



OSPF for IPv6

ISP/IXP Workshops

OSPFv2

- **April 1998 was the most recent revision (RFC 2328)**
- **OSPF uses a 2-level hierarchical model**
- **SPF calculation is performed independently for each area**
- **Typically faster convergence than DVRPs**
- **Relatively low, steady state bandwidth requirements**

OSPFv3 overview

- **OSPF for IPv6**
- **Based on OSPFv2, with enhancements**
- **Distributes IPv6 prefixes**
- **Runs directly over IPv6**
- **Ships-in-the-night with OSPFv2**

OSPFv3 / OSPFv2 Similarities

- **Basic packet types**
Hello, DBD, LSR, LSU, LSA
- **Mechanisms for neighbor discovery and adjacency formation**
- **Interface types**
P2P, P2MP, Broadcast, NBMA, Virtual
- **LSA flooding and aging**
- **Nearly identical LSA types**

V2, V3 Differences

OSPFv3 Is Running per Link Instead of per IP Subnet

- **A link by definition is a medium over which two nodes can communicate at link layer**
- **In IPv6 multiple IP subnet can be assigned to a link and two nodes in different subnet can communicate at link layer therefore OSPFv3 is running per link instead of per IP subnet**
- **An Interface connect to a link and multiple interface can be connected to a link**

V2, V3 Differences (Cont.)

Support of Multiple Instance per Link

- **New field (instance) in OSPF packet header allow running multiple instance per link**
- **Instance ID should match before packet being accepted**
- **Useful for traffic separation, multiple areas per link and AF (see later)**

V2, V3 Differences (Cont.)

Address Semantic Change in LSA

- **Router and Network LSA carry only topology information**
- **Router LSA can be split across multiple LSAs; Link State ID in LSA header is a fragment ID**
- **Intra area prefix are carried in a new LSA payload called intra-area-prefix-LSAs**
- **Prefix are carried in payload of inter-area and external LSA**

V2, V3 Differences (Cont.)

Generalization of Flooding Scope

- In OSPFv3 there are three flooding scope for LSAs (link-local scope, area scope, AS scope) and they are coded in LS type explicitly
- In OSPFv2 initially only area and AS wide flooding was defined; later opaque LSAs introduced link local scope as well

V2, V3 Differences (Cont.)

Explicit Handling of Unknown LSA

- **The handling of unknown LSA is coded via U-bit in LS type**
- **When U bit is set, the LSA is flooded with the corresponding flooding scope, as if it was understood**
- **When U bit is clear, the LSA is flooded with link local scope**
- **In v2 unknown LSA were discarded**

V2, V3 Differences (Cont.)

Authentication Is Removed from OSPF

- **Authentication in OSPFv3 has been removed and OSPFv3 relies now on IPv6 authentication header since OSPFv3 run over IPv6**
- **Autype and Authentication field in the OSPF packet header therefore have been suppressed**

V2, V3 Differences (Cont.)

OSPF Packet format has been changed

- **The mask field has been removed from Hello packet**
- **IPv6 prefix are only present in payload of Link State update packet**

V2, V3 Differences (Cont.)

Two New LSAs Have Been Introduced

- **Link-LSA** has a link local flooding scope and has three purposes
- **Intra-area-prefix-LSA** to advertise router's IPv6 address within the area

Link LSA

- **A link LSA per link**
- **Link local scope flooding on the link with which they are associated**
- **Provide router link local address**
- **List all IPv6 prefixes attached to the link**
- **Assert a collection of option bit for the Router-LSA**

Inter-Area Prefix LSA

- **Describes the destination outside the area but still in the AS**
- **Summary is created for one area, which is flooded out in all other areas**
- **Originated by an ABR**
- **Only intra-area routes are advertised into the backbone**
- **Link State ID simply serves to distinguish inter-area-prefix-LSAs originated by the same router**
- **Link-local addresses must never be advertised in inter-area- prefix-LSAs**

LSA Types

	LSA Function Code	LSA Type
Router-LSA	1	0x2001
Network-LSA	2	0x2002
Inter-Area-Prefix-LSA	3	0x2003
Inter-Area-Router-LSA	4	0x2004
AS-External-LSA	5	0x4005
Group-membership-LSA	6	0x2006
Type-7-LSA	7	0x2007
Link-LSA	8	0x2008
Intra-Area-Prefix-LSA NEW	9	0x2009

