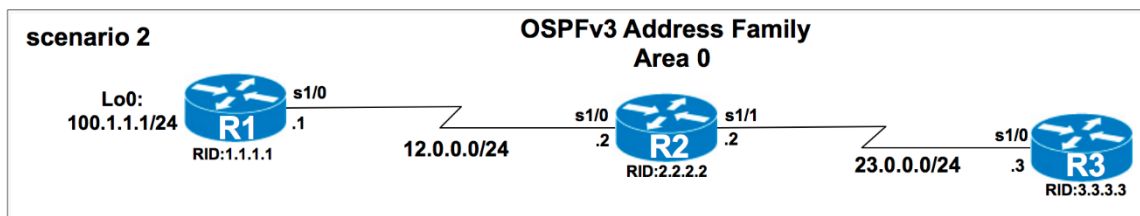
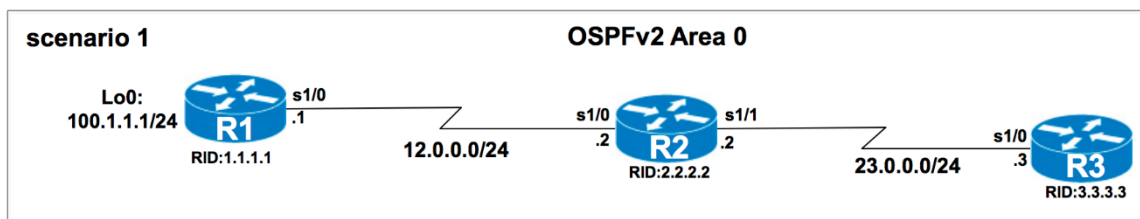


OSPFv2 Versus OSPFv3

Type-9 LSA SPF Optimization In Depth Lecture



Redouane MEDDANE

Basic configuration of all routers:

Scenario 1

R1:

```
interface Serial1/0
 ip address 12.0.0.1 255.255.255.0
 ip ospf 1 area 0
 no shut
!
interface Loopback0
 ip address 100.1.1.1 255.255.255.0
 ip ospf 1 area 0
 no shut
!
router ospf 1
 router-id 1.1.1.1
```

R2:

```
interface Serial1/0
 ip address 12.0.0.2 255.255.255.0
 ip ospf 1 area 0
 no shut
!
interface Serial1/1
 ip address 23.0.0.2 255.255.255.0
 ip ospf 1 area 0
 no shut
!
router ospf 1
 router-id 2.2.2.2
```

R3:

```
interface Serial1/0
 ip address 23.0.0.3 255.255.255.0
 ip ospf 1 area 0
 no shut
!
router ospf 1
 router-id 3.3.3.3
```

Scenario 2

R1:

```
ipv6 unicast-routing
!
interface Loopback0
 ip address 100.1.1.1 255.255.255.0
 ipv6 enable
 ospfv3 1 ipv4 area 0
!
interface Serial1/0
 ip address 12.0.0.1 255.255.255.0
```

```
ipv6 enable
ospfv3 1 ipv4 area 0
no shutdown
!
router ospfv3 1
!
address-family ipv4 unicast
router-id 1.1.1.1
exit-address-family
```

R2:

```
ipv6 unicast-routing
!
interface Serial1/0
ip address 12.0.0.2 255.255.255.0
ipv6 enable
ospfv3 1 ipv4 area 0
!
interface Serial1/1
ip address 23.0.0.2 255.255.255.0
ipv6 enable
ospfv3 1 ipv4 area 0
no shutdown
!
router ospfv3 1
!
address-family ipv4 unicast
router-id 2.2.2.2
exit-address-family
```

R3:

```
ipv6 unicast-routing
!
interface Serial1/0
ip address 23.0.0.3 255.255.255.0
ipv6 enable
ospfv3 1 ipv4 area 0
no shutdown
!
router ospfv3 1
!
address-family ipv4 unicast
router-id 3.3.3.3
exit-address-family
```

In OSPFv3 the LSA Type 9 has an impact to save CPU utilization by avoiding a frequent triggering of SPF when running OSPFv3, to see the important role of this LSA Type 9, i I did two scenarios:

1-The first scenario with OSPFv2, I investigate and compare the LS age and Sequence Number of the LSA Type 1 of R1, and the Number of SPF algorithm executed before and after adding a new ip address on R1.

