

OSPF for IPv6

ISP Workshops



These materials are licensed under the Creative Commons Attribution-NonCommercial 4.0 International license (<http://creativecommons.org/licenses/by-nc/4.0/>)

Acknowledgements

- ❑ This material originated from the Cisco ISP/IXP Workshop Programme developed by Philip Smith & Barry Greene
- ❑ Use of these materials is encouraged as long as the source is fully acknowledged and this notice remains in place
- ❑ Bug fixes and improvements are welcomed
 - Please email *workshop (at) bgp4all.com*

Philip Smith

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 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

- 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

OSPFv3 / OSPFv2 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

OSPF_{v3} / OSPF_{v2} Differences

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)

OSPF_{v3} / OSPF_{v2} Differences

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

OSPFv3 / OSPFv2 Differences

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

OSPF_{v3} / OSPF_{v2} Differences

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

OSPFv3 / OSPFv2 Differences

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

OSPF_{v3} / OSPF_{v2} Differences

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

OSPFv3 / OSPFv2 Differences

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

- ❑ 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
Deprecated	6	0x2006
NSSA-LSA	7	0x2007
Link-LSA	8	0x0008
Intra-Area-Prefix-LSA	9	0x2009

NEW LSAs

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`

Configuring OSPFv3

- ❑ 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

- ❑ 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

- ❑ 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

- 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`

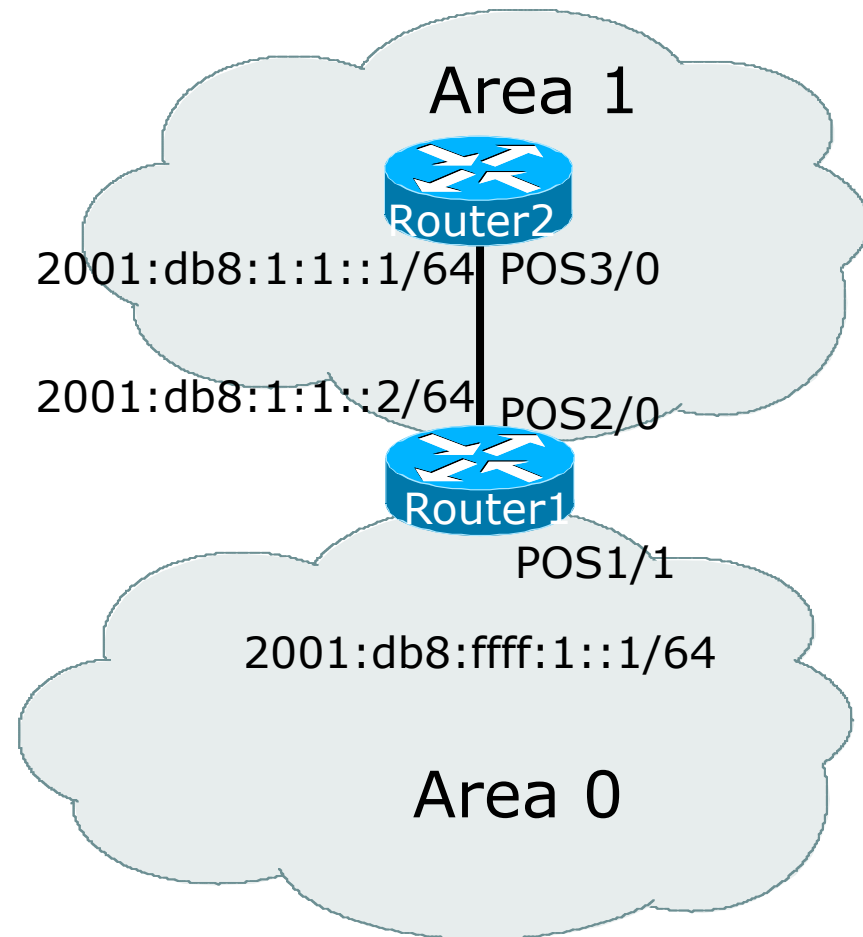
 - `[no] debug ipv6 ospf retransmission`

 - `[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
```


OSPFv3 link troubleshooting

- ❑ 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

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

OSPF for IPv6



ISP Workshops