Configuring OSPFv3 in Cisco IOS® Software

- **Similar to OSPFv2**

 - **Prefixing existing Interface and Exec mode commands with “ipv6”**

- **Interfaces configured directly**

 - **Replaces network command**

- **“Native” IPv6 router mode**

 - **Not a sub-mode of `router ospf`**

Configuration modes in OSPFv3

- **Entering router mode**

```
[no] ipv6 router ospf <process ID>
```

- **Entering interface mode**

```
[no] ipv6 ospf <process ID> area <area ID>
```

- **Exec mode**

```
show ipv6 ospf [<process ID>]
```

```
clear ipv6 ospf [<process ID>]
```

Cisco IOS OSPFv3 Specific Attributes

- **Configuring area range**

```
[no] area <area ID> range <prefix>/<prefix length>
```

- **Showing new LSA**

```
show ipv6 ospf [<process ID>] database link
```

```
show ipv6 ospf [<process ID>] database prefix
```

- **Configuring authentication**

Under ipv6 router ospf:

```
area 0 authentication ipsec spi 256 md5 cisco
```

Under interface:

```
ipv6 ospf authentication ipsec spi 256 md5 cisco
```

OSPFv3 Debug Commands

- **Adjacency is not appearing**

```
[no] debug ipv6 ospf adj
```

```
[no] debug ipv6 ospf hello
```

- **SPF is running constantly**

```
[no] debug ipv6 ospf spf
```

```
[no] debug ipv6 ospf flooding
```

```
[no] debug ipv6 ospf events
```

```
[no] debug ipv6 ospf lsa-generation
```

```
[no] debug ipv6 ospf database-timer
```

- **General purpose**

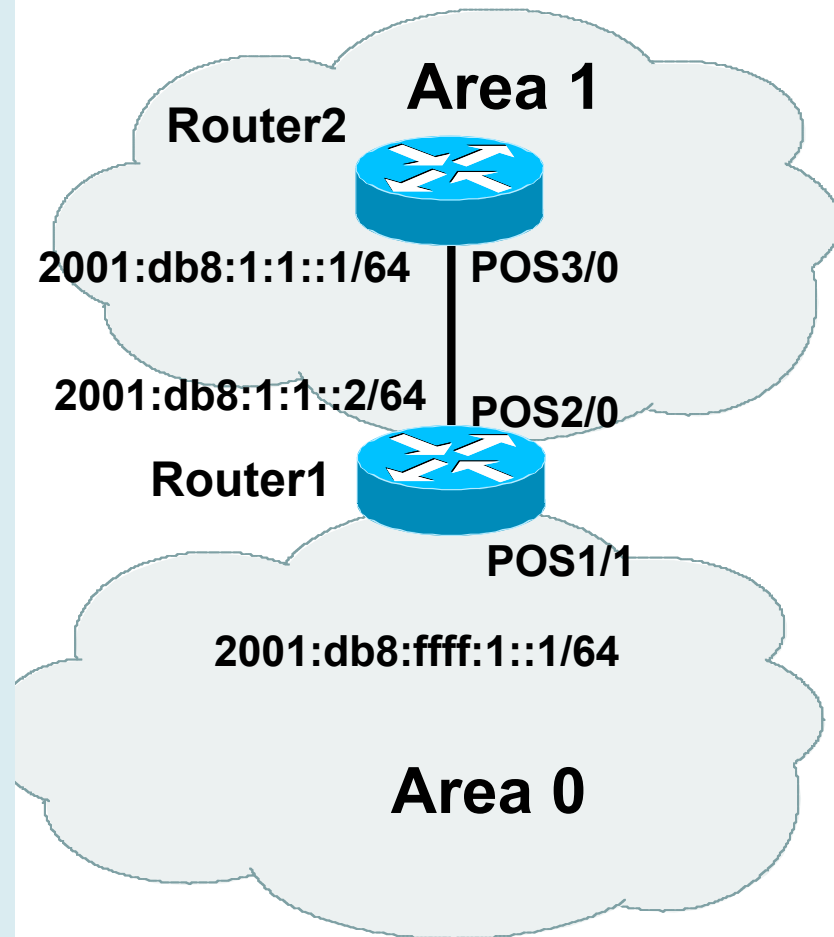
```
[no] debug ipv6 ospf packets
```

```
[no] debug ipv6 ospf retransmission
```

```
[no] debug ipv6 ospf tree
```