2-The second scenario with OSPFv3, I investigate and compare the LS age and Sequence Number of the LSA Type 1 's R1 and the LSA Type 9 's R1, and the Number of SPF algorithm executed before and after adding a new ip address on R1.

Case 1 OSPFv2:

R1, R2 and R3 are running OSPFv2 in Area 0:

Let's verify the LSDB of each router, in OSPFv2 all routers in an area need to have identical LSDB databases, we can see that below R1, R2 and R3 located in the same Area 0, they have the same LSDB as shown by the show ip ospf database commands:

```
R1#show ip ospf database

      OSPF Router with ID (1.1.1.1) (Process ID 1)

      Router Link States (Area 0)

Link ID      ADV Router    Age           Seq#          Checksum Link count
1.1.1.1      1.1.1.1      205          0x80000004   0x00AFC8 2
2.2.2.2      2.2.2.2      156          0x80000003   0x007029 4
3.3.3.3      3.3.3.3      159          0x80000001   0x0084CE 2
R1#
```

```
R2#show ip ospf database

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

      Router Link States (Area 0)

Link ID      ADV Router    Age           Seq#          Checksum Link count
1.1.1.1      1.1.1.1      267          0x80000004   0x00AFC8 2
2.2.2.2      2.2.2.2      216          0x80000003   0x007029 4
3.3.3.3      3.3.3.3      219          0x80000001   0x0084CE 2
R2#
```

```
R3#show ip ospf database

      OSPF Router with ID (3.3.3.3) (Process ID 1)

      Router Link States (Area 0)

Link ID      ADV Router    Age           Seq#          Checksum Link count
1.1.1.1      1.1.1.1      95           0x80000004   0x00AFC8 2
2.2.2.2      2.2.2.2      46           0x80000003   0x007029 4
3.3.3.3      3.3.3.3      46           0x80000001   0x0084CE 2
R3#
```

Let's verify the LSA Type 1 advertised by R1 to R3, the LSA Type 1 shown two important fields : the LSA's age and the LSA sequence number, recall that by default OSPF does reflood each LSA every 30 minutes based on each LSA's age variable. The router that creates the LSA sets this age to 0 (seconds). Each router then increments the age of its copy of each LSA over time. If 30 minutes pass with no changes to an LSA, the owning router increments the sequence number, resets the timer to 0, and refloods the LSA. The output of various show ip ospf database commands should also show an age of less than 1800 seconds. For example, focusing on the LSA Type 1 of R1, the Type 1 LSA for R1 (RID 1.1.1.1) shows an age of 347 seconds and a sequence number of 0x80000004:

Also with OSPFv2 for each interface on which no DR has been elected like the serial interfaces used in this topology, the LSA Type 1 lists the router's interface subnet number/mask and interface OSPF cost and it refers to these subnets as stub networks. In the LSA Type 1 created by R1 and received by R3, R1 includes the Prefix and the Mask of its serial interface s1/0 12.0.0.0/24:

```
R3#show ip ospf database router adv-router 1.1.1.1
```

```

OSPF Router with ID (3.3.3.3) (Process ID 1)

Router Link States (Area 0)

LS age: 347
Options: (No TOS-capability, DC)
LS Type: Router Links
Link State ID: 1.1.1.1
Advertising Router: 1.1.1.1
LS Seq Number: 80000004
Checksum: 0xAFC8
Length: 48
Number of Links: 2

Link connected to: another Router (point-to-point)
(Link ID) Neighboring Router ID: 2.2.2.2
(Link Data) Router Interface address: 12.0.0.1
Number of MTID metrics: 0
TOS 0 Metrics: 64

Link connected to: a Stub Network
(Link ID) Network/subnet number: 12.0.0.0
(Link Data) Network Mask: 255.255.255.0
Number of MTID metrics: 0
TOS 0 Metrics: 64

R3#

