b  1940  0x0  0x36e3  28
Summary  10.0.0.3        10.0.0.4         0x8000002a  1832  0x0  0x2eeb  28
Summary  10.0.0.4        10.0.0.4         0x80000028  1640  0x0  0x1efd  28
Summary  10.0.0.6        10.0.0.4         0x80000029  1340  0x0  0x1cfa  28
Summary  10.1.12.0       10.0.0.4         0x8000002b  1232  0x0  0xb15f  28
Summary  10.1.23.0       10.0.0.4         0x8000002b  1040  0x0  0x38cd  28
Summary  10.1.24.0       10.0.0.4         0x80000029   932  0x0  0x27e0  28
Summary  10.1.34.0       10.0.0.4         0x80000029   740  0x0  0xb845  28
Summary  10.1.36.0       10.0.0.4         0x80000029   632  0x0  0xac4e  28
```

Sample Output 2 The following sample output shows the route from R6 to external router A:

```
user@R6> show route 10.0.0.100

inet.0: 29 destinations, 31 routes (29 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

10.0.0.100/32      *[OSPF/150] 16:52:11, metric 0, tag 0
                    > via so-0/0/3.0
```

```
user@R6> show ospf database

    OSPF link state database, area 0.0.0.3
 Type       ID               Adv Rtr          Seq      Age  Opt  Cksum  Len
Router   10.0.0.3         10.0.0.3         0x8000001d   502  0x2  0x6639  48
Router  *10.0.0.6         10.0.0.6         0x80000019   807  0x2  0x443a  60
Summary  10.0.0.1         10.0.0.3         0x8000001c  1570  0x2  0x50d7  28
Summary  10.0.0.2         10.0.0.3         0x8000001c  1402  0x2  0x3ceb  28
Summary  10.0.0.3         10.0.0.3         0x80000019  2470  0x2  0x2efc  28
Summary  10.0.0.4         10.0.0.3         0x80000019  1702  0x2  0x2efa  28
Summary  10.0.0.5         10.0.0.3         0x80000019   970  0x2  0x2ef8  28
Summary  10.1.12.0        10.0.0.3         0x8000001c  1270  0x2  0xb767  28
Summary  10.1.23.0        10.0.0.3         0x8000001c  1102  0x2  0x34e0  28
Summary  10.1.24.0        10.0.0.3         0x8000001c  2002  0x2  0x33df  28
Summary  10.1.34.0        10.0.0.3         0x8000001c   802  0x2  0xba4f  28
Summary  10.1.45.0        10.0.0.3         0x80000019  1870  0x2  0x51af  28
ASBRSum  10.0.0.1         10.0.0.3         0x8000001c   370  0x2  0x42e4  28
ASBRSum  10.0.0.2         10.0.0.3         0x8000001c    70  0x2  0x2ef8  28
    OSPF AS SCOPE link state database
 Type       ID               Adv Rtr          Seq      Age  Opt  Cksum  Len
Extern   10.0.0.100       10.0.0.2         0x80000042   384  0x2  0x804   36
Extern  *10.0.0.101       10.0.0.6         0x80000015   807  0x2  0xc37b  36
Extern   10.1.13.0        10.0.0.2         0x80000041   234  0x2  0x481e  36
Extern   10.1.15.0        10.0.0.2         0x80000041   233  0x2  0x3232  36
Extern   100.168.64.0     10.0.0.2         0x80000041    82  0x2  0xe0f7  36
```

Sample Output 3 The following sample output shows the route from R4 to R6:

```
user@R4> show route 10.0.0.6

inet.0: 27 destinations, 31 routes (27 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