OSPFv3 Configuration Example

```
Router1#  
interface POS1/1  
  ipv6 address 2001:db8:FFFF:1::1/64  
  ipv6 enable  
  ipv6 ospf 100 area 0  
  
interface POS2/0  
  ipv6 address 2001:db8:1:1::2/64  
  ipv6 enable  
  ipv6 ospf 100 area 1  
  
ipv6 router ospf 100  
  router-id 10.1.1.3  
  
Router2#  
interface POS3/0  
  ipv6 address 2001:db8:1:1::1/64  
  ipv6 enable  
  ipv6 ospf 100 area 1  
  
ipv6 router ospf 100  
  router-id 10.1.1.4
```



Enhanced Routing Protocol Support Cisco IOS OSPFv3

```
Router2#sh ipv6 ospf int pos 3/0
POS3/0 is up, line protocol is up
  Link Local Address FE80::290:86FF:FE5D:A000, Interface ID 7
  Area 1, Process ID 100, Instance ID 0, Router ID 10.1.1.4
  Network Type POINT_TO_POINT, Cost: 1
  Transmit Delay is 1 sec, State POINT_TO_POINT,
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:02
  Index 1/1/1, flood queue length 0
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 3, maximum is 3
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 10.1.1.3
  Suppress hello for 0 neighbor(s)
```

Enhanced Routing Protocol Support Cisco IOS OSPFv3

```
Router2#sh ipv6 ospf neighbor detail
Neighbor 10.1.1.3
  In the area 1 via interface POS3/0
  Neighbor: interface-id 8, link-local address FE80::2D0:FFFF:FE60:DFFF
  Neighbor priority is 1, State is FULL, 12 state changes
  Options is 0x630C34B9
  Dead timer due in 00:00:33
  Neighbor is up for 00:49:32
  Index 1/1/1, retransmission queue length 0, number of retransmission 1
  First 0x0(0)/0x0(0)/0x0(0) Next 0x0(0)/0x0(0)/0x0(0)
  Last retransmission scan length is 2, maximum is 2
  Last retransmission scan time is 0 msec, maximum is 0 msec
```

Enhanced Routing Protocol Support Cisco IOS OSPFv3

```
Router2#sh ipv6 route
IPv6 Routing Table - 5 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       U - Per-user Static route
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
OI  2001:db8:FFFF:1::/64 [110/2]
     via FE80::2D0:FFFF:FE60:DFFF, POS3/0
C   2001:db8:1:1::/64 [0/0]
     via ::, POS3/0
L   2001:db8:1:1::1/128 [0/0]
     via ::, POS3/0
L   FE80::/10 [0/0]
     via ::, Null0
L   FF00::/8 [0/0]
     via ::, Null0
```

Cisco IOS OSPFv3 Database Display

```
Router2# show ipv6 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
0	1.1.1.1	2009	0x8000000A	0x2DB1	1
0	3.3.3.3	501	0x80000007	0xF3E6	1

```
Net Link States (Area 0)
```

Link ID	ADV Router	Age	Seq#	Checksum
7	1.1.1.1	480	0x80000006	0x3BAD

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

ADV Router	Age	Seq#	Prefix
1.1.1.1	1761	0x80000005	2001:db8:2:2::/64
1.1.1.1	982	0x80000005	2001:db8:2:4::2/128

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

Link ID	ADV Router	Age	Seq#	Checksum	Interface
11	3.3.3.3	245	0x80000006	0xF3DC	Lo0
7	1.1.1.1	236	0x80000008	0x68F	Fa2/0
7	3.3.3.3	501	0x80000008	0xE7BC	Fa2/0

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

Link ID	ADV Router	Age	Seq#	Checksum	Ref lstype
0	1.1.1.1	480	0x80000008	0xD670	0x2001
107	1.1.1.1	236	0x80000008	0xC05F	0x2002
0	3.3.3.3	245	0x80000006	0x3FF7	0x2001

Cisco IOS OSPFv3 Detailed LSA Display

