

# 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 DVRRPs
- ⌘ Relatively low, steady state bandwidth requirements

# OSPFv3 overview

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

# OSPFv3 / OSPFv2 Similarities

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

- p Authentication in OSPFv3 has been removed
- p OSPFv3 relies now on the IPv6 authentication header since OSPFv3 run over IPv6
- p 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

- p 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
- p 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	9	0x2009

NEW

# Configuring OSPFv3 in Cisco IOS

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- p Similar to OSPFv2
  - Prefixing existing Interface and Exec mode commands with `"ipv6"`
- p Interfaces configured directly
  - Replaces `network` command
  - (Also available in OSPFv2 from IOS 12.4)
- p "Native" IPv6 router mode
  - Not a sub-mode of `router ospf`

# Configuring OSPFv3

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



# OSPFv3 exec mode commands

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p Exec mode commands:

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

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

p Showing new LSA:

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

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

# OSPFv3 Authentication

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p 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>
```

p Disabling authentication on a specific link when area authentication is activated:

```
interface fastethernet 0/0
```

```
ipv6 ospf authentication null
```

p 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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p Adjacency is not appearing

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

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

p 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
```

p General purpose

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

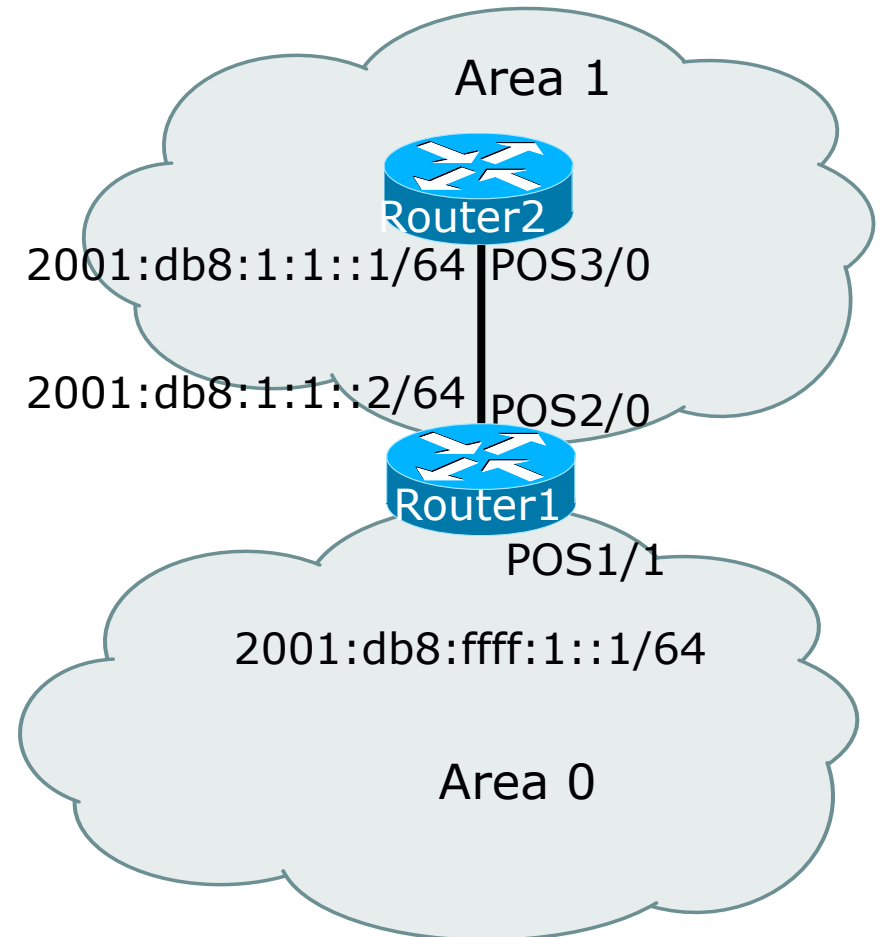
```
[no] debug ipv6 ospf retransmission
```

```
[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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- p 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
```

- p 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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