10.0.0.6/32        *[OSPF/10] 17:02:28, metric 2
                    > via so-0/0/0.0

user@R4> show ospf database

    OSPF link state database, area 0.0.0.0
 Type       ID               Adv Rtr          Seq      Age  Opt  Cksum  Len
Router   10.0.0.2         10.0.0.2         0x8000002f   632  0x2  0xc10   84
Router   10.0.0.3         10.0.0.3         0x8000001e  2271  0x2  0x24f3  84
Router  *10.0.0.4         10.0.0.4         0x80000022  1582  0x2  0x848a  84
Summary  10.0.0.1         10.0.0.2         0x8000002d   789  0x2  0x2aee  28
Summary *10.0.0.5         10.0.0.4         0x8000001e   982  0x2  0x140e  28
Summary  10.0.0.6         10.0.0.3         0x8000001a   302  0x2  0x180e  28
Summary  10.1.12.0        10.0.0.2         0x8000002c  1847  0x2  0x937d  28
Summary  10.1.36.0        10.0.0.3         0x8000001c   771  0x2  0xa463  28
Summary *10.1.45.0        10.0.0.4         0x8000001f  1789  0x2  0x35c5  28
ASBRSum  10.0.0.1         10.0.0.2         0x8000002b  1533  0x2  0x20f9  28
ASBRSum  10.0.0.6         10.0.0.3         0x80000018  2402  0x2  0xe19   28
```

```
    OSPF link state database, area 0.0.0.2
 Type       ID               Adv Rtr           Seq      Age  Opt  Cksum  Len
Router  *10.0.0.4         10.0.0.4         0x80000020  1282  0x0  0x97f3  48
Router   10.0.0.5         10.0.0.5         0x80000018  1685  0x0  0x86ec  60
Summary *10.0.0.1         10.0.0.4         0x80000021  1189  0x0  0x5ec5  28
Summary *10.0.0.2         10.0.0.4         0x80000021   889  0x0  0x4ad9  28
Summary *10.0.0.3         10.0.0.4         0x80000020   682  0x0  0x42e1  28
Summary *10.0.0.4         10.0.0.4         0x8000001e  1489  0x0  0x32f3  28
Summary *10.0.0.6         10.0.0.4         0x8000001f   589  0x0  0x30f0  28
Summary *10.1.12.0        10.0.0.4         0x80000021   382  0x0  0xc555  28
Summary *10.1.23.0        10.0.0.4         0x80000021   289  0x0  0x4cc3  28
Summary *10.1.24.0        10.0.0.4         0x80000020    82  0x0  0x39d7  28
Summary *10.1.34.0        10.0.0.4         0x8000001f  2089  0x0  0xcc3b  28
Summary *10.1.36.0        10.0.0.4         0x8000001f  1882  0x0  0xc044  28
    OSPF AS SCOPE link state database
 Type       ID               Adv Rtr           Seq      Age  Opt  Cksum  Len
Extern   10.0.0.100       10.0.0.2         0x80000042   484  0x2  0x804   36
Extern   10.0.0.101       10.0.0.6         0x80000015   910  0x2  0xc37b  36
Extern   10.1.13.0        10.0.0.2         0x80000041   333  0x2  0x481e  36
Extern   10.1.15.0        10.0.0.2         0x80000041   332  0x2  0x3232  36
Extern   100.168.64.0     10.0.0.2         0x80000041   182  0x2  0xe0f7  36
```

What It Means Sample output 1 shows an OSPF default route (0.0.0.0/0) with a preference value of 10. In the area 0.0.0.2 link-state database, a Type 3 summary LSA advertises the default route.

Sample output 2 shows an OSPF route with a preference value of 150. In the AS scope link-state database, an external Type 5 LSA indicates that the route from R6 to external router A is through R2, the advertising router. By default, routes resulting from OSPF external LSAs are installed with a preference value of 150.

Sample output 3 shows an OSPF route with a preference value of 10. In the area 0.0.0.0 link-state database, a summary Type 3 LSA indicates that the route from R4 to R6 is through R3, the advertising router.

The LSAs placed into the link-state database are used by the router to run the Dijkstra algorithm (also called the shortest path first algorithm). This computation uses the link-state database as a source, resulting in a loop-free topology using the best metric from the local router to all nodes in the OSPF network.

Step 4: Examine the Forwarding Table

Purpose You can examine the set of routes installed in the forwarding table to verify that the routing protocol process (rpd) has relayed the correct information into the forwarding table.

Action To examine the forwarding table, enter the following CLI commands:

user@host> **show route** *destination-prefix* **extensive**
user@host> **show route forwarding-table destination** *destination-prefix*

Sample Output