```

We can see below

SPF must execute when the intra-area topology changes, only changes to Type 1 and 2 LSAs require an SPF calculation. Take a look R3' and R1's current execution count of SPF, it is equal to 1 from the output of R3 and equal to 5 from the output of R1 as shown by the show ip ospf statistics:

```

R3#show ip ospf statistics

OSPF Router with ID (3.3.3.3) (Process ID 1)

Area 0: SPF algorithm executed 1 times

Summary OSPF SPF statistic

SPF calculation time
Delta T   Intra D-Intra Summ   D-Summ Ext   D-Ext Total Reason
00:07:02  4     4     0     0     0     0     8     R

R3#

```

```

R1#show ip ospf statistics

OSPF Router with ID (1.1.1.1) (Process ID 1)

Area 0: SPF algorithm executed 5 times

Summary OSPF SPF statistic

SPF calculation time
Delta T   Intra D-Intra Summ   D-Summ Ext   D-Ext Total Reason

```

```

00:10:25 4 0 0 0 0 0 4 R
00:10:05 0 0 0 0 0 0 0 R
00:09:01 0 0 0 0 0 0 0 R
00:08:46 0 0 0 0 0 0 0 R
00:08:01 4 0 4 0 0 0 8 R

```

R1#

On R1 we will add address to the loopback0 interface. This would cause SPF to run in OSPFv2:

```

R1(config)#int lo0
R1(config-if)#ip add 100.1.1.1 255.255.255.0
R1(config-if)#ip ospf 1 area 0

```

Let's verify the LSA Type 1 of R1, there is the new prefix we add, LSA age 21 is lower than the LSA age seen earlier 347 and the Sequence Number is incremented 80000005 (80000005+1) so this is a new one.

```

R3#show ip ospf database router adv-router 1.1.1.1

        OSPF Router with ID (3.3.3.3) (Process ID 1)

        Router Link States (Area 0)

LS age: 21
Options: (No TOS-capability, DC)
LS Type: Router Links
Link State ID: 1.1.1.1
Advertising Router: 1.1.1.1
LS Seq Number: 80000005
Checksum: 0x9E61
Length: 60
Number of Links: 3

Link connected to: a Stub Network
(Link ID) Network/subnet number: 100.1.1.0
(Link Data) Network Mask: 255.255.255.0
Number of MTID metrics: 0
TOS 0 Metrics: 1

Link connected to: another Router (point-to-point)
(Link ID) Neighboring Router ID: 2.2.2.2
(Link Data) Router Interface address: 12.0.0.1
Number of MTID metrics: 0
TOS 0 Metrics: 64

Link connected to: a Stub Network
(Link ID) Network/subnet number: 12.0.0.0
(Link Data) Network Mask: 255.255.255.0
Number of MTID metrics: 0
TOS 0 Metrics: 64

```

R3#

Take a look R3' and R1's current execution count of SPF, now it is equal to 2, because a change occurred in area 0, R1 originates a new LSA Type 1, then R1 and R3 trigger the SPF algorithm to calculate the new intra-area route toward 100.1.1.0/24 prefix, this is why we see

execution count of SPF equal to 2 from the output of R3 and equal to 6 from the output of R1 as shown by the show ip ospf statistics commands below:

```
R3#show ip ospf statistics
```

```
OSPF Router with ID (3.3.3.3) (Process ID 1)
```

```
Area 0: SPF algorithm executed 2 times
```

```
Summary OSPF SPF statistic
```

```
SPF calculation time
```

| Delta T | Intra | D-Intra | Summ | D-Summ | Ext | D-Ext | Total | Reason |
|----------|-------|---------|------|--------|-----|-------|-------|--------|
| 00:10:47 | 4 | 4 | 0 | 0 | 0 | 0 | 8 | R |
| 00:01:50 | 4 | 0 | 0 | 0 | 0 | 0 | 4 | R |

```
R3#
```

```
R1#show ip ospf statistics
```

```
OSPF Router with ID (1.1.1.1) (Process ID 1)
```

```
Area 0: SPF algorithm executed 6 times
```

```
Summary OSPF SPF statistic
```

```
SPF calculation time
```

| Delta T | Intra | D-Intra | Summ | D-Summ | Ext | D-Ext | Total | Reason |
|----------|-------|---------|------|--------|-----|-------|-------|--------|
| 00:15:16 | 4 | 0 | 0 | 0 | 0 | 0 | 4 | R |
| 00:14:56 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R |
| 00:13:52 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R |
| 00:13:37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | R |
| 00:12:52 | 4 | 0 | 4 | 0 | 0 | 0 | 8 | R |
| 00:03:52 | 4 | 0 | 0 | 0 | 0 | 0 | 4 | R |

```
R1#
```

