

# OSPF for IPv6



ISP Training Workshops

# Recap: OSPFv2

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- ❑ 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

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- ❑ OSPF for IPv6
- ❑ Based on OSPFv2, with enhancements
- ❑ Distributes IPv6 unicast prefixes
- ❑ Runs directly over IPv6
- ❑ Ships-in-the-night with OSPFv2
- ❑ OSPFv3 does **not** carry IPv4 prefixes
  - RFC5838 proposes an extension which adds address family support

# OSPFv3 / OSPFv2 Similarities

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- 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

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## 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.)

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### 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 address families (RFC5838)

## V2, V3 Differences (Cont.)

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### 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.)

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### Generalisation 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.)

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### 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.)

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### Authentication is Removed from OSPF

- ❑ Authentication in OSPFv3 has been removed
- ❑ OSPFv3 relies now on the 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.)

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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.)

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### Two New LSAs Have Been Introduced

- ❑ Link-LSA has a link local flooding scope and has three purposes:
  - The router link local address
  - List all IPv6 prefixes attached to the link
  - Assert a collection of option bit for the Router-LSA
- ❑ Intra-area-prefix-LSA
  - Used to advertise router's IPv6 address within the area

# Inter-Area Prefix LSA

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- ❑ 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

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|                                      | 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 <sup>NEW</sup> | 9                 | 0x2009   |

# Configuring OSPFv3 in Cisco IOS

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- ❑ 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**

# Configuring OSPFv3

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- ❑ Setting up the OSPFv3 process:  
`[no] ipv6 router ospf <process ID>`
- ❑ Applying the OSPFv3 process to an interface:  
`interface <router-int-name>`  
`[no] ipv6 ospf <process ID> area <area ID>`
- ❑ Configuring summarisation:  
`ipv6 router ospf <process ID>`  
`[no] area <area ID> range <prefix>/<length>`



# OSPFv3 exec mode commands

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- ❑ Exec mode commands:

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

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

- ❑ Showing new LSA:

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

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

# OSPFv3 Authentication

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- ❑ Configuring authentication per area:

- SPI value has to be unique per area:

```
ipv6 router ospf <process ID>
```

```
area 0 authentication ipsec spi 256 md5 <passwd>
```

- ❑ Disabling authentication on a specific link when area authentication is activated:

```
interface fastethernet 0/0
```

```
ipv6 ospf authentication null
```

- ❑ Configuring authentication per interface:

- SPI value has to be unique per link:

```
interface fastethernet 0/0
```

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

# OSPFv3 Debug Commands

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- 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

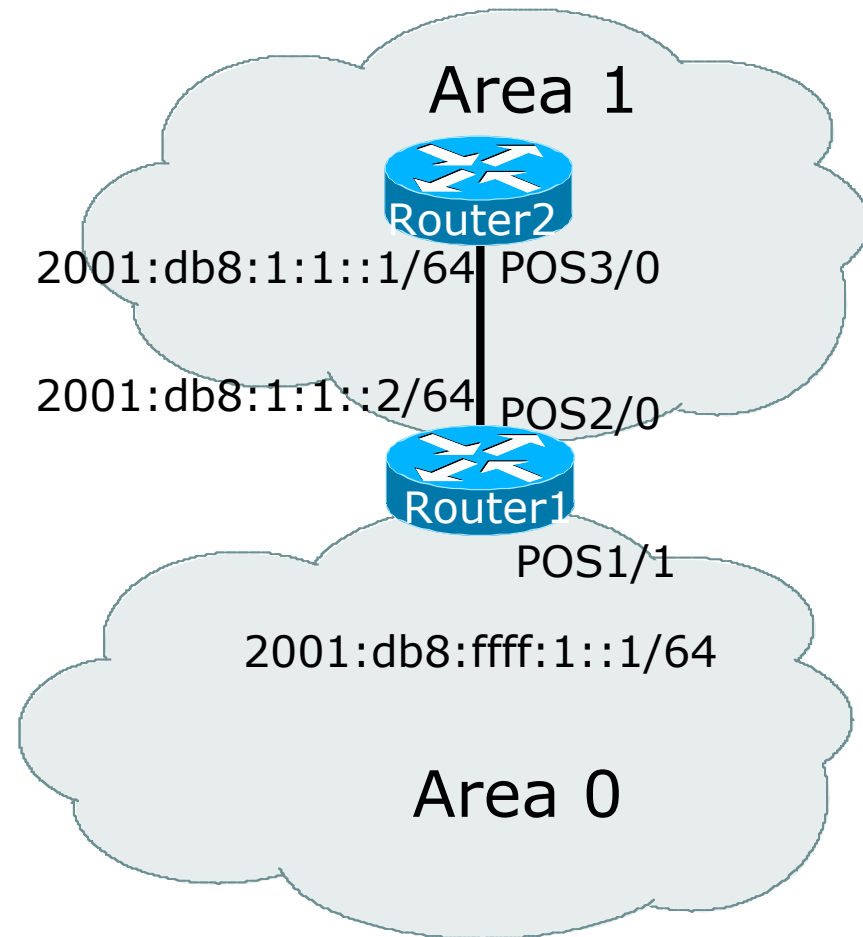
  - `[no] debug ipv6 ospf packets`

  - `[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

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```
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

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```
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

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```
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
```

# OSPFv3 link troubleshooting

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- ❑ Next router address in OSPFv3 is a link-local address

```
OI 2001:db8:FFFF:1::/64 [110/2]  
   via FE80::2D0:FFFF:FE60:DFFF, POS3/0
```

- ❑ How to troubleshoot??
  - SSH to neighbouring router needs extended SSH command, for example:  
`ssh FE80::2D0:FFFF:FE60:DFFF /source-int POS3/0`
  - Source interface has to be specified – a router with multiple interfaces has no idea which interface the remote link local address is attached to



# 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
```

# Conclusion

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- ❑ Based on existing OSPFv2 implementation
- ❑ Similar CLI and functionality

# OSPF for IPv6



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