```
user@R2> show route 10.0.0.3 extensive

inet.0: 19 destinations, 24 routes (19 active, 0 holddown, 0 hidden)
10.0.0.3/32 (1 entry, 1 announced)
TSI:
KRT in-kernel 10.0.0.3/32 -> {so-0/0/1.0}
        *OSPF   Preference: 10
                Next hop: via so-0/0/1.0, selected
                State: <Active Int>
                Local AS: 65002
                Age: 5d 16:07:37        Metric: 1
                Area: 0.0.0.0
                Task: OSPF
                Announcement bits (2): 0-KRT 4-Resolve inet.0
                AS path: I

user@R2> show route forwarding-table destination 10.0.0.3
Routing table: inet
Internet:
Destination        Type RtRef Next hop           Type Index NhRef Netif
10.0.0.3/32        user     1                    ucst   294     3 so-0/0/1.0
```

What It Means The sample output shows that the same next hop appears in the output for the show route *destination-prefix* extensive and the show route forwarding-table destination *destination-prefix* commands, indicating that the routing protocol process (rpd) is relaying the correct next hop to the forwarding table.

The show route *destination-prefix* extensive command displays very detailed route information about the active entries for the specified address or range of addresses.

The show route forwarding-table destination *destination-prefix* command displays the route entries in the kernel's forwarding table. This is the version of the forwarding table in the Routing Engine. The Routing Engine copies this table to the Packet Forwarding Engine.

NOTE: The show route forwarding-table command is an independent command, not a filter that selects specific information that is displayed from the routing tables. You cannot use this command in conjunction with any of the show route filter options.

For more information about the show route command, see the *JUNOS Routing Protocols and Policies Command Reference.*

Step 5: Examine Link-State Advertisements in Detail

Purpose You can obtain important information about the routers in your network by examining LSAs in detail.

Steps To Take To examine OSPF LSAs, follow these steps:

1. Examine a Type 1 Router LSA on page 152
2. Examine a Type 3 Summary LSA on page 153
3. Examine a Type 4 ASBR Summary LSA on page 154
4. Examine a Type 5 AS External LSA on page 155
5. Examine Type 7 NSSA External LSA on page 156

Examine a Type 1 Router LSA

Action To examine a Type 1 router LSA, enter the following CLI operational mode command:

user@host> **show ospf database router extensive**

Sample Output

```
user@R1> show ospf database router extensive

    OSPF link state database, area 0.0.0.1
 Type       ID               Adv Rtr          Seq      Age  Opt  Cksum  Len
Router  *10.0.0.1        10.0.0.1        0x8000005a  1180  0x0  0x5828  60
  bits 0x2, link count 3
  id 10.0.0.1, data 255.255.255.255, Type Stub (3)
  TOS count 0, TOS 0 metric 0
  id 10.0.0.2, data 10.1.12.1, Type PointToPoint (1)
  TOS count 0, TOS 0 metric 1
  id 10.1.12.0, data 255.255.255.252, Type Stub (3)
  TOS count 0, TOS 0 metric 1
  Gen timer 00:30:19
  Aging timer 00:40:19
  Installed 00:19:40 ago, expires in 00:40:20, sent 00:19:38 ago
  Ours
Router   10.0.0.2        10.0.0.2        0x8000004b   679  0x0  0xe6c0  48
  bits 0x3, link count 2
  id 10.0.0.1, data 10.1.12.2, Type PointToPoint (1)
  TOS count 0, TOS 0 metric 1
  id 10.1.12.0, data 255.255.255.252, Type Stub (3)
  TOS count 0, TOS 0 metric 1
  Aging timer 00:48:40
  Installed 00:11:16 ago, expires in 00:48:41, sent 3w0d 23:33:12 ago
```

What It Means The sample output shows the details of two router LSAs: the first for R1 (*10.0.0.1) and the second for R2 (10.0.0.2). The asterisk (*) indicates that the LSA was generated by R1. You can also determine ownership of the LSA by the last line of the output in this case, ours.

Each time the LSA is updated, the sequence (seq) field increments, indicating that the router has the most recent version of the LSA. Values range from 0x80000001 to 0x7FFFFFFF. If the sequence field is not incrementing, there may be problems with the connection.

The bits field is set to 0x2 in the first LSA and 0x3 in the second LSA. When the bits field is set to 0x2,the originating router (R1) is an ASBR. When the bits field is set to 0x3, the originating router (R2) is both ABR and ASBR.

R1 has three links connected to area 0.0.0.1 shown by the link count field that is set to a value of 3. The Type field shows that R1 has a single point-to-point link to R2 and two links advertised as stub networks.

Each OSPF router generates a single Type 1 LSA to describe the status and cost (metric) of all links on the router. This LSA is flooded to each router in the OSPF area. It is defined as having an area scope, so it is not flooded across an area boundary.

Examine a Type 3 Summary LSA

Action To examine a Type 3 summary LSA, enter the following CLI operational mode command:

```
user@host> show ospf database netsummary extensive
```

Sample Output

```
user@R2> show ospf database netsummary extensive

   OSPF link state database, area 0.0.0.0
 Type       ID               Adv Rtr          Seq      Age  Opt  Cksum  Len
Summary *10.0.0.1        10.0.0.2        0x80000043   529  0x2  0xfd05  28
  mask 255.255.255.255
  TOS 0x0, metric 1
  Gen timer 00:34:13
  Aging timer 00:51:10
  Installed 00:08:49 ago, expires in 00:51:11, sent 00:08:47 ago
  Ours,
[...Output truncated...)
OSPF link state database, area 0.0.0.1
[...Output truncated...]
Summary *10.0.0.5        10.0.0.2        0x80000047  2198  0x0  0xf506  28
  mask 255.255.255.255
  TOS 0x0, metric 2
  Gen timer 00:07:19
  Aging timer 00:23:22
  Installed 00:36:38 ago, expires in 00:23:22, sent 00:36:36 ago
  Ours,
```

What It Means The sample output shows that R2 is an ABR because it contains two databases: one for the backbone area 0.0.0.0 and one for area 0.0.0.1. Within the backbone area, the summary LSA *10.0.0.1 is generated from R2 as indicated by the asterisk (*) next to the link-state ID field, and ours in the last line of the LSA. The cost to transmit data out of the interface is 1, as indicated by the metric field.

Within area 0.0.0.1, the summary LSA *10.0.0.5 is generated by R2 and has a metric of 2, which is the cost to R5 from R2. Before calculating the SPF algorithm, the local router (R2) must add an additional metric of 1 to the existing metric of 1. The additional metric of 1 must be added because there is another router between R2 and R5 (R4).

Each time the LSA is updated, the sequence (seq) field increments, indicating that the router has the most recent version of the LSA. Values range from 0x80000001 to 0x7FFFFFFF. If the sequence field is not incrementing, there may be problems with the connection.

Examine a Type 4 ASBR Summary LSA

Action To examine a Type 4 ASBR summary LSA, enter the following CLI operational mode command:

user@host> **show ospf database asbrsummary extensive**

Sample Output

```
user@R3> show ospf database asbrsummary extensive

    OSPF link state database, area 0.0.0.0
[...Output truncated...]
ASBRSum *10.0.0.6        10.0.0.3        0x80000042  1023  0x2  0xb943  28
  mask 0.0.0.0
  TOS 0x0, metric 1
  Gen timer 00:27:57
  Aging timer 00:42:57
  Installed 00:17:03 ago, expires in 00:42:57, sent 00:17:01 ago
  Ours,
[...Output truncated...]
```

What It Means The sample output shows that an LSA within the backbone area, *10.0.0.6, is generated by ASBR R3, as indicated by the asterisk (*) next to the link-state ID field and ours in the last line of the LSA.

Each time the LSA is updated, the sequence (seq) field increments, indicating that the router has the most recent version of the LSA. Values range from 0x80000001 to 0x7FFFFFFF. If the sequence field is not incrementing, there may be problems with the connection.

Because the router ID of all the ASBR summary LSAs is a full 32-bit value, the network mask is not needed and is set to a value of 0.0.0.0. The metric for the LSA within the backbone area is set to 1, which is the cost to the advertising router (R3) from the originating router (R6). The metric is calculated before the SPF algorithm is calculated.

In general, each ABR that must transmit information about an ASBR from one OSPF area into another generates a Type 4 LSA. This LSA is flooded to each router in the OSPF area. A Type 4 LSA is defined as having an area scope so that another ABR does not reflood it across the area boundary.

Examine a Type 5 AS External LSA

Action To examine a Type 5 AS external LSA, enter the following CLI operational mode command:

user@host> **show ospf database extern extensive**

Sample Output