Case 2 OSPFv3:

Remove OSPFv2 configured previously and configure OSPFv3 Address Family IPv4.

```
R1(config)#ipv unicast-routing
R1(config)#router ospfv3 1
R1(config-router)#address-family ipv4 unicast
R1(config-router-af)#router-id 1.1.1.1
R2(config-router-af)#exit-address-family
R2(config-router)#exit
R1(config)#int s1/0
R1(config-if)#ipv6 enable
R1(config-if)#ospfv3 1 ipv4 area 0
```

```
R2(config)#ipv uni
R2(config)#router ospfv3 1
R2(config-router)#address-family ipv4 unicast
R2(config-router-af)#router-id 2.2.2.2
R2(config-router-af)#exit-address-family
R2(config-router)#exit
R2(config)#int s1/0
```

```

R2(config-if)#ipv6 enable
R2(config-if)#ospfv3 1 ipv4 area 0
R2(config)#int s1/1
R2(config-if)#ipv6 enable
R2(config-if)#ospfv3 1 ipv4 area 0

```

```

R3(config)#ipv uni
R3(config)#router ospfv3 1
R3(config-router)#address-family ipv4 unicast
R3(config-router-af)#router-id 3.3.3.3
R3(config-router-af)#exit-address-family
R3(config-router)#exit
R3(config)#int s1/0
R3(config-if)#ipv6 enable
R3(config-if)#ospfv3 1 ipv4 area 0

```

Let's verify the LSDB of each router using the show ospfv3 database, we can see that unlike with OSPFv2 where all routers in the same area have the same LSDB, in OSPFv3 this is not the case, There are still LSAs Type 1, but also LSAs Type 8 and LSA Type 9. In OSPFv2, the LSA Type 1 would be originated by each router in the area and would contain it's router-id, links, and IPs associated with those links. OSPFv3 removes the IP addressing from the LSA Type 1 as it's now there to show the router-id and links it's connected to: as each router will have different link LSAs Type 8. This LSA has link-only flooding scope and so is never flooded past the link in question, the show ospfv3 database output of R3 shown that there is no LSA Type 8 with RID 1.1.1.1 received, R3 has only its own LSA Type 3 which lists the ip address of the s1/0 interface as shown by the show ospfv3 database link adv-router self-originate and the LSA Type 8 originated by R2 listing the ip address of s1/1's R2 as shown by the show ospfv3 database link adv-router 2.2.2.2 command:

```
R1#show ospfv3 database
```

```
    OSPFv3 1 address-family ipv4 (router-id 1.1.1.1)
```

```
        Router Link States (Area 0)
```

| ADV Router | Age | Seq# | Fragment ID | Link count | Bits |
|------------|-----|------------|-------------|------------|------|
| 1.1.1.1 | 108 | 0x80000002 | 0 | 1 | None |
| 2.2.2.2 | 33 | 0x80000002 | 0 | 2 | None |
| 3.3.3.3 | 34 | 0x80000001 | 0 | 1 | None |

```
        Link (Type-8) Link States (Area 0)
```

| ADV Router | Age | Seq# | Link ID | Interface |
|------------|-----|------------|---------|-----------|
| 1.1.1.1 | 163 | 0x80000001 | 4 | Se1/0 |
| 2.2.2.2 | 109 | 0x80000001 | 4 | Se1/0 |

```
        Intra Area Prefix Link States (Area 0)
```

| ADV Router | Age | Seq# | Link ID | Ref-lstype | Ref-LSID |
|------------|-----|------------|---------|------------|----------|
| 1.1.1.1 | 163 | 0x80000001 | 0 | 0x2001 | 0 |
| 2.2.2.2 | 86 | 0x80000002 | 0 | 0x2001 | 0 |
| 3.3.3.3 | 34 | 0x80000001 | 0 | 0x2001 | 0 |

```
R1#
```

```
R2#show ospfv3 database
```

```
    OSPFv3 1 address-family ipv4 (router-id 2.2.2.2)
```

```
        Router Link States (Area 0)
```


| ADV Router | Age | Seq# | Fragment ID | Link count | Bits |
|------------|-----|------------|-------------|------------|------|
| 1.1.1.1 | 198 | 0x80000002 | 0 | 1 | None |
| 2.2.2.2 | 121 | 0x80000002 | 0 | 2 | None |
| 3.3.3.3 | 122 | 0x80000001 | 0 | 1 | None |

