



# OSPF for IPv6

ISP/IXP Workshops

## Recap: 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 runs on a 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 <b>NEW</b>	9	0x2009

# Configuring OSPFv3 in Cisco IOS

- Similar to OSPFv2
  - Prefixing existing Interface and Exec mode commands with **“ipv6”**
- Interfaces configured directly
  - Replaces **network** command
  - (Also available in OSPFv2 from IOS 12.4)
- “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 <passwd>
```

Under interface:

```
ipv6 ospf authentication ipsec spi 256 md5 <passwd>
```

# 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
```

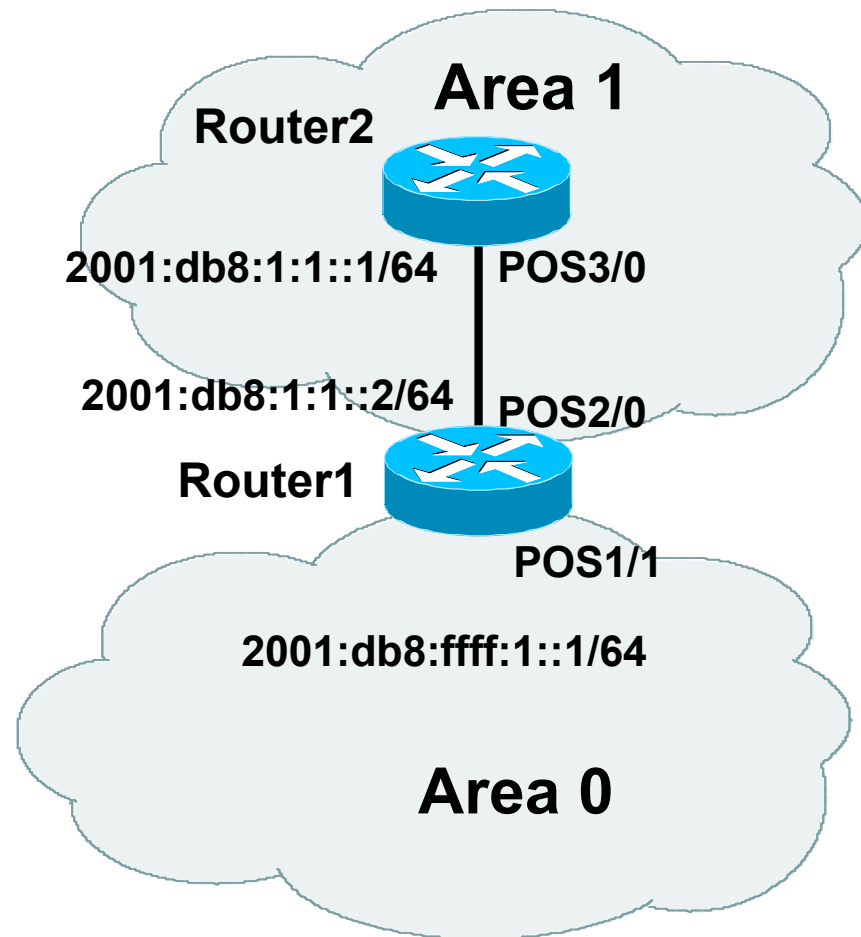
```
[no] debug ipv6 ospf retransmission
```

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

# OSPFv3 Configuration Example

```
Router1#
interface POS1/1
  ipv6 address 2001:db8:FFFF:1::1/64
  ipv6 ospf 100 area 0
!
interface POS2/0
  ipv6 address 2001:db8:1:1::2/64
  ipv6 ospf 100 area 1
!
  ipv6 router ospf 100
    log-adjacency-changes
!

Router2#
interface POS3/0
  ipv6 address 2001:db8:1:1::1/64
  ipv6 ospf 100 area 1
!
  ipv6 router ospf 100
    log-adjacency-changes
```



# OSPFv3 Interface Status

```
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)
```

# OSPFv3 Neighbour Status

```
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
```

# OSPFv3 entries in Routing Table

```
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
```

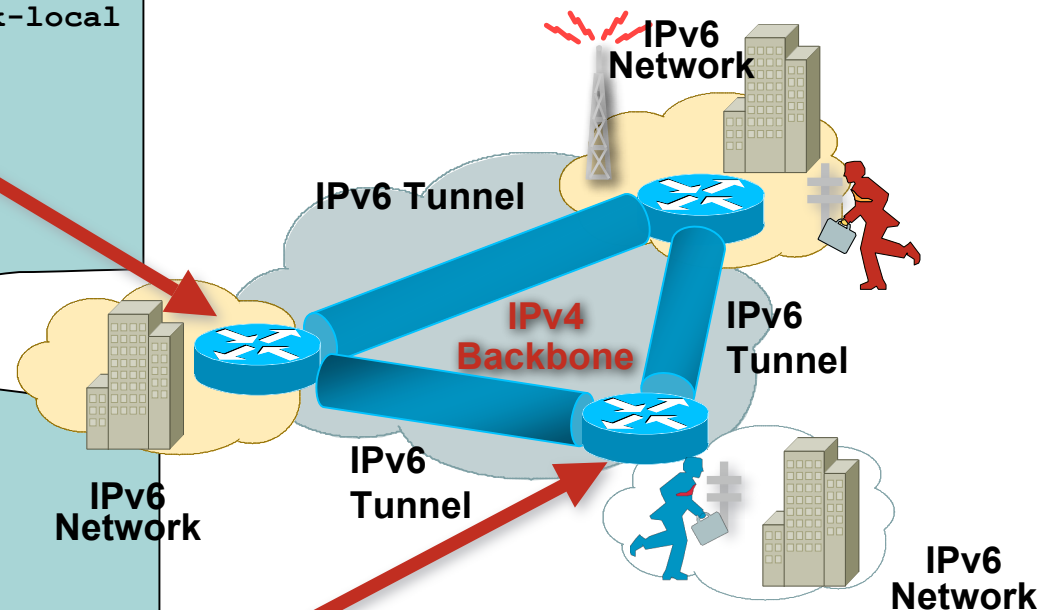
```
show ipv6 ospf 1 database link
```

```
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:db8:1::1/64
  ipv6 address FE80::10:7BC2:ACC9:10 link-local
  ipv6 router ospf 1 area 0
  tunnel source 10.42.1.1
  tunnel destination 10.42.2.1
  tunnel mode ipv6ip
  !
  ipv6 router ospf 1
```

```
interface Tunnel0
  no ip address
  ipv6 address 2001:db8:1::2/64
  ipv6 address FE80::10:7BC2:B280:11 link-local
  ipv6 router ospf 1 area 0
  tunnel source 10.42.2.1
  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 Routers



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