```
user@R2> show ospf database extern extensive
    OSPF AS SCOPE link state database
 Type       ID               Adv Rtr           Seq      Age  Opt  Cksum  Len
Extern  *10.0.0.100      10.0.0.2        0x80000047  1377  0x2  0xfd09  36
  mask 255.255.255.255
  Type 2, TOS 0x0, metric 0, fwd addr 10.0.0.1, tag 0.0.0.0
  Gen timer 00:21:02
  Aging timer 00:37:02
  Installed 00:22:57 ago, expires in 00:37:03, sent 00:22:55 ago
  Ours,
[...Output truncated...]
```

What It Means The sample output shows one Type 5 external LSA, *10.0.0.100. The status of the router represented by this LSA is indicated by the fwd addr field, which shows that it does not belong to any particular OSPF area. The forwarding address provides the address toward which packets should be sent to reach the external router (10.0.0.1). R1 is the ASBR with the connection to external router A.

The mask field represents the subnet mask associated with the advertised router. It is used with the link-state ID field (10.0.0.100), which encapsulates the network address in a Type 5 LSA. This LSA has a metric value of 0, the default value, indicating that this is a Type 2 external metric. Thus, any local router should use the default metric (0) when performing an SPF algorithm.

Each time the LSA is updated, the sequence (seq) field increments, indicating that the router has the most recent version of the LSA. Values range from 0x80000001 to 0x7FFFFFFF. If the sequence field is not incrementing, there may be problems with the connection.

In general, each ASBR generates a Type 5 LSA to advertise any routers external to the OSPF AS. This LSA is flooded to each non-stub router in the entire AS.

Examine Type 7 NSSA External LSA

Action To examine a Type 7 NSSA external LSA, enter the following CLI operational mode command:

user@host> **show ospf database nssa extensive**

Sample Output

```
user@R1> show ospf database nssa extensive

    OSPF link state database, area 0.0.0.1
 Type       ID               Adv Rtr          Seq      Age  Opt  Cksum  Len
[...Output truncated...]
NSSA    *10.0.0.100      10.0.0.1        0x8000003b   843  0x8  0xa566  36
  mask 255.255.255.255
  Type 2, TOS 0x0, metric 0, fwd addr 10.0.0.1, tag 0.0.0.0
  Gen timer 00:35:56
  Aging timer 00:45:56
  Installed 00:14:03 ago, expires in 00:45:57, sent 00:14:01 ago
  Ours
```

What It Means The sample output shows that the LSA belongs to a single NSSA, 0.0.0.1, and was generated by R1. This router has a metric value of 0, which is the default, and is listed as a Type 2 external metric. Any local router must use the default metric as the total cost for the route when performing an SPF calculation. The default metric of the route must be added to the cost to reach the advertising ASBR. This value then represents the total cost for the route.

In general, each ASBR within the NSSA generates a Type 7 LSA to advertise any routers external to the OSPF AS. This LSA is flooded to each router within the NSSA (R2). Because the LSA has only an area flooding scope, it is not sent into other adjacent areas. For each Type 7 LSA received, the ABR (R2) translates the information into a Type 5 LSA and sends the information into the backbone. The other backbone routers do not know that the original information came from an NSSA. The Type 5 LSA is then flooded to each non-stub router in the entire AS.