Link (Type-8) Link States (Area 0)

| ADV Router | Age | Seq# | Link ID | Interface |
|------------|-----|------------|---------|-----------|
| 2.2.2.2 | 174 | 0x80000001 | 5 | Se1/1 |
| 3.3.3.3 | 123 | 0x80000001 | 4 | Se1/1 |
| 1.1.1.1 | 253 | 0x80000001 | 4 | Se1/0 |
| 2.2.2.2 | 198 | 0x80000001 | 4 | Se1/0 |

Intra Area Prefix Link States (Area 0)

| ADV Router | Age | Seq# | Link ID | Ref-lstype | Ref-LSID |
|------------|-----|------------|---------|------------|----------|
| 1.1.1.1 | 253 | 0x80000001 | 0 | 0x2001 | 0 |
| 2.2.2.2 | 174 | 0x80000002 | 0 | 0x2001 | 0 |
| 3.3.3.3 | 123 | 0x80000001 | 0 | 0x2001 | 0 |

R2#

R3#show ospfv3 database

OSPFv3 1 address-family ipv4 (router-id 3.3.3.3)

Router Link States (Area 0)

| ADV Router | Age | Seq# | Fragment ID | Link count | Bits |
|------------|-----|------------|-------------|------------|------|
| 1.1.1.1 | 274 | 0x80000002 | 0 | 1 | None |
| 2.2.2.2 | 198 | 0x80000002 | 0 | 2 | None |
| 3.3.3.3 | 197 | 0x80000001 | 0 | 1 | None |

Link (Type-8) Link States (Area 0)

| ADV Router | Age | Seq# | Link ID | Interface |
|------------|-----|------------|---------|-----------|
| 2.2.2.2 | 250 | 0x80000001 | 5 | Se1/0 |
| 3.3.3.3 | 198 | 0x80000001 | 4 | Se1/0 |

Intra Area Prefix Link States (Area 0)

| ADV Router | Age | Seq# | Link ID | Ref-lstype | Ref-LSID |
|------------|-----|------------|---------|------------|----------|
| 1.1.1.1 | 329 | 0x80000001 | 0 | 0x2001 | 0 |
| 2.2.2.2 | 250 | 0x80000002 | 0 | 0x2001 | 0 |
| 3.3.3.3 | 198 | 0x80000001 | 0 | 0x2001 | 0 |

R3#

R3#show ospfv3 database link self-originate

OSPFv3 1 address-family ipv4 (router-id 3.3.3.3)

Link (Type-8) Link States (Area 0)

LS age: 18
Options: (E-Bit, R-bit, DC-Bit, AF-Bit)
LS Type: Link-LSA (Interface: Serial1/0)
Link State ID: 4 (Interface ID)
Advertising Router: 3.3.3.3
LS Seq Number: 80000003

```
Checksum: 0x525F
Length: 52
Router Priority: 1
Link Local Address: 23.0.0.3
Number of Prefixes: 1
Prefix Address: 23.0.0.0
Prefix Length: 24, Options: None
```

R3#

```
R3#show ospfv3 database link adv-router 2.2.2.2
```

```
OSPFv3 1 address-family ipv4 (router-id 3.3.3.3)
```

```
Link (Type-8) Link States (Area 0)
```

```
LS age: 108
Options: (E-Bit, R-bit, DC-Bit, AF-Bit)
LS Type: Link-LSA (Interface: Serial1/0)
Link State ID: 5 (Interface ID)
Advertising Router: 2.2.2.2
LS Seq Number: 80000003
Checksum: 0x5C59
Length: 52
Router Priority: 1
Link Local Address: 23.0.0.2
Number of Prefixes: 1
Prefix Address: 23.0.0.0
Prefix Length: 24, Options: None
```

R3#

```
R3#show ospfv3 database link adv-router 1.1.1.1
```

```
OSPFv3 1 address-family ipv4 (router-id 3.3.3.3)
```

```
Link (Type-8) Link States (Area 0)
```