```
show ipv6 ospf 1 database inter-area prefix
```

```
LS age: 1714  
LS Type: Inter Area Prefix Links  
Link State ID: 0  
Advertising Router: 1.1.1.1  
LS Seq Number: 80000006  
Checksum: 0x25A0  
Length: 36  
Metric: 1  
Prefix Address: 2001:db8:2:2::  
Prefix Length: 64, Options: None
```

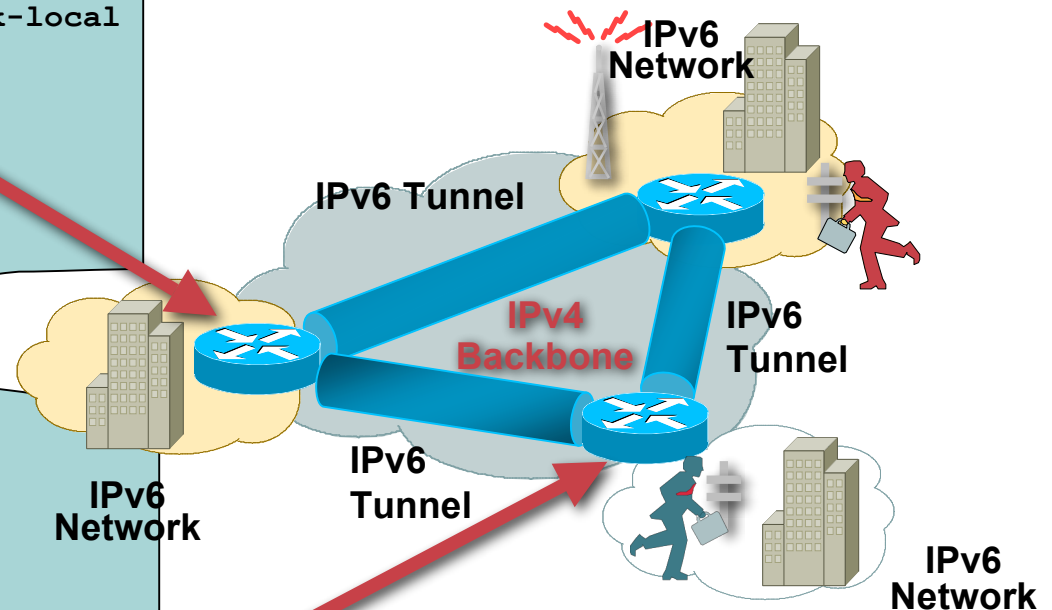
```
show ipv6 ospf 1 database link
```

```
LS age: 283  
Options: (IPv6 Router, Transit Router, E-Bit, No Type 7-to-5, DC)  
LS Type: Link-LSA (Interface: Loopback0)  
Link State ID: 11 (Interface ID)  
Advertising Router: 3.3.3.3  
LS Seq Number: 80000007  
Checksum: 0xF1DD  
Length: 60  
Router Priority: 1  
Link Local Address: FE80::205:5FFF:FEAC:1808  
Number of Prefixes: 2  
Prefix Address: 2001:db8:1:3::  
Prefix Length: 64, Options: None  
Prefix Address: 2001:db8:1:3::  
Prefix Length: 64, Options: None
```

OSPFv3 on IPv6 Tunnels over IPv4

```
interface Tunnel0
  no ip address
  ipv6 address 2001:db8::45A/64
  ipv6 address FE80::10:7BC2:ACC9:10 link-local
  ipv6 router ospf 1 area 0
  tunnel source Ethernet1
  tunnel destination 10.42.2.1
  tunnel mode ipv6ip
  !
  ipv6 router ospf 1
```

```
interface Tunnel0
  no ip address
  ipv6 address 2001:db8::45C/64
  ipv6 address FE80::10:7BC2:B280:11 link-local
  ipv6 router ospf 1 area 0
  tunnel source Ethernet2
  tunnel destination 10.42.1.1
  tunnel mode ipv6ip
  !
  ipv6 router ospf 1
```



Conclusion

- **Based on existing OSPFv2 implementation**
- **Similar CLI and functionality**
- **Cisco IOS Software availability:**

Release 12.2(15)T and 12.3 onwards

Release 12.2(18)S for Cisco 7000 Series Routers and Cisco Catalyst 6000 Series Switches

Release 12.0(24)S the Cisco 12000 Series Internet Routers

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