R3#

Now let's verify the LSA Type 1 originated by R1, we can see that this LSA Type 1 does not contain the p2p IP address 12.0.0.0/24. It's simply a link topology LSA. 2.2.2.2 is simply the neighbours router-id, notice the LS age 344 and Sequence Number 80000002:

```
R3#show ospfv3 database router adv-router 1.1.1.1
```

```
OSPFv3 1 address-family ipv4 (router-id 3.3.3.3)
```

```
Router Link States (Area 0)
```

```
LS age: 344
Options: (E-Bit, R-bit, DC-Bit, AF-Bit)
LS Type: Router Links
Link State ID: 0
Advertising Router: 1.1.1.1
LS Seq Number: 80000002
Checksum: 0x9C0F
Length: 40
```

```
Number of Links: 1
```

```
Link connected to: another Router (point-to-point)
Link Metric: 64
Local Interface ID: 4
Neighbor Interface ID: 4
Neighbor Router ID: 2.2.2.2
```

```
R3#
```

The information of the ip address subnet 12.0.0.0/24 in this topology is contained in the LSA Type 9 originated by R1. The intra-area prefix LSA as shown by the show ospfv3 database prefix adv-router 1.1.1.1 command, notice the LS age 547 and the Sequence Number 80000001:

```
R3#show ospfv3 database prefix adv-router 1.1.1.1
```

```
OSPFv3 1 address-family ipv4 (router-id 3.3.3.3)
```

```
Intra Area Prefix Link States (Area 0)
```

```
Routing Bit Set on this LSA
```

```
LS age: 547
```

```
LS Type: Intra-Area-Prefix-LSA
```

```
Link State ID: 0
```

```
Advertising Router: 1.1.1.1
```

```
LS Seq Number: 80000001
```

```
Checksum: 0xFCA1
```

```
Length: 40
```

```
Referenced LSA Type: 2001
```

```
Referenced Link State ID: 0
```

```
Referenced Advertising Router: 1.1.1.1
```

```
Number of Prefixes: 1
```

```
Prefix Address: 12.0.0.0
```

```
Prefix Length: 24, Options: None, Metric: 64
```

```
R3#
```

Let's Take a look R3' and R1's current execution count of SPF, it is equal to 1 from the output of R3 and equal to 3 from the output of R1 as shown by the show ospfv3 statistic commands:

```
R3#show ospfv3 statistic
```

```
OSPFv3 1 address-family ipv4 (router-id 3.3.3.3)
```

```
Area 0: SPF algorithm executed 1 times
```

```
SPF calculation time
```

| Delta T | SPT | Prefix | D-Int | Sum | D-Sum | Ext | D-Ext | Total | Reason |
|----------|-----|--------|-------|-----|-------|-----|-------|-------|--------|
| 00:08:24 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 4 | R L P |

```
R3#
```

```
R1#show ospfv3 statistic
```

```
OSPFv3 1 address-family ipv4 (router-id 1.1.1.1)
```

```
Area 0: SPF algorithm executed 3 times
```

```

SPF calculation time
Delta T   SPT   Prefix D-Int  Sum    D-Sum  Ext    D-Ext  Total Reason
00:11:20  0     0     0     0     0     0     0     4     R L P
00:10:25  0     0     0     0     0     0     0     0     R L P
00:10:01  0     4     0     0     0     0     0     4     P
00:09:09  0     0     0     0     0     0     0     4     R P

```

R1#

On R1 we will enable OSPFv3 on the loopback0 interface:

```

R1(config)#int lo0
R1(config-if)#ospfv3 network point-to-point
R1(config-if)#ipv6 enable
R1(config-if)#ospfv3 1 ipv4 area 0

```

Recall that in OSPFv2 if a router originated a new LSA Type 1 (or new LSA Type 2), it would cause all routers in the area to run SPF. If we changed the IP address of any OSPF link, that would cause SPF to run. If we added a secondary address to an OSPF link, SPF would run. In OSPFv3 the adding or changing of addresses does not cause the router to originate a LSA Type 1. This means that addresses being changed will not cause SPF to run.

Take a look at R3's current execution count and R1's current execution count, what do R1 and R3 see?

No increase, the number of SPF executed is not increased as shown by the show show ospfv3 statistic command:

```

R3#show ospfv3 statistic

      OSPFv3 1 address-family ipv4 (router-id 3.3.3.3)

```

Area 0: SPF algorithm executed 1 times

```

SPF calculation time
Delta T   SPT   Prefix D-Int  Sum    D-Sum  Ext    D-Ext  Total Reason
00:13:25  0     4     0     0     0     0     0     4     R L P
00:03:00  0     4     0     0     0     0     0     4     P

```

R3#

```

R1#show ospfv3 statistic

      OSPFv3 1 address-family ipv4 (router-id 1.1.1.1)

```

Area 0: SPF algorithm executed 4 times

```

SPF calculation time
Delta T   SPT   Prefix D-Int  Sum    D-Sum  Ext    D-Ext  Total Reason
00:16:48  0     0     0     0     0     0     0     4     R L P
00:15:53  0     0     0     0     0     0     0     0     R L P
00:15:29  0     4     0     0     0     0     0     4     P
00:14:37  0     0     0     0     0     0     0     4     R P
00:04:13  0     4     0     0     0     0     0     4     L P

```

R1#

Let's verify the LSA Type 1 created by R1, there are no prefixes carried in this LSA, notice the LS age is 721 and Sequence Number 80000002 is the same, the LSA age 721 is higher than the

LS age 344 seen in the LSA Type 1 earlier and the Sequence Number is the same with the Sequence number seen in the LSA Type 1 seen earlier, before adding the Loopback0 in OSPFv3 domain, thus even though we just added a new ip address. no new LSA Type 1:

```
R3#show ospfv3 database router adv-router 1.1.1.1

      OSPFv3 1 address-family ipv4 (router-id 3.3.3.3)

      Router Link States (Area 0)

      LS age: 721
      Options: (E-Bit, R-bit, DC-Bit, AF-Bit)
      LS Type: Router Links
      Link State ID: 0
      Advertising Router: 1.1.1.1
      LS Seq Number: 80000002
      Checksum: 0x9C0F
      Length: 40
      Number of Links: 1

      Link connected to: another Router (point-to-point)
      Link Metric: 64
      Local Interface ID: 4
      Neighbor Interface ID: 4
      Neighbor Router ID: 2.2.2.2

R3#
```

The LSA Type 9 originated by R1 contains two prefixes: 12.0.0.0/24 and the new one added 100.1.1.0/24 . Also notice the LSA can contain more than one prefix at a time. Much like a Router LSA Type 1 in OSPFv2.

If we look at the LSA age 81 and the Sequence Number 80000002, we can see that the LSA age is lower than the LSA age 547 seen previously and the Sequence Number is incremented by 1 (80000001+1) so this is a new one LSA Type 9. R3 already has the existing LSA Type 1 so it knows about router-id 1.1.1.1 by looking at the Referenced Advertising Router: 1.1.1.1 field. It can therefore now work out the route to the new prefix with this LSA Type 9, It does not need to run SPF again as it has already run SPF on that LSA Type 1. R1 therefore has an intra-area route to 100.1.1.0/24 prefix:

```
R3#show ospfv3 database prefix adv-router 1.1.1.1

      OSPFv3 1 address-family ipv4 (router-id 3.3.3.3)

      Intra Area Prefix Link States (Area 0)

      Routing Bit Set on this LSA
      LS age: 81
      LS Type: Intra-Area-Prefix-LSA
      Link State ID: 0
      Advertising Router: 1.1.1.1
      LS Seq Number: 80000002
      Checksum: 0x4ACA
      Length: 48
      Referenced LSA Type: 2001
      Referenced Link State ID: 0
      Referenced Advertising Router: 1.1.1.1
      Number of Prefixes: 2
      Prefix Address: 100.1.1.0
```

```
Prefix Length: 24, Options: None, Metric: 1  
Prefix Address: 12.0.0.0  
Prefix Length: 24, Options: None, Metric: 64
```

```
R3#
```

```
R3#show ip route 100.0.0.0  
Routing entry for 100.0.0.0/24, 1 known subnets  
0 100.1.1.0 [110/129] via 23.0.0.2, 00:00:28, Serial1/0  
R3#
```